4.5 FLORA

A total of 142 flora species were recorded across the vegetation types present throughout the study area. Of these, 86 were native species, 55 were exotic species and one *Digitaria* species could not be identified to species level and therefore it could not be confirmed if this species was native or exotic. In addition, some natives were either planted endemics or native species occurring outside their natural range. A list of those species recorded during the survey is included in Appendix B. It is unlikely that this is a comprehensive list of all species present within the study area but would capture the species diversity and dominant species within each of the communities.

Much of the study area has undergone past vegetation clearance with the most consolidated stand of vegetation present in the south-east of the site, along Duck Creek and in the north-east.

One threatened species (*Chorizema parviflorum*) listed as an endangered population in the Wollongong and Shellharbour Local Government Area on the TSC Act was identified as occurring within the study area. This species was observed on the western boundary of the site (Figure 12) south of Duck Creek in an area proposed for an environmental reserve. No threatened species listed under the EPBC Acts were identified.

4.5.1 Regionally significant species

A list of regionally significant species for the area has been compiled within the Illawarra Biodiversity Strategy by Wollongong Council (2010). No species listed as regionally significant was observed in flora surveys across the site undertaken for this study.

4.5.2 Noxious weeds

A total of 55 exotic flora species were recorded across the site (Appendix B). Nine weeds listed as noxious in the Wollongong LGA (NSW DPI 2010) under the *Noxious Weeds Act 1993* were recorded within the study area and have been listed below in Table 8 together with their control class. Six Weeds of National Significance (DEWHA 2010b) were also recorded. Given the highly disturbed nature of the site, there is the potential for others to occur across the study area but that were not detected during this study.

Table 8: Noxious weeds recorded within the study area

Scientific Name	Common Name	NW Act Class	Weeds of National Significance
Asparagus asparagoides	Bridal creeper	5	x
Alternanthera philoxeroides	Alligator Weed	2	x
Chrysanthemoides monilifera rotunda	Bitou Bush	4	x
Eragrostis curvula	African Lovegrass	4	
Lantana sp.	Lantana	4	x

Scientific Name	Common Name	NW Act Class	Weeds of National Significance
Lycium ferocissimum	African Boxthorn	4	
Opuntia sp.	Prickly pear	4	
Pennisetum setaceum	Fountain Grass	5	x
Rubus fruticosus aggregate species	Blackberry	4	x
Salix sp.	Willows	5	x

Note:

Class 2 = Under the NSW *Noxious Weeds Act 1993*, the presence of a Class 2 weed must be notified to the Local Control Authority and the weed must be fully and continuously suppressed and destroyed

Class 4 = The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority.

Class 5 = The requirements in the *Noxious Weeds Act 1993* for a notifiable weed must be complied with.

4.5.3 Threatened Flora

One threatened species (*Chorizema parviflorum*) listed as an endangered population in the Wollongong and Shellharbour Local Government Area on the TSC Act was identified as occurring within the study area. This species was observed on the western boundary of the site (Figure 12) south of Duck Creek in an area proposed for an environmental reserve.

No other threatened flora species have been recorded at the site either during current or any of the previous surveys, although potential habitat is present for a number of species that have been recorded within the locality (DECCW 2010a, DEWHA 2010a). Table 9 lists those species for which potential habitat is present and the vegetation type supporting this habitat. Areas of potential habitat for threatened flora have been mapped across the study area and are shown in Figure 12.

Table 9: Threatened flora with the potential to occur within the study area

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Vegetation Community*						
				LDSR	CGRGF	MBRGFF	LWMF	ASMF	CSOF	EP
Caladenia tessellata	Thick-lipped Spider-orchid	V	V		✓		✓			
Chorizema parviflorum	*Chorizema parviflorum* population in the Wollongong LGA	EP					✓			
Cryptostylis hunteriana	Leafless Tongue-orchid	V	V		✓	✓	✓	✓		
Cynanchum elegans	White-flowered Wax Plant	E	E	✓	✓		✓	✓		
Daphnandra sp. C Illawarra	Illawarra Socketwood	E	E	✓	✓					

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Vegetation Community*						
				LDSR	CGRGF	MBRGFF	LWMF	ASMF	CSOF	EP
Haloragis exalata subsp. *exalata* var. *laevis*	Square Raspwort	V	V				✓ - riparian areas		✓	
Lespedeza juncea subsp. *juncea*	*Lespedeza juncea* subsp. *sericea* population in Wollongong LGA	EP			✓ - north east		✓			✓ - areas adjacent Woollybutt Woodland
Melaleuca biconvexa	Biconvex Paperbark	V	V				✓ - limited	✓ - limited		
Pterostylis gibbosa	Illawarra Greenhood	E	E				✓			
Solanum celatum		E		✓						
Thesium australe	Austral Toadflax, Toadflax	V	V		✓ - limited		✓ - limited			

Note: E = Endangered, EP = Endangered Population, V = Vulnerable

TSC Act = *Threatened Species Conservation Act 1995*; EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999*

*Vegetation communities abbreviations shown in Table 7, Section 4

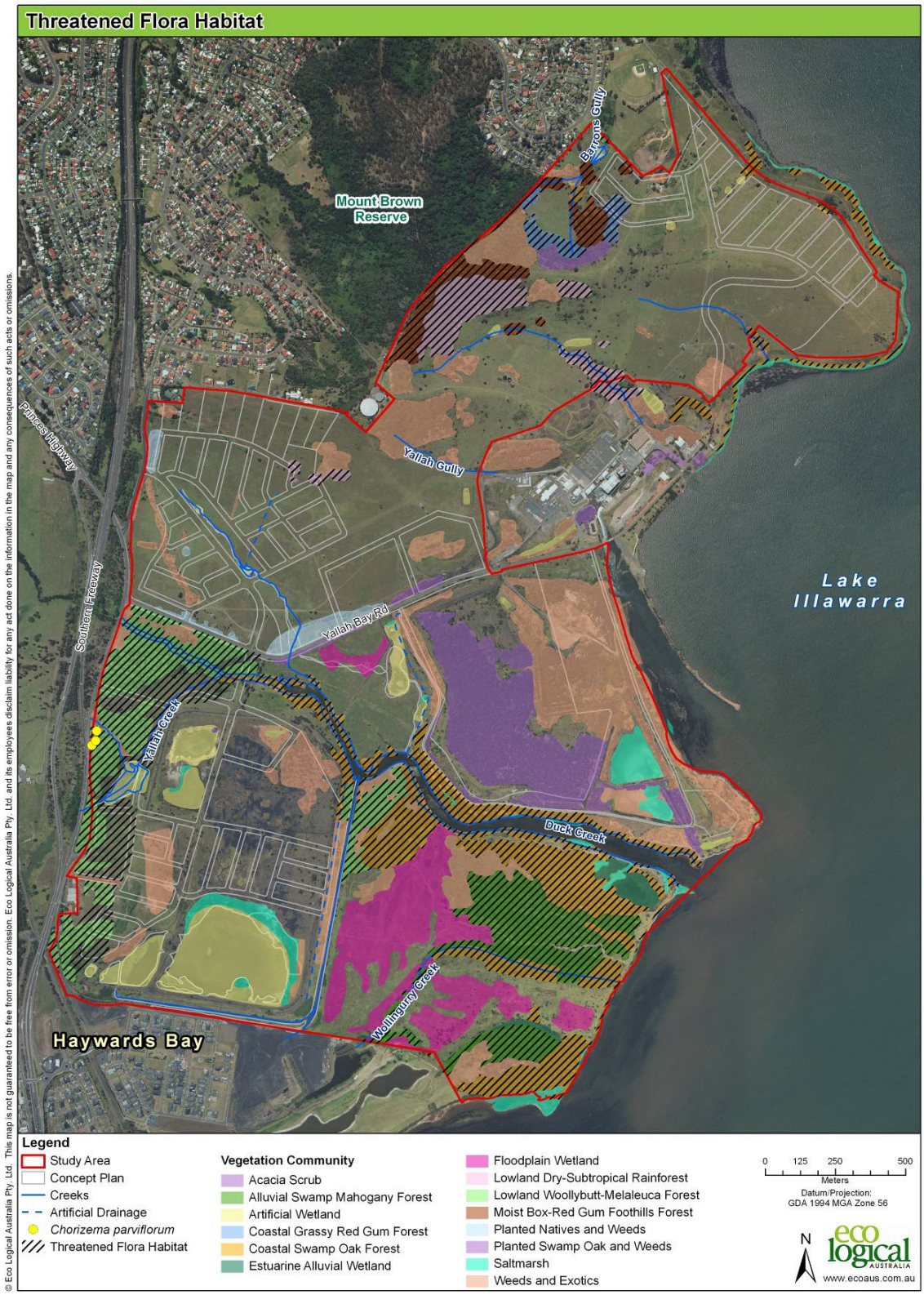

Figure 12: Threatened flora habitat

4.6 FAUNA SPECIES AND HABITAT

Seventy six fauna species were recorded during the field survey, the majority of which were birds (see Appendix A). Five amphibian species were recorded calling during the site inspection and target Green and Golden Bell Frog survey (Table 20) and a She-oak Skink (*Cyclodomorphus casuarinae*) was recorded in a disturbed area dominated by *Chloris gayana* in the central east of the site. Species listed as threatened on the TSC Act or EPBC Act are discussed further in Section 4.7.

Fauna habitat across the site is patchy due to extensive past disturbance and current land use. Duck Creek, the artificial wetlands and the larger stands of vegetation in the south east, along the site boundaries in the west and the north east provide the most valuable potential habitat for a variety of species and in particular a wide variety of bird species, particularly waterbirds.

The overhanging Casuarina branches along the watercourses provide roosting sites for many waterbirds and a variety were seen using this habitat during the surveys. The mud flats and foreshores of Lake Illawarra also provide important habitat for birds as do reeds on the edges of the waterbodies.

Areas of high, moderate and low quality habitat for both waterbirds and the Green and Golden Bell Frog have been mapped across the study area and are shown in Figure 13. Areas identified as providing the greatest habitat value for waterbirds included:

- Duck Creek
- Artificial wetlands in the south-west of the site;
- Lake Illawarra Foreshore;
- SEPP 14 wetland in the east of the study area

A number of large hollow-bearing trees were recorded within the study area and these have been mapped in Figure 13. These trees provide habitat for a variety of birds, mammals (including bats) and reptiles. In addition, those trees that contain hollows large enough to provide potential habitat for owls have been identified. The majority of these trees are likely to be retained within the study area although there is the potential for one known hollow-bearing tree to be removed in the south west of the study area for the lakeside residential precinct. This stag with hollows was surveyed one evening in October (see Section 3.2.8) to note any use of an existing raptor nest and any utilisation of its tree hollows, particularly by micro bats. The raptor nest was observed to being utilised at the time by a juvenile Whistling Kite and whilst this species is not TSC or EPBC listed it is recommended that any removal of this stag with nest (if required) occurs outside the breeding season for this species which is indicatively between July to January. There were no micro bats observed to be utilising the tree hollows. If this tree is proposed to be removed, relocation of the nest and tree hollows may be a mitigation measure sought.

A summary of the fauna habitat features across the site and their location is included in Table 10.

Table 10: Fauna habitat features

Habitat Feature	Species	Location within study area
Woodland and scattered trees	Birds, microchiropteran bats (microbats), arboreal mammals, reptiles	ASMF, CGRG, CSOF, LDSR, LWMF, MGRGFF, PSOF
Trees with defoliating bark	Microbats, reptiles	ASMF, CGRG, LDSR, LWMF, MGRGFF,
Hollow-bearing trees	Birds, microbats, arboreal mammals, reptiles	ASMF, CSOF, CGRG, LWMF, MBRGFF, WE
Fallen logs and woody debris	Ground-dwelling mammals	ASMF, CGRG, LWMF, MGRGFF
Creek lines and wetlands	Amphibians, microbats, birds.	Duck Creek, Wollingurry Creek, AW, EAW
Mud flats	Waterbirds	Lake Illawarra foreshore, AW in SW
Reedland	Birds, amphibians, reptiles	EAW, AW
Winter flowering Eucalypts	Mammals, bats, birds	ASMF PWE – *Banksia* sp.

Note:

Alluvial Swamp Mahogany Forest (ASMF), Coastal Grassy Red Gum Forest (CGRG), Coastal Swamp Oak Forest (CSOF), Estuarine Alluvial Wetland (EAW), Saltmarsh (SM), Floodplain Wetland (FW), Lowland Dry – Subtropical Rainforest (LDSR), Lowland Woollybutt – Melaleuca Forest (LWMF), Moist Box – Red Gum Foothills Forest (MGRGFF), Planted Swamp Oak and Weeds (PSOF), Artificial Wetland (AW), Acacia Scrub (AS), Planted Native, Weeds and Exotics (PWE), Weeds and Exotics (WE), Exotic Pasture (EP).

4.6.1 Aquatic Habitat

A literature review was undertaken to review potential ecological impacts to aquatic environments both on and off site. A detailed aquatic assessment was outside the scope of works for the ecological assessment however detailed saltmarsh mapping was undertaken for this study and ELA (2010a).

King *et al*. (1997) identified that extensive subdivision since the 1970's around the shores of Lake Illawarra has increased the nutrient load with the waters occasionally becoming eutrophic because of the occurrence of macroalgal blooms. Therefore it will be a requirement that all stormwater and sewer infrastructure will need to be constructed to perform at a high environmental standard, with the aim being for no increase in nutrient loads received by Lake Illawarra.

Lake Illawarra Authority (2009) identified seagrass within Lake Illawarra (Figure 14). Aurecon (2009) has undertaken more recent mapping of the area and distribution of seagrass in Lake Illawarra (Figure 15), with detailed analysis south of Wollingurry Point (near the Duck Creek outlet), and found that the Zostera area in the southwest of the lake consistently increased from 1987 to 2007, but decreased in 2008 and 2009. Thus, seagrass abundance and distribution within Lake Illawarra is subject to significant yearly fluctuations, but the presence of large seagrass beds in close proximity to Duck Creek, and smaller beds in proximity to other portions of the Tallawarra study area further reinforce the need for a high standard of stormwater treatment.

Figure 13: Key fauna habitat (with GGBF survey locations)

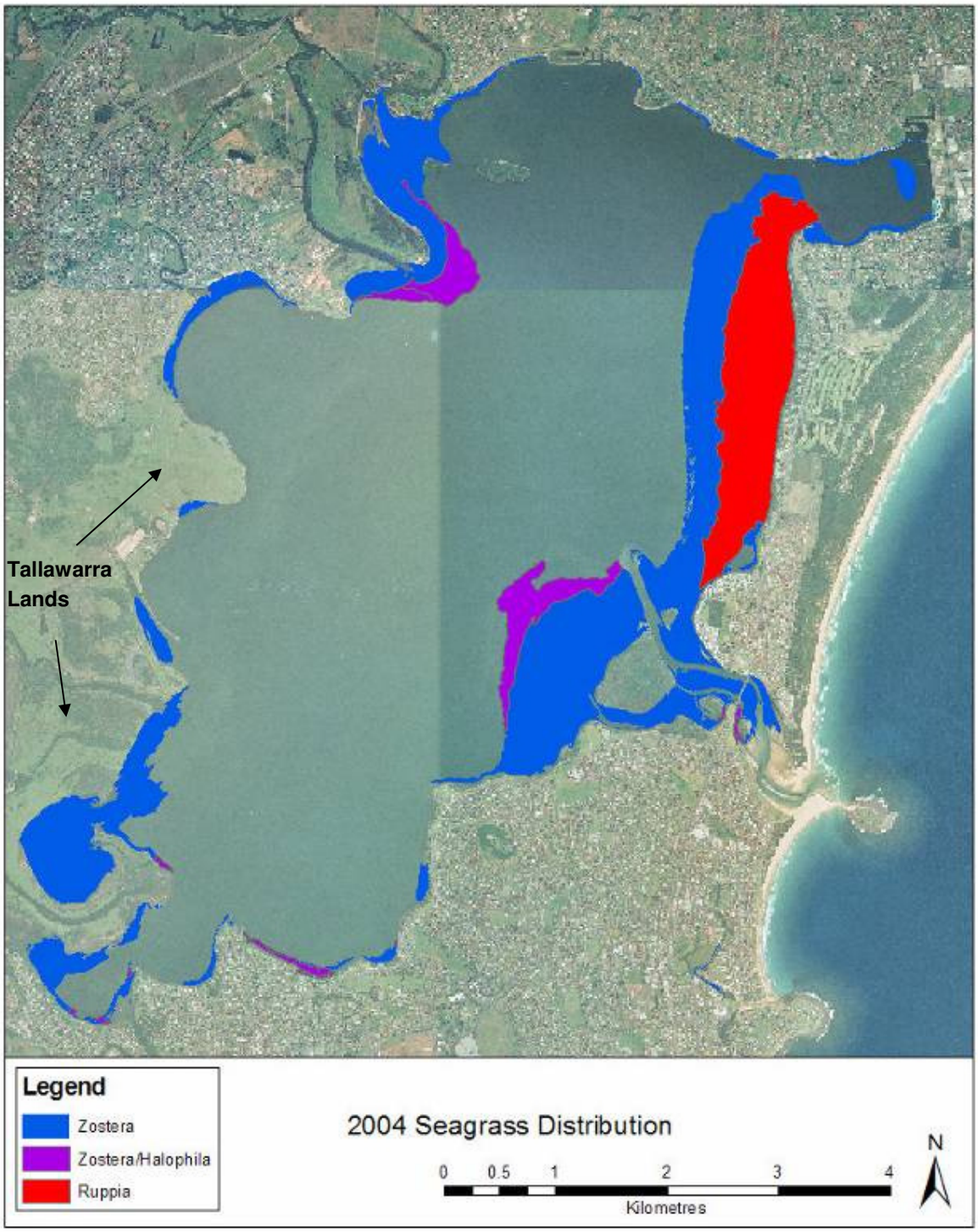

Figure 14: 2004 mapping of seagrass in Lake Illawarra (from Lake Illawarra Authority 2009)

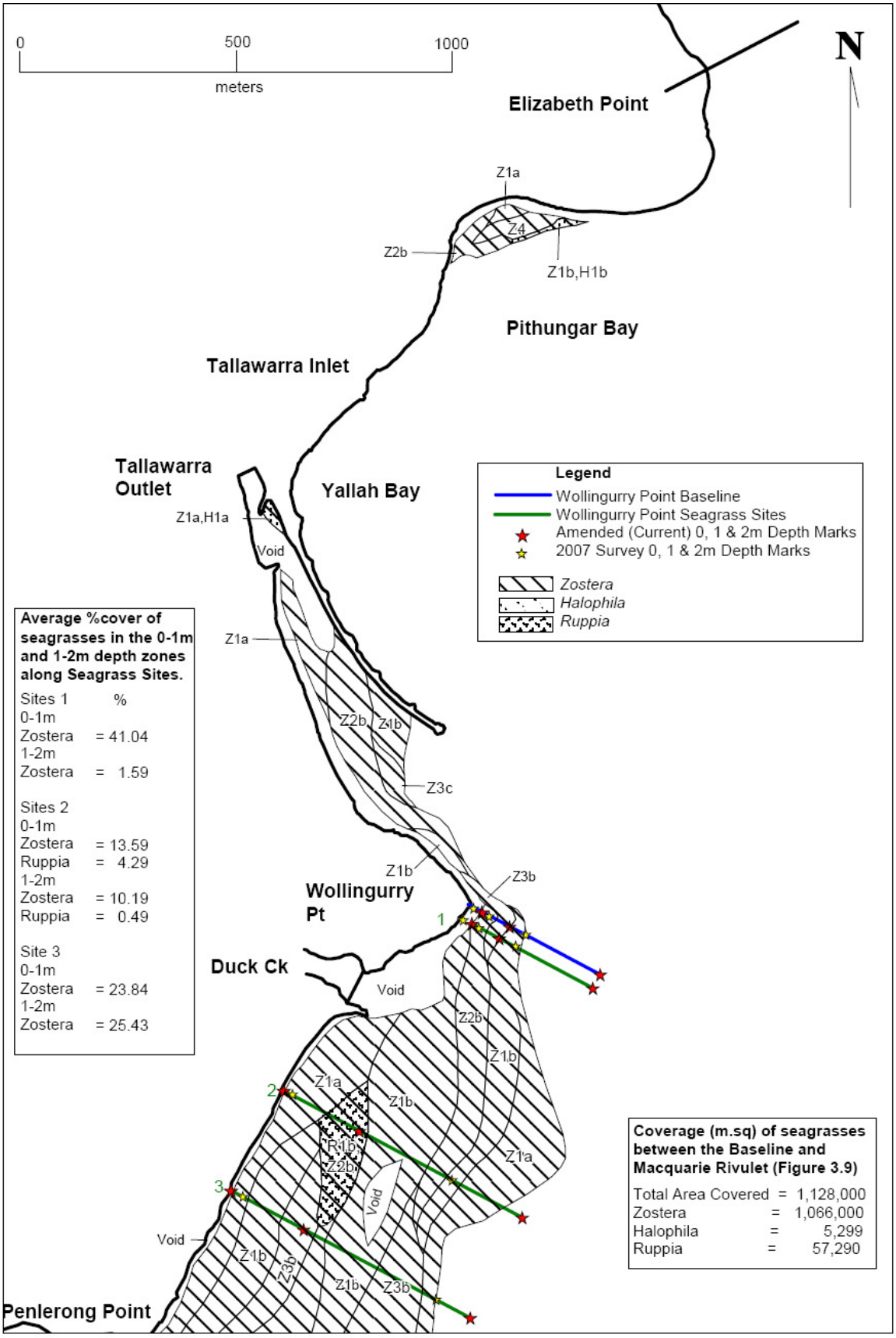

Figure 15: Areas of seagrass species for Summer 2008 – 2009 (source: Aurecon 2009)

4.7 THREATENED FAUNA

A number of threatened fauna species have been recorded within the study area (DECCW 2010, Burcher 1997, Brandis 2010, Turton 1996, Richards 1997a, Richards 1997a, URS 2006). These are listed in Table 11. Based on database or other records, the presence or absence of suitable habitat, features of the study area, results of the field survey and professional judgement, an assessment of the likelihood that those threatened species identified from the database searches as occurring within the locality (10 km radius) or considered to have the potential to occur within the locality would utilise the site. Those species for which the site is likely to provide habitat and their conservation status are listed below in Table 11. Threatened species or species groups of relevance to the site are discussed in following sections.

A number of species listed as migratory under the EPBC Act, were recorded flying over or adjacent to the study area over Lake Illawarra (see Section 4.7). A number of others have also been recorded within the study area during past surveys (Mills & Associates 1997, Brandis 2010 and 2010, Burcher 1997). Migratory species are further discussed in Section 4.8.

Table 11: Threatened fauna known or that have the potential to occur within the study area

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Likelihood of Occurrence
AMPHIBIANS				
Litoria aurea	Green and Golden Bell Frog	E	V	Potential but unlikely
BIRDS – Diurnal				
Botaurus poiciloptilus	Australasian Bittern	V	-	Potential
Calidris alba	Sanderling	V	M	Potential
Calidris tenuirostris	Great Knot	V	M	Potential
Charadrius leschenaultii	Greater Sand-plover	V	M	Potential
Charadrius mongolus	Lesser Sand-plover	V	M	Potential
Circus assimilis	**Spotted Harrier**	**V**	-	**Recorded**
Ephippiorhynchus asiaticus	Black-necked Stork	E	-	Potential
Haematopus fuliginosus	**Sooty Oystercatcher**	**V**	**-**	**Recorded – onsite 2010**
Haematopus longirostris	**Pied Oystercatcher**	**V**	**-**	**Recorded – onsite previously & 2010**
Hieraaetus morphnoides	**Little Eagle**	**V**		**Recorded**
Ixobrychus flavicollis	**Black Bittern**	**V**	**-**	**Recorded**
Lathamus discolor	Swift Parrot	E	E	Potential
Limicola falcinellus	Broad-billed Sandpiper	V	M	Potential
Limosa limosa	Black-tailed Godwit	V	M	Potential
Lophoictinia isura	Square-tailed Kite	V	M	Potential
Neophema pulchella	Turquoise Parrot	V	-	Potential
Oxyura australis	Blue-billed Duck	V	-	Potential
Pandion haliaetus	**Osprey**	**V**	**M**	**Recorded**
Petroica boodang	**Scarlet Robin**	**V**	**-**	**Recorded**
Petroica rodinogaster	Pink Robin	V	-	Potential
Rostratula benghalensis australis	Painted Snipe (Australian subspecies)	E	E	Potential
Sterna albifrons	Little Tern	E	M	Potential

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Likelihood of Occurrence
Sterna fuscata	Sooty Tern	V	-	Potential
Stictonetta naevosa	**Freckled Duck**	**V**	**-**	**Recorded**
Thinornis rubricollis	Hooded Plover	E	M	Potential
Xanthomyza phrygia	Regent Honeyeater	E	E, M	Potential
Xenus cinereus	Terek Sandpiper	V	M	Potential
BIRDS - Nocturnal				
Ninox connivens	Barking Owl	V	-	Potential
Ninox strenua	Powerful Owl	V	-	Potential
Tyto novaehollandiae	Masked Owl	V	-	Potential
MAMMALS (BATS)				
Chalinolobus dwyeri	**Large-eared Pied Bat**	**V**	**V**	**Recorded**
Falsistrellus tasmaniensis	***Eastern False Pipistrelle***	***V***	**-**	***Recorded – onsite 2010***
Miniopterus australis	**Little Bentwing-bat**	**V**	**-**	**Recorded – onsite 2010**
Miniopterus schreibersii oceanensis	**Eastern Bent-wing Bat**	**V**	**-**	**Recorded – onsite previously & 2010**
Mormopterus norfolkensis	**Eastern Freetail Bat**	**V**	**-**	**Recorded – onsite 2010**
Myotis macropus	**Large-footed Myotis**	**V**	**-**	**Recorded – onsite previously & 2010**
Pteropus poliocephalus	**Grey-headed Flying-Fox**	**V**	**V**	**Recorded**
Saccolaimus flaviventris	**Yellow-bellied Sheathtail-bat**	**V**	**-**	**Recorded**
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	Potential
Species recorded onsite during ELA 2010 survey				

Bold = Threatened species: V = Vulnerable, E = Endangered, M = Migratory

4.7.1 Threatened Bats

Five threatened bat species were recorded at the site during the surveys including three which had not been previously recorded within the locality based on the database searches (DECCW 2010a) and past studies. These included:

- Eastern Freetail Bat (*Mormopterus norfolkensis*)
- Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)
- Eastern False Pipistrelle *(Falsistrellus tasmaniensis)*
- Little Bentwing-bat (*Miniopterus australis*)
- Large-footed Myotis (*Myotis macropus*)

Habitat for threatened bats is present across the study area in the form of woodland and waterbodies for foraging and bridges, culverts and hollow-bearing trees for roosting. An inspection of the culvert beneath Yallah Road, the bridge over Duck Creek and other culverts across the study area was undertaken during the site inspections however no roosting bats were observed.

Large-footed Myotis

A number of previous studies have been undertaken throughout the study area including anabat detection and harp trapping and have detected a number of threatened bat species. Richards (1997a) captured a mix of Large- footed Myotis adults (primarily females) and sub adults within the study area along Duck Creek in the west of the site and therefore concluded that this indicated that a breeding colony is present in the vicinity of the capture site (headwaters of Duck Creek, within remnant woodland). Some of the Large-footed Myotis individuals were released at the breakwater near the power station to see which direction they would fly in. Most flew downstream along Duck Creek but others roosted under the adjacent road bridge. However, this area was inspected later and no individuals were recorded. Therefore it was assumed that the site was likely to be used as a temporary roost for released individuals (Richards 1997a).

However, additional surveys were conducted by Richards (1997b) in May 1997 to verify if the Large-footed Myotis was roosting on site. Three bats (two female and one male) were radio-tagged. Based on the results of the study, it was concluded that this species was not roosting on the site and was roosting in the nearby escarpment (Richards 1997b). It was also noted that Duck Creek appeared to be a favoured foraging site for this species and that preservation of this watercourse should be a priority (Richards 1997b). The current master plan is consistent with this recommendation.

In the surveys undertaken for this study the Large-footed Myotis was recorded frequently at the Duck Creek survey site (113 calls) as well as the Yallah Bay Road site (8 calls), the Swamp Mahogany Woodland in the south east of the site (2 possible calls) and one definite call recorded at the small artificial wetland in the south west of the site. These results indicate that the Duck Creek area remains heavily utilised by this species along with the various waterbodies and possibly bridges, culverts and hollow bearing trees providing other habitat elements.

Eastern Bentwing-bat

The Eastern Bentwing-bat has only been recorded at the site during some surveys. Surveys conducted by Richards 1997a failed to detect this species although it was recorded by Turton (1996). Given this species can be seasonal in its occupation of local environments during its regular movement patterns, it is thought that the inconsistent recording of this species may show the seasonality of the distribution at southern latitudes (Richards 1997a). Furthermore, it was noted that the escarpment to the west may provide suitable natural roosts and the wet sclerophyll vegetation adjacent to the escarpment, particularly in the nearby Macquarie Pass National Park, provides foraging habitat that would be more suitable for this species than the patchily distributed vegetation surrounding the Tallawarra Power Station (1997a).

In the surveys undertaken for this study the Eastern Bentwing-bat was recorded heavily at the Duck Creek site (47 calls), the Yallah Bay Road site (23 calls) as well as four calls within the Swamp Mahogany Woodland in the south east of the site.

Eastern False Pipistrelle

The Eastern False Pipistrelle has not been recorded in previous studies across the subject site although it was known from the locality. Six calls of the Eastern false Pipistrelle were recorded on the subject site during the microbat survey conducted on 18th November at the Duck Creek bridge crossing with another two recorded at the Yallah Bay Road survey site. This species generally occupies moist forest and potential habitat is provided on the site in areas of ASMF, LWMF, CGRGF and MBRGFF.

Little Bentwing-bat

The Little Bentwing-bat was recorded in the surveys for this study at the Barrons Gully Site (13 calls), the Duck Creek Bridge site (5 calls) and three definite calls recorded adjacent to the artificial wetland in the south west of the site. This species has not been recorded onsite during any of the previous surveys and has the potential to forage throughout the woodland vegetation and roost within the hollow-bearing trees, culverts and bridges.

Eastern Freetail Bat

One definite call of the Eastern Freetail Bat was recorded in the south west of the study area at the site adjacent to the artificial wetland along with one possible call at the Barrons Gully site. This species is known to roost in hollows as well as under bark and in man-made structures and forages throughout a variety of vegetation types. Therefore the study area provides extensive areas of potential habitat for this species.

Large-eared Pied-bat

The Large-eared Pied-bat has been recorded north-east of the current power station during previous surveys (DECCW 2010a) although was not recorded during surveys for this study. This species roosts predominantly in caves but is also known to utilise crevices in cliffs, old mine workings and in disused Fairy Martin (*Hirundo ariel*) mud nests. It is more likely to forage across the study area given the absence of cliffs for roosting and that the power station is unlikely to contain cave-like crevices that contain the moisture required for roost sites for this species. Furthermore, this species roosts are strongly associated with sandstone rock.

Yellow-bellied Sheathtail-bat

The Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) has been previously recorded amongst the scrub vegetation on the southern slope of Mt Brown (Richards 1997a). The species was not recorded during surveys completed for this study. This area will not be impacted by the proposal.

Grey-headed Flying-fox

The Grey-headed Flying-fox has also been recorded at the site and is likely to forage widely across the study area and in the broader locality.

4.7.2 Green and Golden Bell Frog

Habitat values

GGBF habitat was broadly categorized into breeding, foraging and dispersal habitat and the extent of this habitat across the site was coarsely mapped. Large areas of the site could be considered potential dispersal and foraging habitat given the general open grassed nature of large parts the site. Several large and small water bodies were also identified across various precincts of the site. These structures though constructed and /or heavily modified provide potential breeding habitat for the species. Those with fringing sedges and/or rushes provide better habitat than those without. Similarly some of the water bodies have exotic fish (*Gambusia* sp) present and this would reduce likely breeding success rates if the GGBF were present and breeding. All the large water bodies in the south west precinct (1 to 4, see Figure 13) had Gambusia present. The value of the habitat provided by the onsite water bodies

may however be potentially affected by the occurrence of elevated levels of heavy metals and ammonia (Coffey 2010a, 2010b and 2010c) although the impact of these observations is not fully understood.

Concrete overflow structures associated with adjusting water levels between water bodies (3 and 4), the STP polishing ponds within the power station Zone (outside consideration of the concept plan) and a farm dam within the northern Environmental Management Zone were identified as having some of the best potential GGBF breeding habitat values that were detected, the latter two water bodies did not appear to have exotic fish present.

Given the broad extent of foraging and dispersal habitat across the entire site it is difficult to envisage the proposed development impacting on the species to any major extent provided that some substantial areas of open grassed vegetation is retained by the concept plan. Impact on the GGBF from this aspect of the proposed land use zoning would be considered low.

One waterbody (2) is proposed for removal from the south west precinct. This structure is likely to provide some habitat components for the GGBF in the south west precinct however their removal is somewhat compensated for by retention and improvement of other water bodies, and provision of connectivity through open space. Both ponds 3 and 4 are similarly surrounded by large extents of fringing sedges and rushes. The sedges and rushes surrounding the fresh water bodies provide important foraging and shelter habitat for the GGBF where they occur (DEC 2005; DECC 2008).

Rehabilitation works and possible habitat enhancement works for the retained water bodies (3 and 4) will provide additional GGBF habitat components that might compensate to some extent for the habitat values removed with the development.

Likelihood of occurrence

The Green and Golden Bell Frog was historically distributed across much of the Illawarra up until the early 1970s. The species underwent significant declines such that the species has contracted to only three definite populations in the Illawarra: north at Woonona; east at Port Kembla; and south near Bombo (DEC 2005).

Records from the west of Lake Illawarra were always low in number and none have been positively identified for decades, the most recent being from around Albion Park in 1973/4.

Nevertheless potential habitat for the species persists across extensive areas of former dairy land as well as the subject land at Tallawarra. The species is well known for its tendency to persist in old industrial areas that have been left long undisturbed and/or may even have contamination issues.

The long absence of GGBF records from the west of Lake Illawarra does provide an indication of low probability that the species still persists in the locality. In addition, the extensive targeted survey for this species undertaken during this project does provide further evidence that this species does not persist at the study site.

4.7.3 Threatened Birds

The study area is known to support a wide variety of bird species given the diversity of habitat types present. Twelve threatened bird species have been recorded at the site (DECCW 2010a, Burcher 1997, Brandis 2010, Turton 1996, Richards 1997a, Richards 1997a, URS 2006). These include:

- Australian Painted Snipe (*Rostratula australis*)

- Black Bittern (*Ixobrychus flavicollis*)
- Black-tailed Godwit (*Limosa limosa*)
- Freckled Duck (*Stictonetta naevosa*)
- Greater Sand-plover (*Charadrius leschenaultii*)
- Lesser Sand-plover (*Charadrius mongolus*)
- Little Eagle (*Hieraaetus morphnoides*)
- Osprey (*Pandion haliaetus*)
- Pied Oystercatcher (*Haematopus longirostris*)
- Scarlet Robin (*Petroica boodang*)
- Sooty Oystercatcher (*Haematopus fuliginosus*)
- Spotted Harrier (*Circus assimilis*)

The Pink Robin (*Petroica rodinogaster*) and Barking Owl (*Ninox connivens*) have also been recorded in close proximity to the western boundary of the study area (DECCW 2010a).

It is likely that the majority of the aforementioned species would utilise the various artificial wetlands throughout the south of the study area and the woodland and foreshore areas in the south east of the study area. The majority of water birds have been recorded either within the large artificial wetland in the south west of the site, along Duck Creek or along the foreshore areas of Lake Tallawarra. Based on the current concept plan, all of these areas would be conserved.

Areas of open woodland provide potential nesting and foraging habitat for species such as the Osprey, Scarlet Robin, Little Eagle and Spotted Harrier. The Osprey has been recorded nesting near the power station in the past (1993 – 1994) (Chafer 1995, Brandis 2010). Based on the current master plan this area would form part of an environmental reserve and there impacts on this species are not anticipated.

The Black Bittern has been recorded along Duck Creek in the past (Burcher 1997, DECCW 2010a) and is likely to utilise the densely vegetated margins of the creek such as those present in the east of the study area. There is one reported breeding record for this species along Duck Creek (Brandis 2010).

The Freckled Duck (2 - 10 birds) has been recorded on the site on three occasions by the Tallawarra Bird Observers Club since 1992 and is therefore considered a periodic visitor to the site. This species was recorded within Ash Pond 3 in the south west of the site (Brandis 2010).

The Little Eagle has been recorded within study area with several old nesting records just west of Ash Pond 3 in the south west of the site with a few sightings over the grasslands of Mt. Brown (Brandis 2010).

The Pied Oystercatcher was recorded along the foreshores of Lake Tallawarra during the ELA (2010) survey but has also been recorded a number of times in the ash ponds and attempted to breed at the mouth of Duck Creek in the past (Chafer 1995). A Lake Illawarra resident pair has been observed around the shores, and occasionally sighted on Ash Pond 3 by the Tallawarra Bird Observers Club. A pair attempted to breed adjacent to the coal wash dump besides Hayward's Bay in 2001 but were thought to have been fox predated (Brandis 2010).

The Spotted Harrier has occasionally been recorded hunting over the grasslands within the study area during dry inland periods (Brandis 2010). It is unlikely that the study area is key habitat for this species.

In addition to the threatened birds recorded within the study area, there are a number of other threatened birds for which the study area provides potential habitat and have been either recorded within the locality or considered to have the potential to occur within the locality and therefore could also utilise the site. Those species with the potential to occur on the site are listed in Table 11 above.

4.8 MIGRATORY SPECIES

Eighteen migratory bird species are known to occur on site at Tallawarra as they have either been observed by the Illawarra Bird Observers Club and/or recorded on the DECCW database records. These include:

- Bar-tailed Godwit (*Limosa lapponica*)
- Black-faced Monarch (*Monarcha melanopsis*)
- Caspian Tern (*Sterna caspia*)
- Cattle Egret (*Ardea ibis*)
- Curlew Sandpiper (*Calidris ferruginea*)
- Double-banded Plover (*Charadrius bicinctus*)
- Eastern Curlew (*Numenius madagascariensis*)
- Great Egret (*Ardea alba*)
- Latham's Snipe (*Gallinago hardwickii*)
- Marsh Sandpiper (*Tringa stagnatilis*)
- Osprey (*Pandion haliaetus*)
- Pacific Golden Plover (*Pluvialis fulva*)
- Red-necked Stint (*Calidris ruficollis*)
- Rufus Fantail (*Rhipidura rufifrons*)
- Sharp-tailed Sandpiper (*Calidris acuminata*)
- Sharp-tailed Sandpiper (*Calidris acuminata*)
- White-bellied Sea-Eagle (*Haliaeetus leucogaster*)
- White-throated Needletail (*Hirundapus caudacutus*)

The Black-faced Monarch and Rufus Fantail have been observed occasionally flying through the Tallawarra site when migrating between larger patches (Brandis 2010). The proposed development is unlikely to disturb this migration, particular when it is considered that the largest patches of vegetation on the site, which may form a potential migration corridor, are to be retained.

The Satin Flycatcher (*Myiagra cyanoleuca*) has not been recorded at the site but has been recorded nearby at Yallah and therefore has the potential to utilise the site.

The Osprey and Crested Tern are regularly sighted both at Tallawarra and along the foreshores of Lake Illawarra (Brandis 2010). The proposed development will have limited impact on the foreshore within the site boundary and no impact on the rest of the foreshore area. Therefore, these birds will continue to have access to large areas of foraging and roosting habitat. The Osprey has been recorded nesting in the south east of the site. Based on the current master plan this area would form part of an environmental reserve and therefore impacts on this species are unlikely.

The Cattle Egret and Great Egret are common at Ash Pond 3 (Brandis 2010) and a pair of White-bellied Sea Eagles is known to nest in the eucalypt forest on site. These areas are to be retained within conservation areas. The White-bellied Sea Eagle has been recorded nesting in the woodland in the south east of the site (Brandis 2010). This area will be protected under the current concept plan. Successful breeding requires minimal disturbance during incubation and the small nestling stage (Brandis 2010). Threats to this species include potential predation by Australian Ravens and potential indirect impacts and disturbance from the proposed nearby development.

The Caspian Tern was recorded along the foreshore of Lake Tallawarra during the ELA (2010) survey and there have been several sightings on Ash Pond 3 when full in the past as well as being regularly sighted along the shores of Lake Illawarra, mainly in winter (Brandis 2010).

Latham's Snipe has been infrequently recorded at Ash Pond 3 in the south west of the site and along the foreshores of Lake Tallawarra (Brandis 2010).

There have been a few sightings of the Curlew Sandpiper from the shores of Ash Pond 3 with no records since 1995, reflecting a similar trend about Lake Illawarra and Shoalhaven Heads (Brandis 2010).

Pacific Golden Plover is occasionally sighted on Ash Pond 3 but generally present during summer about the shores of Hayward's and Koona Bays (Brandis 2010).

White-throated Needletails have been recorded circling over the study area during periods of thunderstorm activity (Brandis 2010). However, it is unlikely that the site would provide important habitat for this species.

There have been occasional sightings of the Red-necked Stint from the shores of Ash Pond 3 and the Marsh Sandpiper on Ash Pond 3 when water levels are low. The Sharp-tailed Sandpiper has also been sighted (2 to 5 birds) on the shores of Ash Pond 3, mainly during dryer inland summers with up to 100 birds in the summer 2008/9 when water levels were low (Brandis 2010).

Many of the other species recorded across the study are marine species that primarily utilise the foreshore areas. Direct impacts on foreshore areas are not anticipated. Furthermore, all of the migratory species have large natural ranges and are found throughout Australia. The site at Tallawarra is likely to be only one of many areas these birds will utilise.

Species with the potential to occur within the study area

A number of additional migratory species have the potential to utilise the study area although they have not been recorded within the study area in surveys to date. These species include:

- Black-tailed Godwit (*Limosa limosa*)

- Broad-billed Sandpiper (*Limicola falcinellus*)
- Fork-tailed Swift (*Apus pacificus*)
- Great Knot (*Calidris tenuirostris*)
- Greater Sand-plover (*Charadrius leschenaultii*)
- Grey-tailed Tattler (*Heteroscelus brevipes*)
- Hooded Plover (*Thinornis rubricollis*)
- Lesser Sand-plover (*Charadrius mongolus*)
- Little Curlew (*Numenius minutes*)
- Little Tern (*Sterna albifrons*)
- Painted Snipe (*Rostratula benghalensis* s. lat.)
- Rainbow Bee-eater (*Merops ornatus*)
- Red Knot (*Calidris canutus*)
- Regent Honeyeater (*Xanthomyza phrygia*)
- Sanderling (*Calidris alba*)
- Satin Flycatcher (*Myiagra cyanoleuca*)
- Square-tailed Kite (*Lophoictinia isura*)
- Terek Sandpiper (*Xenus cinereus*)
- Whimbrel (*Numenius phaeopus*)

4.9 SEPP 44 – KOALA HABITAT

URS (2006) recorded Koala scratch marks in woodland to the west of the site although there are no records of this species occurring on the project site (DECCW 2010). Scratch marks can be often difficult to identify to species level particularly on the harder barked species such as *Eucalyptus tereticornis* where the marks do not persist as long. The Koala is listed as a threatened species under the TSC Act. The nearest database record (DECCW 2010b) for this species is located more than 10 km for the site within the Cordeaux Nepean – Avon Dam Catchment. The number of sightings in proximity to the site and habitat connection and quality was considered. Consequently it is considered unlikely that this species would occur within the study area for the following reasons:

- The nearest record for this species is over 10 km to the west of the study area;
- Vegetation between the nearest record and the study area is highly fragmented;
- Vegetation on the site is fragmented and therefore is less likely to be used by this species; and

- It is difficult to definitively identify scratch marks given the number of species that can create scratch marks and therefore it is possible that the recorded from URS is a misidentification.

Eucalyptus tereticornis and *Eucalyptus robusta* are listed as a Koala feed trees under Schedule 2 of SEPP 44 and are present in areas of Coastal Grassy Red Gum Forest; Moist Box – Red Gum Foothills Forest; Lowland Woollybutt – Melaleuca Forest and Alluvial Swamp Mahogany Forest. In most areas, the Koala Feed Tree species would constitute at least 15% of the total number of trees in the upper or lower strata of the tree component and, therefore, would be considered an area of potential koala habitat according to SEPP 44 definitions. However, given that there are no known resident populations of Koalas on the project site or indeed the locality, the study area does not support core koala habitat as defined under SEPP 44. Furthermore, SEPP 44 does not formally apply to Part 3A projects.

4.10 WETLANDS

Natural and artificial wetlands are present across the study area including two that are protected under SEPP 14. The SEPP 14 wetlands occur in the south eastern portion of the site and have limited weed invasion. The southern-most wetland as per the gazetted boundaries supports saltmarsh and SOFF, whilst the one to the north supports a more sedgeland structure (EAW) with patches of saltmarsh and SOFF in the west. These wetlands provide potential habitat for a variety of species including birds, reptiles, mammals and amphibians. An inventory of flora species present within each of the SEPP 14 wetlands was recorded and is provided in Appendix B.

A number of artificial wetlands are also present across the site with the largest occurring in the south west. These wetlands provide habitat for waterbirds, reptiles and amphibians and vary in the quality of habitat that each provides. The largest wetland in the south west of the study area supports mudflats, is fringed by macrophytes, is utilised by a large variety of water birds and is considered to be of high conservation value. Other artificial wetlands across the study area vary in the habitat values they provide to fauna. Figure 9 shows the location of natural and artificial wetlands across the study area and Figure 13 ranks the wetland areas in term of their fauna habitat values.

The two SEPP 14 wetlands and the artificial wetlands in the south east and south west of the site are considered the most valuable wetland habitat within the study area and as such are to be conserved as part of the current concept. A 50 m buffer will be provided around all SEPP 14 wetlands. This is easily achieved as both SEPP 14 wetlands are to be conserved within a 95.98 ha reserve zoned for environmental conservation.

4.11 CORRIDORS

Regional corridors

The Bioregional Assessment of the Wollongong LGA (2003) identified the Yallah Calderwood Corridor as one of two regionally significant corridors that provides a 'stepping stone' connection between the escarpment and the plateau lands and the coastal plain. This corridor has since been included in Draft Illawarra Regional Biodiversity Corridors (Figure 16), though it is important to note that this corridor is subject to current West Dapto discussions and negotiations.

Much of the land within the Yallah Corridor is currently cleared, and it is unclear how the desired connectivity is to be delivered, and what this means in practice for the Tallawarra Lands concept plan application, particularly when the ecological connectivity to the west of the site is impeded by both the Southern Freeway/Princes Highway and southern railway.

Nevertheless, the study area provides potential linkages through the Duck Creek riparian area to the remainder of the Yallah Corridor and more broadly the Escarpment Moist Forests Corridor and the Johnstons Spur (Wollongong Council *et al.* 2010). The retention of this broad connection is considered important and has been acknowledge in the current concept plan design through the proposed protection and rehabilitation of the Duck Creek riparian zone.

The Yallah – Calderwood Fauna Linkage connects the escarpment and plateau to Lake Illawarra. This corridor is comprised of a closely spaced linkage of remnant patches of vegetation within 550 m of each other (NPWS 2003). Current 'stepping stone' linkages throughout the section of the Yallah to Calderwood corridor will not become further isolated by the proposal as the vegetation along Duck Creek and the consolidated stands of vegetation in the north east and south east of the study area will be retained.

Local corridors

Local scale corridors throughout the study area are currently highly fragmented and consist primarily of east-west linkages. However, the drainage line running from Duck Creek in the centre of the site across pasture areas and beneath Yallah Road through box culverts provides potential movement pathways to northern areas for some species. Similar north-south connection is possible using the foreshore environmental reserve between Duck Creek and the power station buffer lands. Duck Creek also provides a dispersal pathway for species to move from the site, to the foreshore of Lake Tallawarra and hence to the north and south of the site. In the south western part of the study area, corridors for movement are also formed through the creek and drainage lines and the artificial wetlands also providing 'stepping stone' habitat.

Based on the current master plan, most of the habitat connectivity across the study area would be maintained and the conservation of the south eastern portion of the study area means linkages from the most consolidated area of habitat and Lake Tallawarra will be preserved.

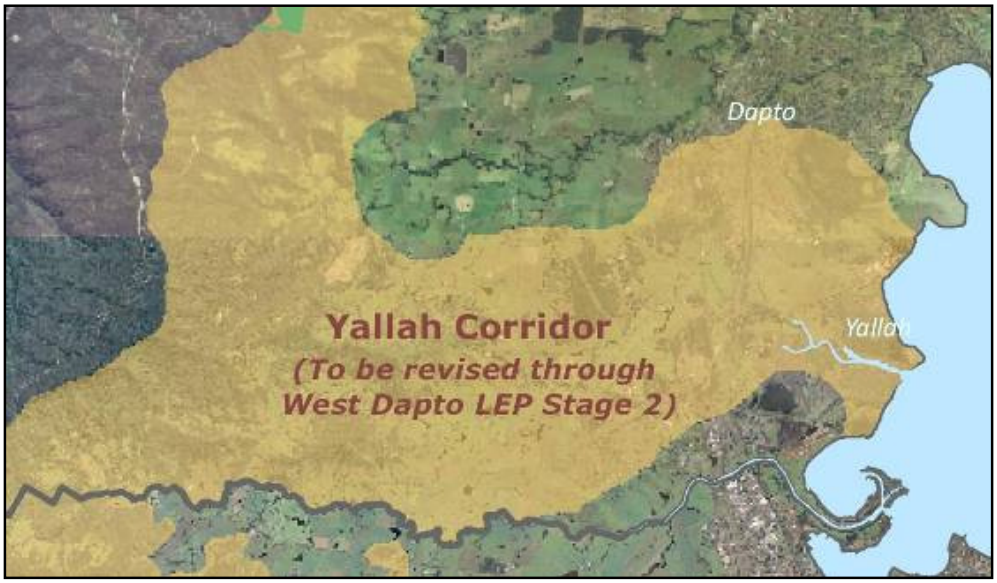

Figure 16: Yallah regional biodiversity corridor (extract from Wollongong Council *et al.* 2010)

5 Impact Evaluation

This section of the report outlines the anticipated impacts from the proposal on the ecological values of the site. It is structured to mirror the DECCW policy to avoid, mitigate and if required offset. Initially impacts have been avoided and minimised wherever possible. A number of mitigation measures were then formulated to further minimise the impacts from the proposal. The residual direct and indirect impacts are then outlined and cumulative impacts and key threatening processes considered. This approach is consistent with the requirements of the DGRs (i.e. description of actions that will be taken to avoid or mitigate impacts or compensate for unavoidable impacts of the project on threatened species and their habitat). For any impacts that cannot be avoided or mitigated, offsets will need to be provided and these are discussed in Chapter 6.

Impacts have also been assessed in accordance with the Part 3A requirements of maintaining or improving the biodiversity values. The key thresholds include:

- Whether or not the proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts will maintain and improve biodiversity values;
- Whether or not the proposal is likely to reduce the long-term viability of a local population of the species, population or ecological community;
- Whether or not the proposal is likely to accelerate the extinction of the species, population or ecological community or place it at risk of extinction; and
- Whether or not the proposal will adversely affect critical habitat.

5.1 AVOIDANCE MEASURES

Environmental Impact Assessment and Biodiversity Offset Principles have been established by DECCW and the first of these principles states that impacts must first be avoided using prevention and mitigation measures (DECC 2008). The proponent has considered the ecological values of the site and sensitive areas and has avoided impacts on these areas wherever possible.

Detailed below are the avoidance measures which have been implemented to minimise impacts on the ecological integrity of the study area. These include:

- Development has primarily been restricted to the disturbed parts of the study area or areas of small, isolated and degraded vegetation/habitat except where impacts are unavoidable due to road design and engineering constraints such as the entry road locations;
- The vegetation in the south east of the site including the SEPP 14 wetlands and a number of coastal EECs under the current concept plan will be conserved as an environmental reserve;
- Areas of known breeding habitat for the White-bellied Sea Eagle will be conserved within an environmental reserve;
- Areas of known nesting habitat for the Osprey have been avoided;

- The Duck Creek riparian corridor will be established and restored due to the important function this area plays in connectivity not only across the site but also within the context of potential regional corridors;

- Ash pond 3, the largest artificial wetland (AW3) in the south west of the site, will be conserved and incorporated into the landscape design as this area is known to support habitat utilised by a variety of waterbirds and migratory species;

- The removal of hollow-bearing trees has been minimised as much as possible. Based on the current concept plan it is likely that one hollow-bearing tree would be impacted in the south west of the site. All other known hollow-bearing trees have been avoided; and

- Riparian features are protected through avoidance and improved through the provision of riparian zone vegetation, buffer setbacks and vegetation management (ELA 2010a. 2010b and Figure 17).

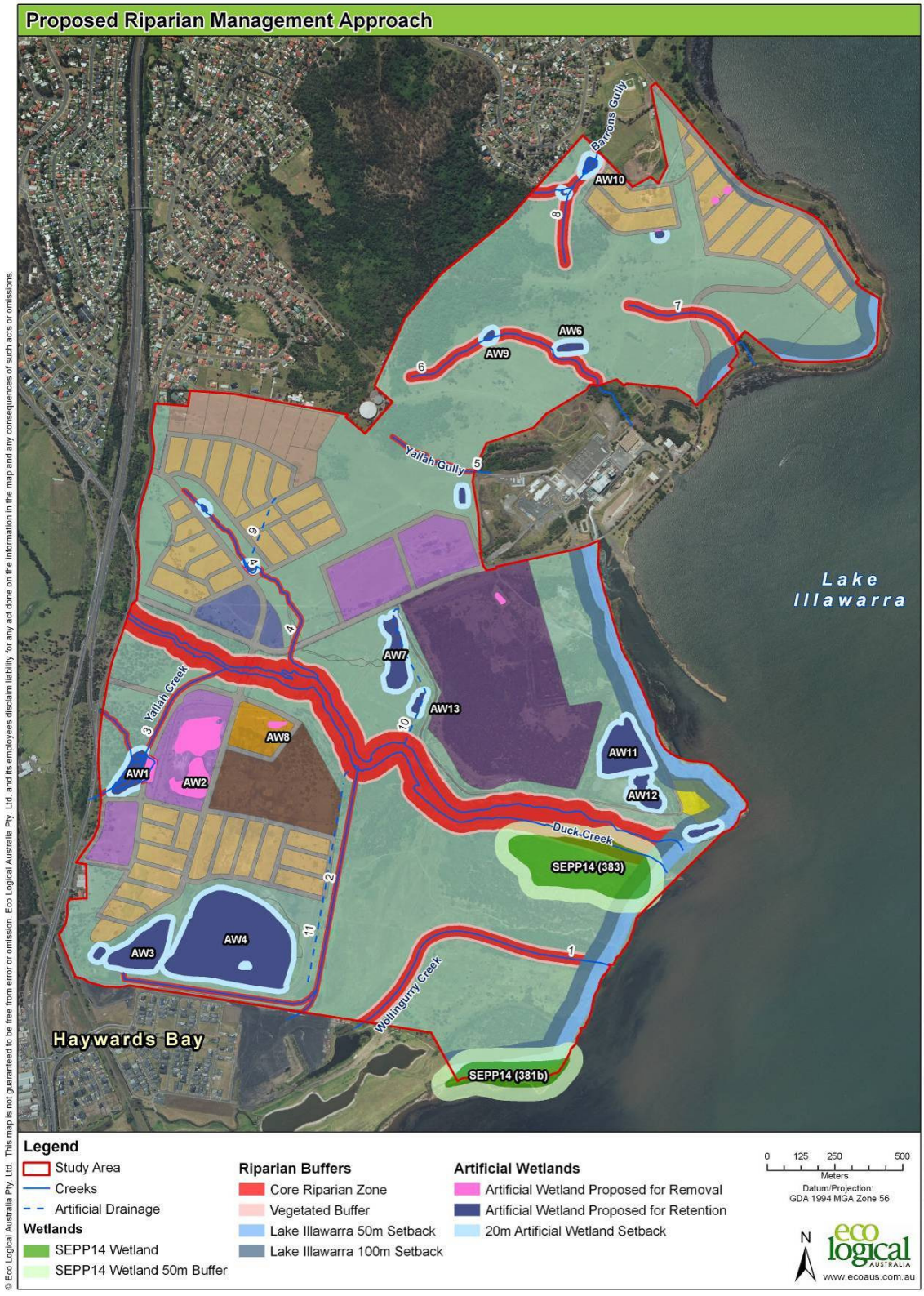

Figure 17: Proposed riparian management approach showing wetland buffers

5.2 MITIGATION MEASURES / RECOMMENDATIONS

In order to protect the ecological values of the study area number of management and mitigation measures have been recommended. These are outlined in Table 12 together with the project stage during which each should be implemented.

Table 12: Recommended mitigation measures

Impact / Threat	Values	Mitigation Measure	Timeframe	Prior to construction	During construction	Post construction
General construction, and operational impacts	All	Preparation of Construction Environmental Management Plan (CEMP) incorporating a Soil and Water Management Plan (SWMP)		✓		
		Preparation of Vegetation Management Plan (VMP)		✓		
Spread of weeds						
Spread of noxious and environmental weeds	Ecological	Noxious and environmental weeds present within the study area should be controlled in accordance with the provisions of the VMP (ELA 2010b).		✓	✓	✓
Spread of weeds through soil disturbance and vegetation clearance	Ecological	Piling of soil that may contain seeds of exotic species at least 50m away from the creeklines, drainage lines and other areas of native vegetation, where possible, to prevent spread of weeds into adjacent areas of ecological significance during rainfall or wind events. Soil will not be piled within riparian and wetland buffer areas nor vegetated areas.			✓	

Impact / Threat	Values	Mitigation Measure	Timeframe	Prior to construction	During construction	Post construction
Spread of weeds through movement of vehicles and machinery between sites	Ecological	All machinery, equipment and vehicles are to be washed down before entering and leaving the site.	Wash down area locations to be identified during the detailed design phase and CEMP		✓	
Spread of weeds through topsoil removal	Ecological	Topsoil re-use should only be undertaken within construction areas and top soil is not to be relocated to areas retained for environmental reservation unless required for engineering purposes. Where topsoil is relocated weed control is likely to be required.			✓	✓
Spread of noxious weeds through soil disturbance and vegetation clearance	Ecological	All onsite staff and contractors will be made aware of noxious weeds present at the site and ways to prevent their spread.	Prior to commencement of construction works	✓		
Spread of weeds through importation of soil, rubble etc	Ecological	It should be ensured that any soil, rubble etc imported to the site is certified that it is free of weeds and weed seed			✓	✓

Impact / Threat	Values	Mitigation Measure	Timeframe	Prior to construction	During construction	Post construction
Spread of weeds through revegetation	Ecological	Revegetation using locally native endemic species characteristic of the native vegetation types present.	Species should be sourced prior to construction to ensure availability.	✓		✓
Spread of weeds through revegetation	Ecological	Weed management measures implemented to control perennial grass weeds except in areas where they have been identified in the VMP as required for bank stabilisation.				✓
Sedimentation, Erosion and Runoff						
Sedimentation, and soil erosion	Riparian / Wetlands and Ecological	Before any remediation works that will disturb the soil, grazing will be removed to allow grasses to regenerate to minimise any areas of bare soil. Jute matting or similar should be used to stabilise bare areas of soil where grass is not present.				✓
Sedimentation, and soil erosion	Riparian / Wetlands and Ecological	All soil stockpiles will be covered to prevent the loss of material during high wind and rain events. Where practicable soil stockpiles will be placed in areas sheltered from the wind.	Location to be determined during detailed design phase.		✓	✓
Sedimentation, and soil erosion	Riparian / Wetlands and Ecological	Implement provisions of SWMP.	Prior to the commencement of construction.	✓		

Impact / Threat	Values	Mitigation Measure	Timeframe	Prior to construction	During construction	Post construction
Sedimentation and erosion	Riparian / Wetlands and Ecological	All erosion and sedimentation control devices will be regularly monitored, cleared and repaired, particularly after periods of heavy rainfall.	Monthly and after heavy rainfall.		✓	✓
Sedimentation, and soil erosion through soil disturbance	Riparian / Wetlands and Ecological	All disturbed soil surfaces shall be stabilised as soon as practicable after works have ceased in the area.				✓
Reduced water quality through uncontrolled runoff and sedimentation	Riparian / Wetlands and Aquatic species	Management measures implemented to prevent sediment and runoff entering the watercourse in accordance with SWMP.	Prior to the commencement of construction.	✓		
Spread of pesticides through runoff	Riparian / Wetlands and Aquatic species	Management measures implemented to prevent sediment and runoff entering the watercourses and artificial wetlands in accordance with the SWMP.		✓	✓	✓
Increase nutrient loads	Riparian / Wetlands and Aquatic species	Stormwater and sewer infrastructure will need to be constructed to perform at a high environmental standard, with the aim being for no increase in nutrient loads received by Lake Illawarra.		✓ -design phase	✓	✓
Vegetation Clearance / Disturbance						
Loss of local genetic integrity	Native vegetation	Prior to clearing – collect native seed from vegetated areas for use in revegetation works and landscaping throughout the study area.	During the appropriate seed collection season for target species.	✓		

Impact / Threat	Values	Mitigation Measure	Timeframe	Prior to construction	During construction	Post construction
Disturbance / degradation of EECs and reserves due to edge effects	Reserves and EECs	A vegetation buffer should be maintained between the development area and environmental reserves / EEC to prevent indirect impacts due to edge effects. VMP to minimise the opportunity for edge effects.	Buffers for riparian areas been identified in the concept plan		✓	
Disturbance from the movement of vehicles & machinery between sites	Ecological	All vehicles are to remain on formed roads or tracks designed specifically for the purposes of the construction, except where required for the implementation of the VMP.			✓	
Damage to surrounding tree roots	Ecological	Care is to be taken when working near treed areas to prevent direct damage to adjacent tree roots, or from soil compaction or smothering.			✓	
		Where possible, construction is to be undertaken at least 15 m away from the base of trees			✓	
Smothering of vegetation by dust	Vegetation	Minimise dust during construction via the use of water carts where required.			✓	
Temporary removal of fauna habitat / dead wood	Ground-dwelling species	All logs and large rocks removed from within the proposed development areas are to be relocated to the proposed environmental reserves to provide fauna habitat augmentation.			✓	

Roost / Hollow disturbance						
Disturbance of nests, dens and roosts through hollow-bearing tree removal	Hollow-dependant species	Pre-clearing surveys will be undertaken to determine if there are roosts, nests or dens present in any trees proposed for clearing.				
Disturbance to roosts through bridge or culvert alterations	Microchiropteran bats	Pre-construction surveys will be undertaken to determine if there are roosts present in any bridges or culverts present within the study area.				
Waterbird Habitat – disturbance / clearance						
Disturbance of waterbird habitat through changes to water levels	Waterbirds / amphibians	The pre-development hydrological regime of the site is to be sought to be replicated through the WSUD.		✓	✓	✓
Discharge from construction area	Waterbirds / amphibians	Runoff from the construction area will not be discharged into artificial wetlands that are to be retained. Appropriate controls to be established in the SWMP and work practices in the CEMP.			✓	✓
Disturbance / clearance of potential breeding habitat	Waterbirds	Areas around the artificial wetland that provide potential breeding habitat for waterbirds should not be impacted by the proposal and any trails will be placed well outside these areas. Works in these areas according to the VMP (ELA 2010b).		✓		

Disturbance to waterbirds due to increased noise from construction	Waterbirds	If any waterbirds are known to breed on the site, construction around/within the vicinity of their breeding habitat will be undertaken outside the key breeding period for the species to prevent disturbance to these species. There are no records to date of waterbirds breeding on the site in areas of direct impact.			✓	
Disturbance of waterbird habitat through indirect impacts	Waterbirds / amphibians	Buffers between the development and areas of waterbird habitat should be maintained to minimise indirect impacts. Resident eduction is encouraged to facilitate community awareness and protection of these values. Sensitive landscape treatments and management approaches to minimise impacts from noise, lighting and human interaction.				✓
The use of herbicides and pesticides near aquatic environments	Waterbirds / amphibians	Where herbicides are to be used near waterways, these will be suitable for use near aquatic environments (as detailed in ELA 2010b).				✓

Predation						
Predation from dogs	Fauna and particularly waterbirds	Barriers (fencing, vegetative screens or other landscape treatments) will be erected between residential areas and areas of potential fauna habitat to minimise opportunities for predation by dogs on native fauna. Dog free areas should be considered for higher significance fauna habitat.	To be further developed at detailed design stages		✓	✓
	Fauna and particularly waterbirds	It must be a requirement of trail use (for walking trails though sensitive areas) that dogs must be kept on a leash. Signage indicative of this and of the significance and value of the vegetation and habitat will be erected to inform and educate users. In areas where fencing of the trail may restrict fauna movement, the trail should be raised up 0.6 m - 1 m from the ground in parts to allow fauna to pass beneath.			✓	✓
Predation from cats	Fauna and particularly waterbirds	It should be a requirement that all cats have a collar with a bell as it is difficult to contain cats within the residential areas.				✓
Increased feral animal activity	Fauna and particularly waterbirds	A feral animal management plan should be implemented to reduce feral animal activity across the site.				✓

Rubbish dumping						
Dumping of rubbish in ecologically sensitive areas	Vegetation, Habitat and Riparian	Landscape masterplan seeks to integrate open space utilisation whilst restricting opportunities for adverse open space outcomes including rubbish dumping. The CEMP and the SWMP will avoid these impacts during periods of construction. Installation of fauna proof rubbish bins at strategic locations to prevent rubbish disposal within environmental reserve areas.			✓	✓
Riparian Areas						
Disturbance to vegetation protected under the WM Act	Riparian	Any works that may be carried out within a riparian corridor will need to be in accordance with Water Management Act guidelines.			✓	
Impacts on riparian areas	Riparian	Vegetated riparian buffers are to be established according to the Riparian Assessment (ELA 2010a) and in consultation with DECCW. Appropriate measures implemented to ensure bed and bank stability is maintained to prevent soil erosion and impacts of water quality and habitat.		✓	✓	✓

Encroachment on buffer areas	Riparian	Buffer areas will be clearly identified and/or fenced to prevent encroachment from construction or other activities.		✓		
Fire						
Accidental fire resulting in loss of property, life, vegetation and injury to fauna	All	Adherence to all regulations. Development of a Bushfire Management Plan and implementation of relevant fire prevention measures.	BMP to be prepared prior to construction	✓		✓
Inappropriate fire regimes resulting in vegetation and habitats being over or under burnt	All	Development of a BMP to advise on bushfire biodiversity thresholds of relevance to vegetation communities and threatened flora and fauna species.		✓		✓
Hazardous Materials						
Spills of hazardous material (eg. fuel, oil, chemicals)	All	Hazardous materials be stored on or off-site in specific lay-down/storage areas, and will be handled and stored according to regulatory requirements and Australian Standards AS1940			✓	
Others						
Boundary encroachment	All	The boundaries of the construction area will be clearly marked and/or fenced to prevent construction works breaching the boundaries and extending into environmental areas.	Prior to commencement of construction works	✓	✓	

5.3 DIRECT IMPACTS

5.3.1 Construction

Vegetation clearance

The proposal will result in the removal of small areas of a number of EECs, planted areas and highly degraded vegetation. The proposed concept plan has been designed to avoid impacts on key areas of ecological value across the site where possible although some impacts are unavoidable due to engineering and road design constraints. The proposal will result in the clearance of 51.63 ha of vegetation of which 4.37 ha are EECs. The EEC clearance is comprised of a number of very small areas of differing communities ranging from 0.17 ha to 2.54 ha. The remaining 117.23 ha of EEC vegetation will be preserved much of which will be incorporated into the proposed environmental reserves across the study area and improved using restoration techniques.

Table 13 summarises the clearance and retention of vegetation (each type) implied by the concept plan and the proportion of the total vegetation type within the study area that the clearance / retention represents. Table 14 provides a summary of EEC vegetation clearance and retention. Table 15 outlines the vegetation clearance by development type within the concept plan.

Based on the current proposal the following EECs will be impacted:

- Illawarra Lowlands Grassy Woodland of the Sydney Basin Bioregion (ILGW) - 3.28 ha or 11.07 % to be removed
- Swamp Oak Floodplain Forest on the NSW North Coast, Sydney Basin and South East Corner Bioregions (SOFF) – 0.54 ha or 1.68 %
- Coastal Saltmarsh of the Sydney Basin Bioregion (CS) - 0.17 ha or 2.23 %
- Illawarra Subtropical Rainforest in Sydney Basin Bioregion (ISR) – 0.38 ha or 4.51 %

Impacts on areas of Swamp Sclerophyll Forest (EAW and ASMF) and Freshwater Wetlands on Coastal Floodplains (Freshwater Wetlands) (FW) are not anticipated and mitigation measures will be implemented to prevent any potential indirect impacts. The majority of the EEC clearance has been restricted to the small isolated and heavily weed invaded stands of vegetation (eg. ISR, some ILGW). Furthermore, the most consolidated stand of vegetation in the south east of the site that currently supports a number of EECs (EAW, SSF, FW, and SOFF) and known habitat for threatened and migratory species, will be conserved and incorporated into an environmental reserve.

An assessment of the likely impacts on each EEC have been undertaken in accordance with the DECCW Part 3A *Guidelines for Threatened Species Assessment* (2005) and are included in Appendix E.

Table 13: Summary of vegetation clearance and retention (all types)

Vegetation type	LDSR (ISR)	CGRGF (ILGW)	MBRGFF (ILGW)	LWMF (ILGW)	ASMF (SSF)	CSOF (SOFF)	SM (CS)	EAW (SSF)	AW	FW (FW)	PSOF	AS	PWE	W&E	Total
Total within study area (ha)	8.43	2.64	7.20	19.79	17.34	32.12	7.61	2.24	21.89	24.23	25.66	1.48	3.83	64.80	**239.26**
Total clearance (ha)	0.38	0.54	0.20	2.54	0.00	0.54	0.17	0.00	3.96	0.00	21.69	0.00	2.43	19.18	**51.63**
Total retained (ha)	8.05	2.10	7.00	17.25	17.34	31.58	7.44	2.24	17.93	24.23	3.97	1.48	1.40	45.62	**187.63**
% of vegetation type cleared within the study area	4.51	20.45	2.78	12.83	0.00	1.68	2.23	0.00	18.09	0.00	84.53	0.00	63.45	29.60	**21.58**
% of vegetation type retained within the study area	95.49	79.55	97.22	87.17	100.00	98.32	97.77	100.00	81.91	100.00	15.47	100.00	36.55	70.40	**78.42**

Pink = Endangered Ecological Community

*Vegetation community and EEC (in brackets) abbreviations shown in Table 7, Section 4

Table 14: Summary of EEC vegetation clearance and retention

Impact	Illawarra Subtropical Rainforest	Illawarra Lowlands Grassy Woodland	Swamp Sclerophyll Forest	Swamp Oak Floodplain Forest	Coastal Saltmarsh	Freshwater Wetlands	Total
Total within study area (ha)	8.43	29.63	19.58	32.12	7.61	24.23	121.60
Total clearance area (ha)	0.38	3.28	0.00	0.54	0.17	0.00	4.37
Total retained area (ha)	8.05	26.35	19.58	31.58	7.44	24.23	117.23
Proportion (%) of EEC cleared within the study area	4.51	11.07	0.00	1.68	2.23	0.00	3.59
Proportion (%) of EEC retained within the study area	95.49	88.93	100.00	98.32	97.77	100.00	96.41

Table 15: Outline of vegetation clearance (area) by Development type

Development type/ Vegetation type*	LDSR	CGRGF	MBRGFF	LWMF	ASMF	CSOF	SM	EAW	AW	FW	PSOF	AS	PWE	W&E	Total (ha)
Employment				0.75			0.17		3.36		0.53		0.57	1.37	6.75
Employment - Neighbourhood Centre													0.48		0.48
Hillside Residential/Large Lots	0.19													0.25	0.44
Future Development Area									0.10		20.73			7.66	28.49
Primary School (Possible Use)									0.15					0.57	0.72
Residential	0.02	0.42	0.14	0.47		0.06			0.10				0.09	2.80	4.10
Road	0.17	0.12	0.06	1.32		0.39			0.25		0.43		0.72	2.75	6.21
Retirement Living (Possible Use)						0.09								2.90	2.99
Sporting Field													0.57		0.57
Tourism														0.88	0.88
TOTAL CLEARANCE	0.38	0.54	0.20	2.54	0.00	0.54	0.17	0.00	3.96	0.00	21.69	0.00	2.43	19.18	51.63

*Vegetation community abbreviations shown in Table 7, Section 4

Loss of flora habitat

Habitat for a variety of threatened flora species is present across the study area and the vegetation clearance outlined above will result in the removal of small areas of potential habitat (Figure 12). Only one threatened species *Chorizema parviflorum* has been found at the site following targeted threatened flora searches. This species is listed as an Endangered Population in the Wollongong and Shellharbour Local Government Areas and was found along the western boundary of the site in an area proposed for retention within an environmental reserve.

Loss of riparian vegetation and aquatic habitat

Riparian vegetation and aquatic environments is found throughout the study area and consists of riparian and aquatic vegetation associated with creeks, drainage lines, wetlands, artificial waterbodies and the lake and its foreshore.

The proposal has been designed to avoid impacts on riparian and aquatic habitat areas and further, to provide riparian buffers zones, revegetation, vegetation management and WSUD to protect and improve these areas (ELA 2010a).

Based on the concept plan there are no areas where a significant loss of native riparian vegetation is likely, conversely the riparian assessment and VMP (ELA 2010a and 2010b) propose extensive riparian zone revegetation and other improvements.

Minor impacts to riparian vegetation may occur in specific and restricted areas such as with the upgrading of the bridge crossing over Duck Creek however this will be minimal and will need to conform to appropriate WM Act requirements.

Some aquatic vegetation fringing some of the artificial wetlands will be impacted on and some lost, however, this will mostly be minimial and will primarily concern non-natural and non-native vegetation.

All high value environmental riparian and aquatic features are proposed for protection and improvement. The role of the riparian assessment (ELA 2010a) was to guide the protection of riparian features and recommend appropriate treatment for the maintenance of water quality, natural flow regimes for both riparian areas and receiving environments

Loss of fauna habitat

The study area provides a variety of habitat features including many that would provide habitat for threatened species. A number of threatened bats have been recorded across the study area and it is likely that small areas of potential habitat for bats will be impacted. Based on the current concept plan the removal of only one hollow-bearing tree is anticipated, with all remaining known hollow-bearing trees currently situated outside the proposed development footprint. This hollow-bearing tree was surveyed to observe for microbat activity and utilisation of the raptor nest. No microbats where observed utilising this tree and the raptor nest was observed to be utilised by a juvenile Whistling Kite. Areas of potential foraging and roosting habitat for bats will remain across the site.

The proposal will impact on a number of artificial wetlands that provide potential habitat for amphibians, reptiles and a large variety of waterbirds. All areas identified as supporting high value habitat for waterbirds have been avoided and either incorporated into open space areas or protected within environmental reserves. The substantial wetlands in the south west of the site (AW 3 & AW 4) provide

key habitat for waterbirds across the study area with a large number of species identified utilising this area and these habitat areas have been retained. Further, WSUD will seek to maintain pre development hydrology to these features so that habitat values such as the mud flats and shallow foraging areas for waders are retained. Prevention of indirect impacts to these areas is discussed in following sections. Further, it is unlikely that the proposal would restrict movement of waterbirds from the site to surrounding areas as the environmental reserve in the east will provide links to the foreshore of Lake Illawarra and these species are highly mobile, many of which are migratory and travel long distances.

Although potential habitat for woodland birds will also be impacted, the most consolidated stand of potential habitat will be conserved and the amount of clearance triggered by the concept plan is small with respect to the amount of potential habitat retained within the study area and locality. Furthermore, given these species are highly mobile and the currently highly fragmented nature of the landscape, it is unlikely that the proposal would result in any isolation in terms of habitat use by woodland birds.

Records of the Green and Golden Bell Frog from the west of Lake Illawarra were always low in number and none have been positively identified for decades, the most recent being from around Albion Park in 1973/4. The proposal will remove areas of moderate and low condition habitat for the amphibians and including GGBF, although all areas of high value habitat and most areas of moderate habitat have been retained. The sedges and rushes surrounding the fresh waterbodies including artificial wetlands provide important foraging and shelter habitat for the GGBF where they occur (DEC 2005; DECC 2008). Intensive survey was completed for the GGBF although failed to detect this species.

5.4 INDIRECT IMPACTS

Runoff, sedimentation and erosion

Given that the site is located adjacent to Lake Tallawarra (with adjacent aquatic vegetation and habitat), supports two SEPP 14 wetlands, Duck Creek, areas of saltmarsh and a number of important wetlands, potential impacts should be mitigated through the preparation and implementation of Water Sensitive Urban Design (WSUD), revegetation of riparian areas and measures to manage runoff and sediment within the study area. This should include but not be limited to:

- Runoff control measures;
- Sediment and erosion control;
- Weed control to reduce or eliminate the potential for seeds of exotic species to be spread into adjacent bushland and creeks; and
- Pollution controls to avoid impact on remaining vegetation and waterways.

Measures will need to be put in place to ensure that the water levels of the proposed 'Lake' and the natural wetting and drying cycles are maintained. Therefore, runoff from the adjacent road will need to be trapped and prevented from entering the adjacent wetland. Furthermore, measures will be incorporated into the WSUD to prevent increased nutrient loads in Lake Illawarra.

Hydrological changes

The proposal involves the establishment of large impervious surfaces in the form of roads and development areas. Impervious surfaces and changes to natural hydrological processes can have a number of potential effects including:

- limiting groundwater recharge by preventing rainwater from infiltrating through the ground;
- alter the ecology of an area including the vegetation composition and loss of fauna habitat;
- changes in soil moisture content; and
- may create conditions conducive to invasion by exotic species.

Potential impacts from hydrological changes may occur during construction or post development. Construction related impacts such as erosion, sedimentation and storage and use of water should be managed through a construction environmental management plan. Overall impacts to the hydrological system from the development will need to be managed in line with WSUD (WBM BMT, 2010).

Furthermore, some communities such as saltmarsh and wetlands are sensitive to changes in water levels and sedimentation. Therefore it is not recommended that the wetlands to be conserved across the site are used for stormwater detention or similar as changes to the hydrology may impact on the species composition and habitat value of these areas.

Groundwater Dependant Ecosystems (GDE) at the site would include the two SEPP 14 wetlands in the south east of the site. It is unlikely that the artificial wetlands in the south west of the site are groundwater dependant as clay linings may have been laid when these wetlands were constructed to prevent contaminants leaching into the groundwater. It is unlikely that the small dams (labelled artificial wetlands) present across pasture areas would be groundwater dependant.

It is also likely that the moist vegetation types present in the south east of the site (LWMF, SOFF, SM, ASMF and FW) are also dependant on groundwater to some degree. The degree to which these communities are influenced by groundwater is unknown. However, it is unlikely that significant changes to groundwater in this area would occur as a consequence of the proposal. Impacts on groundwater have been assessed in a separate report prepared by Coffey (2010a) and the GDEs by ELA (2010c).

Edge effects/ increased weed invasion

Vegetation clearance is primarily to occur in highly disturbed areas. However, impacts on some bushland areas are anticipated and many of the vegetated areas of the site currently have high levels of weed invasion. Although edge effects are evident through much of the vegetation across the study area, the proposal has the potential to increase weed invasion / edge effects.

Stringent weed management measures need to be implemented during and post construction to ensure weed invasion and edge effects do not increase across the study area. These need to include the control of runoff that may contain weed seeds and the washing down of vehicles to prevent the spread of weeds between areas. A Vegetation Management Plan (VMP) has been prepared for the site (ELA 2010b) and details measures to be implemented to reduce weed infestation across the site, revegetation of the Duck Creek and other riparian zones and minimise the potential spread of weeds during construction. Bush regeneration works are currently undertaken along Duck Creek in the west of the site and the VMP will build on this work extending east along Duck Creek to the confluence with Lake Illawarra.

Disturbance to fauna due to increased site utilisation

The development proposed by the concept plan will increase the human utilisation of the site from what is a site that is currently comparatively un-utilised. This has the potential to result in an increase of disturbance to fauna from human activities (such as recreation through areas of fauna habitat), from pet animals (i.e. predation and disturbance), road strike as well as potential ancillary impacts such as from noise and lighting.

Areas to be retained that provide fauna habitat will need to be managed appropriately in the future to minimise these potential impacts. The Landscape Masterplan (Corkery Consulting, 2010) for the concept plan has sought to integrate open space and recreation needs with retention of fauna habitat in a sympathetic fashion. Low key recreation opportunities such as bush trails and the like have been sought in such areas in preference to more formalised open space recreation land uses.

Inherent design solutions along with mitigation measures have been recommended (Table 12) to minimise potential impacts from fauna disturbance, such as through:

- Provision of setbacks to provide a buffer from development;
- Provision of buffer vegetation (ELA 2010a and 2010b) to minimise ancillary impacts and restrict utilisation in parts of the site;
- Landscape design solutions that seek to exclude non-compatible uses in certain areas; and
- Measures to minimise impacts from pet animals.

Predation

The presence of residential development in proximity to areas of habitat used by fauna species including waterbirds has the potential to increase predation particularly from dogs and cats. Means of restricting access to high value habitat areas by pet animals have been recommented in Table 12 and along with other predation minimisation measures include:

- Buffers between the development and areas of habitat should be maintained to minimise indirect impacts;
- Resident eduction is encouraged to facilitate community awareness and protection of these values;
- Sensitive landscape treatments and management approaches to minimise impacts from noise, lighting and human interaction;
- Barriers (fencing, vegetative screens or other landscape treatments) will be erected between residential areas and areas of potential fauna habitat to minimise opportunities for predation by dogs on native fauna. Dog free areas should be considered for higher significance fauna habitat;
- It must be a requirement of trail use (for walking trails though sensitive areas) that dogs must be kept on a leash. Signage indicative of this and of the significance and value of the vegetation and habitat will be erected to inform and educate users;

- It should be a requirement that all cats have a collar with a bell as it is difficult to contain cats within the residential areas;
- A feral animal management plan should be implemented to reduce feral animal activity across the site; and
- Installation of fauna proof bins.

Fragmentation

The majority of the threatened species recorded on or within proximity to the site (or with potential to utilise the site) are highly mobile bat and bird species and therefore the proposed development, is unlikely to restrict movement for many species to and from areas of potential habitat. Species for which impacts from fragmentation associated with the development are likely to be the greatest include small birds, mammals and amphibians. Habitat for small mammals is limited across the study area and most consolidated stands of vegetation across the study area are already fragmented such that movement by ground-dwelling fauna is limited (eg. large scale movements across the site are significantly hindered). However, the proposed Duck Creek corridor would provide a movement corridor for fauna between the east and western vegetated parts of the site, as well as offsite, and it is not anticipated that the proposed development would break this link.

Some small birds avoid passing across large open areas between woodlands. Based on the current fragmented nature of vegetation across the study area, it is unlikely that the proposed development would significantly exacerbate the fragmentation for these species although some 'stepping stone' habitat would be removed. Furthermore, all of the threatened bird species listed as potentially occurring on site disperse widely and many are migratory or nomadic species.

Wildfire

The greatest potential for accidental fires is likely to be during construction and maintenance works or through arson. Therefore a number of preventative measures would need to be implemented to reduce the likelihood of accidental fires. Details of these measures are outlined in the mitigation section of this report and include the preparation of a Bushfire Management Plan.

5.5 CUMULATIVE IMPACTS

Many of the NSW coastal vegetation types are threatened due to clearing for development and invasion by exotic species. Whilst the proposal will result in additional clearance of some vegetation, the protection and management of the large parcel of land (95.98 ha) in the south east, incorporating a number of coastal EECs and two SEPP 14 wetlands will assist in protection areas of coastal vegetation and habitat for threatened species throughout the LGA.

Furthermore, the proposed restoration of Duck Creek will assist with enhancing connectivity and the condition of the Yallah Corridor and enhance habitat values for threatened fauna. A VMP has been prepared for the study area (ELA 2010b) and will further assist in managing weeds which are currently prevalent across the site and is likely to increase the quality of the conserved vegetation.

Habitat for migratory species and waterbirds has also declined due to coastal development. However, under the current concept plan areas identified as high quality habitat for migratory species and waterbirds will be conserved and management measures implemented to prevent indirect impacts such as predation and habitat degradation.

5.6 KEY THREATENING PROCESSES

The following key threatening processes (shown with a response following) are considered relevant to the proposal:

- *Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands (TSC Act)*

  The concept plan has been desined such as to not impact on major creek and drainage lines throughout the study area given the sound approach to riparian management (ELA 2010a) and the WSUD proposed for the site (WBM BMT, 2010). This includes a focus on bed and bank stability and the maintenance of water quality through provision of riparian buffers zones, revegetation, vegetation management and WSUD.

  Given that the naturally occurring wetlands across the site will be conserved within an environmental reserve and mitigation measures will be implemented to prevent indirect impacts on waterbodies across the study area, it is unlikely that the proposal would exacerbate this key threatening process with respect to natural wetlands.

- *Clearing of native vegetation (TSC Act) / Land clearance (EPBC Act)*

  Impacts of the proposal on native vegetation have been outlined in Section 5.3.1. Whilst some vegetation removal is unavoidable, vegetation clearance has been avoided wherever possible and offsets will be provided to compensate for vegetation loss.

- *Competition and grazing by the feral European rabbit (TSC Act) / Competition and land degradation by rabbits (EPBC Act)*

  The European Rabbit currently inhabits the site and given that the proposal would not create additional conditions that would favour the European Rabbit it is unlikely that the proposal would exacerbate this key threatening process.

- *Human-caused climate change (TSC Act) / Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases (EPBC Act)*

  The proposal incorporates an employment precinct which may include industrial and other activities that may create green house gas emissions. However, it is anticipated that all businesses would be expected to work within the current enforced emissions limits.

- *Invasion and establishment of exotic vines and scramblers (TSC Act)*

  A number of exotic vines are present across the woodland areas. A VMP has been prepared to manage weeds across the study area. Therefore it is likely that the impacts of this KTP will be decreased due to the current proposal.

- *High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition (TSC Act)*

  The potential for fire during the construction phase of the proposal is considered low however, there is the potential for accidental fires once the development has been completed or through arson. As such a package of mitigation measures have been proposed to reduced the likelihood of fire during these phases. Provided the prevention and mitigation measures are implemented it is unlikely that the proposal would alter current fire regimes across the site.

- *Invasion, establishment and spread of Lantana camara*

  Lantana has also been identified as a threat to the following Endangered Ecological Communities present within the study area:

  - Illawarra Subtropical Rainforest in the Sydney Basin Bioregion
  - Swamp Oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions
  - Swamp sclerophyll forest on the coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions

  It is likely to threaten other communities and is extensive across the study. A VMP has been prepared for the study area (ELA 2010b) and incorporates measures to control and manage Lantana within the study area. Therefore it is likely that the impacts of this KTP will be decreased due to the current proposal.

- *Invasion of native plant communities by exotic perennial grasses (TSC Act)*

  There is the potential for the proposal to result in the spread of exotic perennial grasses. However, a number of mitigation measures have been proposed to prevent the spread of weeds and exotic perennial grasses. Revegetation of temporary disturbance areas is proposed and a VMP has been prepared as part of a commitment to ongoing weed management within disturbance areas and rehabilitation of the riparian zone along Duck Creek. This will help to reduce the potential for the remaining native vegetation to be invaded by exotic perennial grasses.

- *Loss of hollow-bearing trees (TSC Act)*

  Based on the current footprint, one hollow-bearing tree will be removed within the lakeside residential precinct (Figure 13). A number of hollow-bearing trees will be conserved throughout the study area and it has been recommended that the hollow-bearing tree proposed for removal is checked for resident fauna prior to its removal.

- *Predation by feral cats (TSC Act & EPBC Act)*

  Feral cats are likely to be present within the study area. Given that the inherent open nature of the landscape allows this species to move relatively unrestricted across the site, it is unlikely that the proposed roads would increase the activity of this species across the site. The use of fauna proof bins throughout the study area are likely to assist in preventing feral cat activity across the study area.

- *Predation by the European Red Fox (TSC Act & EPBC Act)*

  The European Red Fox is present across the study area. Given that the inherent open nature of the landscape allows this species to move relatively unrestricted across the site, it is unlikely that the proposed roads would increase the activity of this species across the site.

- *Removal of dead wood and dead trees (TSC Act)*

  Dead wood is limited across the project site and is restricted to only small parts of the open woodlands. In areas where dead wood occurs within the proposed construction area, it will be moved to adjacent woodland areas prior to construction. Therefore removal of dead wood is not proposed.

  Dead trees / stags are scarce throughout the study area and primarily restricted to the south west adjacent to the small wetland to be conserved and the woodland in the north east of the site. Although there are hollow-bearing stags in close proximity to the boundary of the residential area in the south west of the site, the removal of dead trees for the proposal is not anticipated.

- *Instream structures and other mechanisms that alter natural flow regimes (FM Act)*

  The proposal involves the upgrading of the Duck Creek crossing to allow access to the south west of the site from Yallah Bay Road. However, the proposed upgrades would need to meet the requirements of the Department of Water and Energy for watercourse crossings under the *Water Management Act 2000*. The crossing should be designed and certified by a suitably qualified engineer in accordance with the "*Guidelines for controlled activities Watercourse Crossings*" (NSW DWE 2008). This will be dealt with during the detailed design phase.

- *Degradation of native riparian vegetation along NSW watercourses (FM Act)*

  The riparian areas in proximity to the Duck Creek crossing that will need to be upgraded are heavily degraded with the riparian zone comprised of a grassed area with limited canopy cover. Therefore impacts on native riparian vegetation are likely to be minimal. Furthermore, this area will be revegetated and enhanced in accordance with the VMP (ELA 2010b) and therefore is likely the condition is likely to increase following the completion of construction works.

  ELA (2010a and 2010b) details that the approach taken with the concept plan with regard to management of the existing natural riparian features on site generally exceeds the prescriptive requirements established under SEPP 14 and RCMS. Further, the approach adopted recognises the hierarchy and significance of Duck Creek and the SEPP 14 wetlands and will establish both land tenure and management controls to enhance their viability and resilience in the future.

  Other currently degraded riparian and wetland areas are integrated into the existing zoning and measures are established through buffers and vegetation management to protect and promote hydrological and habitat values.

5.7 EPBC ACT MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

The study area provides habitat for a large number of threatened and migratory species listed under the EPBC Act. Six threatened fauna have been recorded within the study area and eighteen migratory species. An additional three threatened and eighteen migratory species also have the potential to occur on the site. Habitat is also present for eight threatened flora species.

Whilst areas of key habitat for these species have been protected, there is the potential for indirect impacts on these species due to the proposed development. Likely indirect impacts include:

- increased pedestrian activity around Ash Pond 3 - the largest artificial wetland and the site and key area for waterbirds;

- potential for predation from cats and dogs;
- edge effects;
- decreased water quality due to runoff and sedimentation; and
- disturbance during construction.

A number of mitigation measures have been identified to minimise and prevent indirect impacts on Matters of NES. Provided the mitigation measures outlined in Section 5.2 are implemented it is unlikely that the proposal would have a significant impact on any threatened or migratory species that utilise the study site as areas of key habitat value will be conserved. Nevertheless, given the large number of EPBC Act listed species known or with the potential to occur at the site (see Section 4.7), an EPBC Act Referral will be prepared and submitted to DEWHA as a precautionary measure. Those Matters of NES known of likely to occur within the study area are outlined in Section 4.7.

6 Maintain and Improve

In 2006, a Local Environmental Study was prepared for the Tallawarra Lands (Willana Associates *et al.* 2006) as the Tallawarra Lands were no longer required for the future expansion of the old power station. The LES process was undertaken in accordance with various legislative requirements and the project was supervised by a Project Control Group (PCG) comprising TRUenergy, Wollongong Council Department of Planning and the Premier's Department. The LES was informed on ecological matters by an Ecological Assessment (ELA 2006) which outlined key ecological features of the site and areas of constraint (due to environmental significance) to development.

In 2009, a Landscape Master Plan (TRUenergy 2009) was prepared for the site to further the work detailed in the LES and to assist with the rezoning of the site in the Wollongong Local Environment Plan 2009. The concept plan aligns with the LEP and indeed with advice of avoidance of areas of ecological constraint detailed in the LES (ELA 2006). As such, the development proposed by the concept plan will mostly avoid ecologically significant areas but also provide for their maintenance and improvement through the implementation of a VMP (ELA 2010b).

The proposal will result in the clearance of 51.63 ha of vegetation of which 4.37 ha are EECs. The EEC clearance is comprised of a number of very small areas of differing communities ranging from 0.17 ha to 2.54 ha in size. The remaining 117.23 ha of EEC vegetation (96.41 %) will be preserved much of which will be incorporated into the proposed environmental reserves across the study area. In addition to the retention of EEC vegetation is the retention of a number of artificial wetlands (18 ha) that provide habitat for various species.

Retention of EEC vegetation (and threatened species habitat) will be provided for in the concept plan by:

- Dedication of a number of environmental reserves including:
    - Duck Creek corridor;
    - A large wetlands reserve in the south east;
    - Mount Brown;
    - A reserve on the western boundary of the site near Yallah Creek;
- Retention of vegetation in other areas of the site including:
    - Around a number of artificial wetlands;
    - A foreshore reserve between the power station and Duck Creek;
    - In areas of open space.

Based on the amount of EEC clearance of 4.37 ha, the protection of 117.23 ha of EEC vegetation would represent a 27:1 protection ratio.

In addition to the retention of vegetation, a VMP has been prepared for the site (ELA 2010b) that would facilitate the improvement of EEC vegetation (and habitat) through the implementation of conservation sensitive restoration techniques. The VMP details the framework for management across the site and includes noxious and environmental weed control as well as revegetation of riparian areas, wetland buffers and other target areas.

Given the past rezoning process and the suite of avoidance, mitigation and conservation measures outlined in this report, it is considered that the proposal would meet the 'maintain and improve' test as it:

- Will conserve all key habitat areas across the site through zoning for environmental protection;
- Will conserve the largest and most consolidated stand of vegetation in the south-east of the site;
- Will conserve the largest and most valuable wetland in terms of habitat for threatened and migratory birds in the south east of the site and mitigation measures will be implemented to prevent indirect impacts;
- Implement a Vegetation Management Plan that will reduce the weed invasion in remnant vegetation across the study area and include the rehabilitation of the Duck Creek corridor;
- Improve connectivity of the Duck Creek and regional corridors and will not fragment any current corridors;
- Result in approximately 187.63 ha of vegetation (excluding the disturbed environmental reserve near the power station) including a number of EECs and two SEPP 14 wetland being protected across the study area;
- Undertake significant improvement works through the VMP (ELA 2010b) including a substantial amount of revegetation; and
- Is unlikely to have a significant impact on any EPBC listed species.

7 Conclusion

Under Part 3A of the EP&A Act, the DGRs call on the DECCW Part 3A assessment guidelines, which require the EA to provide details of the measures to avoid, mitigate or offset impacts associated with the development. That is, to meet the principles of the 'maintain and improve' test. Whilst complete avoidance of all impacts on habitat for threatened species and EECs will not be achieved by the concept plan, the most significant areas of vegetation and habitat have been avoided and stringent mitigation measures will be implemented as part of the proposal which will further reduce potential impacts. Areas of vegetation and habitat impacted are primarily highly degraded given the history of disturbance and landuse at the site.

To compensate for those impacts that cannot be avoided, the most valuable areas of land in terms of ecological values have been afforded protection within the concept plan and are covered by a VMP which aims to restore/improve the values of retained vegetation and habitat.

The proposal will result in the clearance of 51.63 ha of vegetation of which 4.37 ha are EECs. The EEC clearance is comprised of a number of very small areas of a number of communities ranging from 0.17 ha to 2.54 ha. The remaining 117.23 ha will be preserved much of which will be incorporated into the proposed environmental reserves across the study area.

Based on the amount of EEC clearance of 4.37 ha, the protection of 117.23 ha of EEC vegetation would represent a 27:1 protection ratio.

The two SEPP 14 wetlands and the artificial wetlands in the south of the site are considered the most valuable wetland habitat within the study area and are to be conserved, with a 50 m buffer provided around the SEPP 14 wetlands.

An assessment in accordance with the Part 3A *Draft Guidelines for Threatened Species Assessment* principles of the Part 3A maintain and improve test were applied to the EECs and threatened and migratory species known or likely to occur within the study area. The suite of avoidance, mitigation and offset measures outlined in this report are consistent with principles of the 'maintain and improve.' The key thresholds are outlined below and a justification as to why the proposal would meet these criteria is provided.

- Whether or not the proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts will maintain and improve biodiversity values;
- Whether or not the proposal is likely to reduce the long-term viability of a local population of the species, population or ecological community;
- Whether or not the proposal is likely to accelerate the extinction of the species, population or ecological community or place it at risk of extinction; and
- Whether or not the proposal will adversely affect critical habitat.

It is considered that the proposal would meet the 'maintain and improve' test as it:

- Will conserve in an environmental reserve the one threatened plant species, *Chorizema parviflorum* found on the site.
- Will conserve all key habitat areas across the site through zoning for environmental protection
- Will conserve the largest and most consolidated stand of vegetation in the south-east of the site;
- Will conserve the largest and most valuable wetland in terms of habitat for threatened and migratory birds in the south east of the site and mitigation measures will be implemented to prevent indirect impacts;
- Implement a Vegetation Management Plan that will reduce the weed invasion in remnant vegetation across the study area and include the rehabilitation of the Duck Creek corridor;
- Improve connectivity of the Duck Creek and regional corridors and will not fragment any current corridors;
- Has avoided or mitigated impacts wherever possible and compensated for unavoidable impacts through the protection of the majority of the vegetation across the study area and the proposed implementation of a VMP;
- Result in approximately 187.63 ha of vegetation (excluding the disturbed environmental reserve near the power station) including a number of EECs and two SEPP 14 wetland being protected across the study area;
- Is unlikely to reduce to long-term viability or accelerate the extinction of a species, population or ecological community or place it at risk of extinction as:
    - the majority of all EECs will be conserved with only minor clearance primarily on the fringes;
    - areas of potential foraging and roosting habitat for all threatened species with the potential to occur will be conserved;
    - known nesting habitat for threatened species has been avoided; and
    - mitigation measures will be implemented to prevent indirect impacts.
- No areas of critical habitat have been identified across the study area and therefore there will be no impacts on critical habitat; and
- Is unlikely to have a significant impact on any EPBC listed species.

Provided the recommended mitigation measures are implemented and the environmental conservation areas are managed, it is unlikely that the proposal would result in a significant impact on any Matters of National Environmental Significance (NES) listed under *the Environment Protection and Biodiversity Conservation Act 1999*. Nevertheless, given the large number of threatened and migratory species that have been recorded at the site, an EPBC Referral will be submitted to DEWHA as a precaution.

8 References

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Appendix A: Director General's Requirements

Table 16: Director General's Requirements and Agency Requests

Agency	Requirements	Section
DEPARTMENT OF PLANNING - DGRs		
DoP	Address impacts on flora and fauna including threatened species, populations and EECs and their habitats. Steps taken to mitigate any identified impacts to protect the environment. Identify the likelihood of the presence and impact on *EPBC* Act listed threatened species and listed migratory species.	Section 5 & Appendix E
DoP	A field survey of the site should be conducted and documented in accordance with the gazetted draft '*Guideline for Threatened Species Assessment*'	Section 3 Note: For species for which extensive previous studies have been undertaken, surveys to supplement these studies were conducted
DoP	The field survey to include: ▪ Assessment and evaluation of the likely impacts on threatened species and their habitat ▪ Description of actions that will be taken to avoid or mitigate impacts or compensate for unavoidable impacts of the project on threatened species and their habitat	Section 5
DoP	Outline the measures for conservation/management of the existing DEC Regional Habitat Corridor values and/or connective importance of any vegetation on the subject land.	Section 4.10
DoP	An Environmental Management Strategy is to be undertaken to address potential impacts on aquatic and terrestrial flora and fauna and their habitats in accordance with DECC's *Threatened Biodiversity and Assessment Guidelines for Developments and Activities*. It shall also address river and wetland protection, water quality, protecting and rehabilitating estuaries, protection of marine ecosystems, and provide measures for their conservation, where relevant.	Section 5.2
DoP	Address any measures to protect and manage the riparian corridor and adjacent aquatic habitat.	Section 5.2

Agency	Requirements	Section
DoP	Address potential impact of the proposal on the wetlands, including modification to wetlands hydrologic regime/groundwater recharge.	Section 5 and Appendix E Drainage and Water Sensitive Urban Design (WBM BMT, 2010).
DoP	Assess water quality and loss/degradation of habitat needs and provide safeguard measures to protect and minimise impacts on wetlands.	Section 5 and Appendix E Drainage and Water Sensitive Urban Design (WBM BMT, 2010).
DoP	Provide details on the presence and distribution of Groundwater Dependent Ecosystems (GDEs) in the vicinity of the site and identify any potential impacts on GDEs as a result of the proposal.	Section 4.2.3 and Section 5.4
DoP	Investigate and map EECs and justify / detail proposed vegetated corridors and riparian buffers, and any other form of proposed methods of conservation within the property.	Section 4
DEPARTMENT OF CLIMATE CHANGE AND WATER – AGENCY REQUESTS		
DECCW	Address the relevant EPI's Policies and Guidelines: ▪ NPWS Wollongong LGA Bioregional Assessment Studies ▪ Estuary Management Plan for Lake Illawarra ▪ Southern Rivers Catchment Authority Catchment Action Plan ▪ Riparian Corridor Management Study (2004) ▪ Draft Guideline for Threatened Species Assessment (2005) ▪ NSW Coastal Policy	Section 2
DECCW	A field survey of the site should be conducted and documented in accordance with the draft '*Guideline for Threatened Species Assessment'*	Section 3
DECCW	Likely impacts on regionally significant, protected and threatened species and their habitats need to be assessed, evaluated and reported. The assessment should specifically report on the considerations listed in Step 3 of the *Draft Threatened Species Assessment Guidelines*.	Section 5, Appendix E & Section 4
DECCW	The actions that will be taken to avoid or mitigate or compensate for unavoidable impacts of the project on threatened species and their habitat.	Section 5
DECCW	Assessment of the effectiveness and reliability of the avoid, mitigate or compensate measures, and any residual impacts after these measures are implemented.	Section 5 & 6
DECCW	The EA should clearly state whether it meets each of the key thresholds set out in Step 5 of the draft guidelines.	Section 5, 6 & Appendix E

Agency	Requirements	Section
DECCW	The EA is to provide details regarding the tenure and responsibility for management of the conservation areas. This shall include details on: ▪ Proposed mechanisms to fund the preparation of management plans ▪ Enhancement work ▪ On-going management of the areas Conservation areas should have adequate funding resources to provide for management of their values in perpetuity.	Vegetation Management Plan (ELA 2010b) and Riparian Assessment (ELA 2010a)
DECCW	Assess the effects of potential changed nutrient and sediment transport from the proposal on the nearby wetlands and the vegetation communities as well as the lake itself. Develop scenarios and mitigation measures for managing potential increased sediment and nutrients as a result of the increased urbanisation of the wetland and lake catchments.	Drainage and Water Sensitive Urban Design (WBM BMT, 2010).
WOLLONGONG CITY COUNCIL – AGENCY REQUESTS		
Wollongong Council	Targeted searches for *Chorizema parviflorum* is required so that the eastern limits of the population (which extend into the property) are accurately mapped.	See Section 3
Wollongong Council	Patches of EECs should be adequately surveyed in order to determine the structure, species composition and condition before assessment of significance of the vegetation patches are carried out.	Section 3.2 and Section 4.2

Appendix B: Species Lists

Table 17: Flora species recorded across the study area

Family	Scientific Name	Common Name	Native	AS	ASMF	AW	CGRGF	CSOF	EAW	FW	LDSR	LWMF	MBRGFF	PWE	PSOF	SM	W&E
Acanthaceae	*Avicennia marina*	Grey Mangrove	Yes													x	
Acanthaceae	*Pseuderanthemum variabile*		No								x						
Adiantaceae	*Adiantum formosum*	Giant Maidenhair Fern	Yes								x						
Aizoaceae	*Tetragonia tetragonioides*	Warrigal Greens	Yes					x		x						x	
Alliaceae	*Agapanthus praecox* ssp *orientalis*	Agapanthus	No									x					
Amaranthaceae	*Alternanthera philoxeroides*	Alligator Weed	No					x									
Amaranthaceae	*Amaranthus sp.*	Amaranth	No								x						
Amaranthaceae	*Sarcocornia quinqueflora*	Samphire	Yes						x							x	
Apiaceae	*Hydrocotyle bonariensis*	Pennywort	No		x					x							
Apocynaceae	*Nerium oleander*	Oleander	No									x		x			
Apocynaceae	*Parsonsia straminea*	Common Silkpod	Yes					x									
Aquifoliaceae	*Alchornea ilicifolia*	Native Holly	Yes									x					
Araliaceae	*Hedera* sp.	Ivy	No								x						
Asclepiadaceae	*Araujia sericifera*	Moth Vine	No					x		x	x	x			x		
Asclepiadaceae	*Gomphocarpus fruticosus*	Narrow-leaved Cotton Bush	No					x			x		x		x		
Asparagaceae	*Asparagus asparagoides*	Bridal Creeper	No		x												
Aspleniaceae	*Asplenium flabellifolium*		Yes								x						
Asteraceae	*Ageratina adenophora*	Crofton Weed	No												x		
Asteraceae	*Bidens pilosa*	Cobbler's Pegs	No					x			x				x		
Asteraceae	*Calotis* sp.		Yes		x												
Asteraceae	*Cirsium vulgare*	Spear Thistle	No							x	x				x		
Asteraceae	*Conyza bonariensis*	Fleabane	No							x				x	x		
Asteraceae	*Cotula coronopifolia*	Water Buttons	Yes						x								

Family	Scientific Name	Common Name	Native	AS	ASMF	AW	CGRGF	CSOF	EAW	FW	LDSR	LWMF	MBRGFF	PWE	PSOF	SM	W&E
Asteraceae	*Craspedia variabilis*		Yes													x	
Asteraceae	*Delairea odorata*	Cape Ivy	No					x			x						x
Asteraceae	*Leptinella longipes*		Yes						x							x	
Asteraceae	*Senecio madagascariensis*	Fireweed	No					x	x	x				x			
Asteraceae	*Tagetes minuta*	Stinking Roger	No					x		x		x					
Basellaceae	*Anredera cordifolia*	Madeira Vine	No											x			
Bignoniaceae	*Pandorea pandorana*	Wonga Wonga Vine	Yes								x		x				
Bignoniaceae	*Tecoma capensis*	Cape Honeysuckle	No											x			
Blechnaceae	*Blechnum cartilagineum*	Gristle Fern	Yes								x						
Cactaceae	*Opuntia* sp.	Prickly Pear	No					x									
Campanulaceae	*Pratia purpurascens*	Whiteroot	Yes		x												
Casuarinaceae	*Casuarina glauca*	Swamp Oak	Yes			x		x	x	x			x		x	x	x
Celastraceae	*Elaeodendron australe var. australe*		Yes								x						
Chenopodiaceae	*Atriplex prostrata*		No						x							x	
Chenopodiaceae	*Einadia hastata*	Berry Saltbush	Yes					x									
Chenopodiaceae	*Suaeda australis*	Austral Seablite	Yes						x							x	
Commelinaceae	*Commelina cyanea*	Creeping Christian	Yes		x			x			x	x					
Convolvulaceae	*Dichondra repens*	Kidney Weed	Yes		x			x			x	x	x				
Convolvulaceae	*Ipomea indica*	Morning Glory	No								x		x		x		
Cyperaceae	*Baumea juncea*		Yes													x	
Cyperaceae	*Carex appressa*	Tall Sedge	Yes		x			x									
Cyperaceae	*Carex longebrachiata*	Drooping Sedge	Yes								x		x				
Cyperaceae	*Ficinia nodosa*	Knobby Clubrush	Yes													x	
Cyperaceae	*Schoenoplectus validus*	River Club-rush	Yes						x								
Dennstaedtiaceae	*Pteridium esculentum*	Bracken	Yes		x					x							x
Dilleniaceae	*Hibbertia scandens*	Snake Vine	Yes		x												
Elaeocarpaceae	*Elaeocarpus reticulatus*	Blueberry Ash	Yes								x						
Euphorbiaceae	*Croton verreauxii*	Green Native Cascarilla	Yes								x						
Euphorbiaceae	*Ricinus communis*	Castor Oil Plant	No					x							x		
Fabaceae	*Erythrina X sykesii*	Coral Tree	No					x									

Family	Scientific Name	Common Name	Native	AS	ASMF	AW	CGRGF	CSOF	EAW	FW	LDSR	LWMF	MBRGFF	PWE	PSOF	SM	W&E
(Caesalpinioideae)																	
Fabaceae (Caesalpinioideae)	*Senna pendula*	Cassia	No												x		
Fabaceae (Faboideae)	*Chorizema parviflorum*	Eastern Flame Pea	Yes									X					
Fabaceae (Faboideae)	*Desmodium varians*	Slender Tick-trefoil	Yes								x						
Fabaceae (Faboideae)	*Glycine* sp.		Yes		x												
Fabaceae (Mimosoideae)	*Acacia mearnsii*	Black Wattle	Yes	x				x				x		x	x		
Fabaceae (Mimosoideae)	*Acacia saligna*	Golden Wreath Wattle	No	x											x		
Fabaceae (Mimosoideae)	*Acacia sophorae*	Coastal Wattle	Yes												x		
Fabaceae (Mimosoideae)	*Acacia* sp.		Yes								x						
Geraniaceae	*Geranium solanderi*		Yes								x						
Geraniaceae	*Geranium* sp.		Yes								x						
Juncaceae	*Juncus kraussii*	Jointed Rush	Yes			x		x	x							x	
Juncaceae	*Juncus usitatus*		Yes					x			x						
Juncaginaceae	*Triglochin striata*	Streaked Arrowgrass	Yes						x							x	
Lamiaceae	*Plectranthus parviflorus*	Cockspur Flower	No								x						
Lauraceae	*Cassytha pubescens*	Downy Dodder-laurel	Yes		x												
Luzuriagaceae	*Geitonoplesium cymosum*	Scrambling Lily	Yes								x						
Malvaceae	*Sida rhombifolia*	Paddy's Lucerne	No		x			x		x	x	x			x		x
Moraceae	*Maclura cochinchinensis*	Cockspur Thorn	Yes				x				x		x				
Moraceae	*Streblus brunonianus*	Whalebone Tree	Yes								x		x				
Myrtaceae	*Angophora costata*	Smooth-barked Apple	Yes												x		
Myrtaceae	*Angophora floribunda*	Rough-barked Apple	Yes		x												
Myrtaceae	*Corymbia maculata*	Spotted Gum	Yes									x					
Myrtaceae	*Eucalyptus botryoides*	Bangalay	Yes		x							x			x		
Myrtaceae	*Eucalyptus longifolia*	Woolybutt	Yes									x					
Myrtaceae	*Eucalyptus punctata*	Grey Gum	Yes									x					

Family	Scientific Name	Common Name	Native	AS	ASMF	AW	CGRGF	CSOF	EAW	FW	LDSR	LWMF	MBRGFF	PWE	PSOF	SM	W&E
Myrtaceae	*Eucalyptus tereticornis*	Forest Red Gum	Yes		x		x					x	x				
Myrtaceae	*Melaleuca decora*	White feather Honeymyrtle	Yes									x					
Myrtaceae	*Melaleuca ericifolia*	Swamp Paperbark	Yes		x			x								x	
Myrtaceae	*Melaleuca styphelioides*	Prickly Paperbark	Yes								x		x				
Ochnaceae	*Ochna serrulata*	Mickey Mouse Plant	No										x				
Oleaceae	*Ligustrum sinense*	Small-leafed Privet	No									x					
Oleaceae	*Olea europaea* ssp. *cuspidata*	African Olive	No				x				x		x				
Phyllanthaceae	*Breynia oblongifolia*	Coffee Bush	Yes		x						x						
Phytolaccaceae	*Phytolacca octandra*	Inkberry	No					x							x		
Pittosporaceae	*Pittosporum multiflorum*		Yes								x						
Pittosporaceae	*Pittosporum undulatum*	Sweet Pittosporum	Yes					x			x						
Plantaginaceae	*Plantago lanceolata*	Plantain	No							x							
Plantaginaceae	*Veronica plebeia*	Trailing Speedwell	Yes		x												
Poaceae	*Andropogon virginicus*	Whiskey Grass	No							x					x		
Poaceae	*Bothriochloa macra*	Red Grass	Yes								x						
Poaceae	*Chloris gayana*	Rhodes Grass	No								x				x		
Poaceae	*Chloris ventricosa*	Plump Windmill Grass	Yes										x				
Poaceae	*Cynodon dactylon*	Couch	No					x	x						x	x	
Poaceae	*Digitaria* sp.		Unknown														x
Poaceae	*Echinopogon caespitosus*	Tufted Hedgehog Grass	Yes								x						
Poaceae	*Echinopogon ovatus*	Forest Hedgehog Grass	Yes														x
Poaceae	*Ehrharta erecta*	Panic Veldt Grass	No								x						
Poaceae	*Entolasia stricta*	Right-angle Grass	Yes		x												x
Poaceae	*Eragrostis* sp.		Yes								x						
Poaceae	*Holcus lanatus*	Yorkshire Fog	No														x
Poaceae	*Hyparrhenia hirta*	Coolatai Grass	No											x			
Poaceae	*Lachnagrostis filiformis*	Blown Grass	Yes						x								
Poaceae	*Melinis repens*	Red Natal Grass	No			x									x		
Poaceae	*Microlaena stipoides*	Weeping Meadow Grass	Yes		x			x		x	x	x	x				x
Poaceae	*Oplismenus aemulus*		Yes		x						x						

Family	Scientific Name	Common Name	Native	AS	ASMF	AW	CGRGF	CSOF	EAW	FW	LDSR	LWMF	MBRGFF	PWE	PSOF	SM	W&E
Poaceae	*Oplismenus imbecillis*		Yes		x						x		x				
Poaceae	*Oplismenus* sp.		Yes					x				x					
Poaceae	*Paspalidium distans*	Spreading Panicgrass	Yes		x							x					
Poaceae	*Paspalum dilatatum*	Paspalum	No		x			x		x		x		x	x		x
Poaceae	*Paspalum distichum*	Freshwater Couch	Yes					x									x
Poaceae	*Paspalum urvillei*	Vasey Grass	No												x		
Poaceae	*Pennisetum clandestinum*	Kikuyu	No					x		x		x		x	x	x	x
Poaceae	*Phragmites australis*	Common Reed	Yes			x										x	
Poaceae	*Poa labillardierei*	Tussock Grass	Yes		x												
Poaceae	*Poa* sp.		Yes							x							
Poaceae	*Setaria gracilis*	Pigeon Grass	No					x		x					x		x
Poaceae	*Sporobolus virginicus*	Saltwater couch	Yes					x	x	x						x	
Poaceae	*Stenotaphrum secundatum*	Buffalo Grass	No					x									
Polygonaceae	*Persicaria subsessilis*	Hairy Knotweed	Yes					x		x							
Proteaceae	*Banksia integrifolia*	Coast Banksia	Yes											x			
Proteaceae	*Grevillea robusta*	Silky Oak	No									x					
Rosaceae	*Cotoneaster* sp.	Cotoneaster	Yes												x		
Rosaceae	*Fragaria × ananassa*	Strawberry	No								x						
Rosaceae	*Pyracantha angustifolia*	Orange Firethorn	No												x		
Rosaceae	*Rubus fruticosus*	Blackberry	No					x	x	x	x	x					
Rosaceae	*Rubus parvifolius*	Native Blackberry	Yes								x						
Salicaceae	*Salix* sp.	Willow	No									x					
Santalaceae	*Exocarpos cupressiformis*	Native Cherry	Yes		x												
Selliera radicans	*Selliera radicans*	Swamp Selliera	Yes						x							x	
Solanaceae	*Lycium ferocissimum*	African Boxthorn	No								x						
Solanaceae	*Solanum mauritianum*	Wild Tobacco	No					x		x	x	x					x
Solanaceae	*Solanum pseudocapsicum*	Jerusalem Cherry	No					x									
Theophrastaceae	*Samolus repens*	Creeping Brookweed	Yes						x							x	
Thymelaeaceae	*Pimelea linifolia*	Flax-leafed Riceflower	Yes		x												
Typhaceae	*Typha orientalis*	Typha	Yes			x			x	x			x				

Family	Scientific Name	Common Name	Native	AS	ASMF	AW	CGRGF	CSOF	EAW	FW	LDSR	LWMF	MBRGFF	PWE	PSOF	SM	W&E
Verbenaceae	*Lantana camara*	Lantana	No	x	x		x	x		x	x	x	x	x	x		x
Verbenaceae	*Verbena bonariensis*	Purple-top	No					x				x			x		
Verbenaceae	*Verbena rigida*	Veined Verbena	No								x						
Violaceae	*Viola hederacea*	Native Violet	Yes		x												

*Abbreviations for vegetation communities shown in Table 7, Section 4.

Table 18: Bird species recorded across the study area

Common Name	Scientific Name	ELA 2010	Mills & Associates 1996	Mills & Associates 1997	Burcher 1997	Brandis 2005	URS 2006	DECCW 2010a	ELA 2008
Australasian Darter	*Anhinga novaehollandiae*	✓	✓	□	✓	✓	□	□	□
Australasian Grebe	*Tachybaptus novaehollandiae*	✓	✓	□	✓	✓	□	□	□
Australasian Shoveler	*Anas rhynchotis*	□	✓	□	✓	✓	□	□	□
Australian Hobby	*Falco longipennis*	□	□	□	✓	✓	□	□	□
Australian Magpie	*Gymnorhina tibicen*	✓	✓	✓	✓	✓	✓	□	□
Australian Painted Snipe	***Rostratula australis***	□	□	□	✓	□	□	□	□
Australian Pelican	*Pelecanus conspicillatus*	✓	✓	□	✓	✓	✓	□	□
Pied Oystercatcher	***Haematopus longirostris***	□	□	□	✓	✓	□	□	□
Australian Pipit	*Anthus novaeseelandiae*	□	□	□	□	✓	□	□	□
Australian Raven	*Corvus coronoides*	✓	✓	✓	✓	✓	✓	□	□
Australian Reed-Warbler	*Acrocephalus australis*	□	□	□	✓	✓	✓	□	□
Australian Shelduck	*Tadorna tadornoides*	□	□	□	✓	✓	□	□	□
Australian Spotted Crake	*Porzana fluminea*	□	□	□	✓	✓	□	□	□
Australian White Ibis	*Threskiornis molucca*	✓	□	□	✓	✓	✓	□	□
Australian Wood Duck	*Chenonetta jubata*	□	✓	✓	✓	✓	□	□	□
Azure Kingfisher	*Ceyx azurea*	□	□	□	✓	✓	□	□	□
Baillon's Crake	*Porzana pusilla*	□	□	□	□	✓	□	□	□
Barn Owl	*Tyto alba*	□	□	□	✓	✓	□	□	□
Bar-shouldered Dove	*Geopelia humeralis*	□	□	□	□	✓	□	□	□
Bar-tailed Godwit	***Limosa lapponica***	□	□	□	✓	✓	□	□	□
Black Bittern	***Ixobrychus flavicollis***	□	□	□	✓	✓	□	✓	□
Black Kite	*Milvus migrans*	□	□	□	□	✓	□	□	□
Black Swan	*Cygnus atratus*	✓	✓	□	✓	✓	□	□	□
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	✓	□	✓	✓	✓	□	□	□
Black-faced Monarch	***Monarcha melanopsis***	□	□	□	□	✓	□	□	✡
Black-fronted Dotterel	*Elseyornis melanops*	□	✓	□	✓	✓	□	□	□

Common Name	Scientific Name	ELA 2010	Mills & Associates 1996	Mills & Associates 1997	Burcher 1997	Brandis 2005	URS 2006	DECCW 2010a	ELA 2008
Black-shouldered Kite	*Elanus axillaris*	✓	□	□	✓	✓	□	□	□
Black-tailed Godwit	***Limosa limosa***	□	□	□	✓	□	□	□	□
Black-winged Stilt	*Himantopus himantopus*	✓	✓	□	✓	✓	□	□	□
Brown Cuckoo-Dove	*Macropygia amboinensis*	□	□	□	✓	□	□	□	□
Brown Falcon	*Falco berigora*	□	✓	✓	✓	✓	□	□	□
Brown Gerygone	*Gerygone mouki*	✓	□	□	✓	✓	□	□	□
Brown Goshawk	*Accipiter fasciatus*	✓	□	□	✓	✓	□	□	□
Brown Quail	*Coturnix ypsilophora*	□	□	□	✓	✓	□	□	□
Brown Songlark	*Cinclorhemphus cruralis*	□	□	□	□	✓	□	□	□
Brown Thornbill	*Acanthiza pusilla*	✓	□	□	✓	✓	□	□	□
Brush Cuckoo	*Cacomantis variolosus*	□	□	□	✓	✓	□	□	□
Buff-banded Rail	*Gallirallus philippensis*	□	□	□	✓	✓	□	□	□
Caspian Tern	***Hydroprogne caspia***	✓	□	□		✓	□	□	□
Cattle Egret	***Ardea ibis***	✓	✓	□	✓	✓	✓	□	✡
Channel-billed Cuckoo	*Scythrops novaehollandiae*	□	□	□	✓	✓	□	□	□
Chestnut Teal	*Anas castanea*	✓	✓	✓	✓	✓	□	□	□
Chestnut-breasted Manikin	*Lonchura castaneothorax*	□	□	□	✓	✓	□	□	□
Collared Sparrowhawk	*Accipiter cirrocephalus*	□	□	□	□	✓	□	□	□
Common Blackbird	*Turdus merula*	✓	□	□	□	✓	□	□	□
Common Bronzewing	*Phaps chalcoptera*	✓	□	□	□	□	□	□	□
Common Greenshank	*Tringa nebularia*	□	□	□	✓	✓	□	□	□
Common Myna	*Sturnus tristis*	✓	✓	✓	✓	✓	✓	□	□
Common Sandpiper	*Actitis hypoleucos*	□	□	□	✓	✓	□	□	□
Common Starling	*Sturnus vulgaris*	□	✓	✓	✓	✓	□	□	□
Crested Pigeon	*Ocyphaps lophotes*	✓	□	□	✓	✓	□	□	□
Crested Tern	***Thalasseus bergii***	✓	□	□	□	✓	□	□	□
Crimson Rosella	*Platycercus elegans*	✓	□	✓	✓	✓	□	□	□

Common Name	Scientific Name	ELA 2010	Mills & Associates 1996	Mills & Associates 1997	Burcher 1997	Brandis 2005	URS 2006	DECCW 2010a	ELA 2008
Curlew Sandpiper	*Calidris ferruginea*	□	□	□	✓	✓	□	□	□
Dollarbird	*Eurystomus orientalis*	□	□	□	✓	✓	□	□	□
Double-banded Plover	***Charadrius bicinctus***	□	✓	□	✓	✓	□	□	□
Double-barred Finch	*Taeniopygia bichenovii*	□	□	□	✓	□	□	□	□
Dusky Moorhen	*Gallinula tenebrosa*	□	□	✓	✓	✓	□	□	□
Dusky Woodswallow	*Artamus cyanopterus*	□	□	□	✓	□	□	□	□
Eastern Curlew	***Numenius madagascariensis***	□	□	□	✓	✓	□	□	□
Eastern Koel	*Eudynamys orientalis*	□	□	□	□	✓	□	□	□
Osprey	***Pandion cristatus***	✓	✓	□	✓	✓	□	✓	□
Eastern Rosella	*Platycercus eximius*	✓	✓	✓	✓	✓	✓	□	□
Eastern Spinebill	*Acanthorhynchus tenuirostris*	✓	□	□	✓	✓	□	□	□
Eastern Whipbird	*Psophodes olivaceus*	✓	□	□	✓	✓	□	□	□
Eastern Yellow Robin	*Eopsaltria australis*	✓	□	□	✓	✓	□	□	□
Eurasian Coot	*Fulica atra*	✓	✓	□	✓	✓	□	□	□
Eurasian Skylark	*Alauda arvensis*	□	□	□	✓	✓	□	□	□
European Goldfinch	*Carduelis carduelis*	✓	✓	✓	✓	✓	□	□	□
Fairy Martin	*Petrochelidon ariel*	□	□	□	✓	✓	□	□	□
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	✓	✓	✓	✓	✓	□	□	□
Freckled Duck	***Stictonetta naevosa***	□	□	□	✓	✓	□	✓	□
Fuscous Honeyeater	*Lichenostomus fuscus*	□	□	□	✓	□	□	□	□
Galah	*Elaphus roseicapilla*	□	✓	✓	✓	✓	✓	□	□
Glossy Ibis	*Plegadis facinellus*	□	□	□	✓	✓	□	□	□
Golden Whistler	*Pachycephala pectoralis*	□	□	□	✓	✓	□	□	□
Golden-headed Cisticola	*Cisticola exilis*	□	✓	□	✓	✓	□	□	□
Great Cormorant	*Phalacrocorax carbo*	□	✓	□	✓	✓	□	□	□
Great Egret	***Ardea alba***	✓	✓	□	✓	✓	□	□	□
Great-crested Grebe	*Podiceps cristatus*	□	□	□	□	✓	□	□	□

Common Name	Scientific Name	ELA 2010	Mills & Associates 1996	Mills & Associates 1997	Burcher 1997	Brandis 2005	URS 2006	DECCW 2010a	ELA 2008
Grey Butcherbird	*Cracticus torquatus*	✓	✓	✓	✓	✓	✓	□	□
Grey Fantail	*Rhipidura albiscapa*	✓	□	✓	✓	✓	□	□	□
Grey Goshawk	*Accipiter novaehollandiae*	□	□	□	□	✓	□	□	□
Grey Heron	*Ardea cinerea*	□	□	□	□	□	✓	□	□
Grey Plover	*Pluvialis squatarola*	□	□	□	✓	□	□	□	□
Grey Shrike-thrush	*Colluricincla harmonica*	✓	✓	✓	✓	✓	□	□	□
Grey Teal	*Anas gracilis*	□	✓	□	✓	✓	□	□	□
Hardhead	*Aythya australis*	□	✓	□	✓	✓	□	□	□
Hoary-headed Grebe	*Poliocephalus poliocephalus*	□	□	□	□	✓	□	□	□
Horsfield's Bronze-Cuckoo	*Chalcites basalis*	□	□	□	✓	✓	□	□	□
House Sparrow	*Passer domesfictus*	□	□	□	✓	✓	□	□	□
Kelp Gull	*Larus dominicanus*	□	□	□	✓	✓	□	□	□
King Quail	*Excalfactoria chinensis*	□	□	□	✓	□	□	□	□
Latham's Snipe	***Gallinago hardwickii***	□	□	□	✓	✓	□	□	□
Laughing Kookaburra	*Dacelo novaeguineae*	✓	✓	✓	✓	✓	✓	□	□
Leaden Flycatcher	*Myiagra rubecula*	□	□	□	✓	✓	□	□	□
Lesser Sand Plover	***Charadrius mongolus***	□	□	□	✓	□	□	□	□
Lewin's Honeyeater	*Meliphaga lewinii*	✓	✓	□	✓	✓	□	□	□
Little Black Cormorant	*Phalacrocorax sulcirostris*	✓	✓	□	✓	✓	□	□	□
Little Corella	*Cacatua sanguinea*	□	□	□	□	✓	□	□	□
Little Eagle	***Hieraaetus morphnoides***	□	□	□	✓	✓	□	□	□
Little Egret	*Egretta garzetta*	□	□	□	✓	✓	□	□	□
Little Grassbird	*Megalurus gramineus*	✓	□	□	✓	✓	□	□	□
Little Pied Cormorant	*Microcarbo melanoleucos*	✓	✓	□	✓	✓	□	□	□
Little Raven	*Corvus mellori*	✓	□	□	□	✓	□	□	□
Little Wattlebird	*Anthochaera chrysoptera*	✓	□	□	✓	□	✓	□	□
Long-billed Corella	*Cacatua tenuirostris*	□	□	✓	□	✓	□	□	□

Common Name	Scientific Name	ELA 2010	Mills & Associates 1996	Mills & Associates 1997	Burcher 1997	Brandis 2005	URS 2006	DECCW 2010a	ELA 2008
Magpie-lark	*Grallina cyanoleuca*	□	✓	✓	✓	✓	□	□	□
Marsh Sandpiper	***Tringa stagnatilis***	□	□	□	✓	✓	□	□	□
Masked Lapwing	*Vanellus miles*	✓	✓	✓	✓	✓	□	□	□
Mistletoebird	*Dicaeum hirundinaceum*	□	✓	□	✓	✓	□	□	□
Musk Duck	*Biziura lobata*	□	□	□	✓	✓	□	□	□
Nankeen Kestrel	*Falco cenchroides*	□	□	✓	✓	✓	□	□	□
Nankeen Night-Heron	*Nycticorax caledonicus*	□	□	□	✓	✓	□	□	□
New Holland Honeyeater	*Phylidonyris novaehollandiae*	□	□	□	✓	✓	□	□	□
Noisy Friarbird	*Philemon corniculatus*	□	□	□	✓	✓	□	□	□
Noisy Miner	*Manorina melanocephala*	✓	✓	✓	✓	✓	✓	□	□
Northern Mallard	*Anas platyrhynchos*	□	□	□	□	✓	□	□	□
Olive-backed Oriole	*Oriolus sagittatus*	□	□	□		✓	□	□	□
Pacific Baza	*Aviceda subcristata*	□	□	□	□	✓	□	□	□
Pacific Black Duck	*Anas superciliosa*	✓	✓	□	✓	✓	✓	□	□
Pacific Golden Plover	***Pluvialis fulva***	□	□	□	✓	✓	□	□	□
Pallid Cuckoo	*Cacomantis pallidus*	□	□	□	✓	✓	□	□	□
Peregrine Falcon	*Falco peregrinus*	✓	□	□	✓	✓	□	□	□
Pied Cormorant	*Phalacrocorax varius*	□	□	□	□	✓	□	□	□
Pied Currawong	*Strepera graculina*	✓	□	✓	✓	✓	✓	□	□
Pink Robin	***Petroica rodinogaster***		□	□	□	□	□	□	✡
Pink-eared Duck	*Malacorhynchus mernbranaceus*	□	□	□	✓	✓	□	□	□
Purple Swamphen	*Porphyrio porphyrio*	✓	✓	□	✓	✓	✓	□	□
Rainbow Lorikeet	*Trichoglossus haematodus*	✓	□	□	□	✓	□	□	□
Red Wattlebird	*Anthochaera carunculata*	□	□	□	✓	✓	□	□	□
Red-browed Finch	*Neochmia temporalis*	✓	✓	□	✓	✓	□	□	□
Red-capped Plover	*Charadrius ruficapillus*	□	□	□	✓	✓	□	□	□
Red-kneed Dotterel	*Erythrogonys cinctus*	✓	□	□	✓	✓	□	□	□

Common Name	Scientific Name	ELA 2010	Mills & Associates 1996	Mills & Associates 1997	Burcher 1997	Brandis 2005	URS 2006	DECCW 2010a	ELA 2008
Red-necked Avocet	*Recurvirostra novaehollandiae*	□	□	□		✓	□	□	□
Red-necked Stint	***Calidris ruficollis***	□	□	□	✓	✓	□	□	□
Red-rumped Parrot	*Psephotus haematonotus*	□	✓	□	✓	✓	□	□	□
Red-whiskered Bulbul	*Pycnonotus jocosus*	✓	□	✓	✓	✓	✓	□	□
Restless Flycatcher	*Myiagra inquieta*	□	□	□	✓	□	□	□	□
Richard's Pipit	*Anthus richardi*	✓	✓	□	✓	□	□	□	□
Rock Dove	*Columba livia*	□	□	□	✓	✓	□	□	□
Rose Robin	*Petroica rosea*	□	□	□	✓	✓	□	□	□
Royal Spoonbill	*Platalea regia*	✓	□	□	✓	✓	□	□	□
Ruddy Turnstone	*Arenaria interpres*	□	□	□	□	✓	□	□	□
Rufous Fantail	***Rhipidura rufifrons***	□	□	□	✓	✓	□	□	□
Rufous Songlark	*Cincloramphus mathewsi*	□	□	□	✓	□	□	□	□
Rufous Whistler	*Pachycephala rufiventris*	✓	□	□	✓	✓	□	□	□
Sacred Kingfisher	*Todiramphus sanctus*	□	□	□	✓	✓	□	□	□
Satin Bowerbird	*Ptilonorhynchus violaceus*	□	□	□	✓	✓	□	□	□
Satin Flycatcher	*Myiagra cyanoleuca*	□	□	□	□	□	□	□	✿
Scarlet Honeyeater	*Myzomela sanguinolenta*	✓	□	□	□	✓	□	□	□
Scarlet Robin	***Petroica boodang***	□	□	✓	□	□	□	□	□
Sharp-tailed Sandpiper	***Calidris acuminata***	□	□	□	✓	✓	□	□	□
Shining Bronze-Cuckoo	*Chalcites lucidus*	□	□	□	✓	✓	□	□	□
Silver Gull	*Chroicocephalus novaehollandiae*	✓	✓	□	✓	✓	□	□	□
Silvereye	*Zosterops lateralis*	✓	✓	✓	✓	✓	✓	□	□
Sooty Oystercatcher	***Haematopus fuliginosus***	✓	□	□	□	□	□	□	□
Southern Boobook	*Ninox novaeseelandiae*	□	□	□	✓	✓	□	□	□
Southern Emu-wren	*Stipiturus malachurus*	□	□	□	✓	✓	□	□	□
Spangled Drongo	*Dicrurus bracteatus*	□	□	□	□	✓	□	□	□
Spotless Crake	*Porana tabuensis*	□	□	□	□	✓	□	□	□

Common Name	Scientific Name	ELA 2010	Mills & Associates 1996	Mills & Associates 1997	Burcher 1997	Brandis 2005	URS 2006	DECCW 2010a	ELA 2008
Spotted Harrier	***Circus assimilis***	□	□	□	□	✓	□	□	□
Spotted Pardalote	*Pardalotus punctatus*	✓	✓	✓	✓	✓	□	□	□
Spotted Turtledove	*Streptopelia chinensis*	□	✓	✓	✓	✓	□	□	□
Straw-necked Ibis	*Threskiornis spinicollis*	□	□	□	✓	✓	□	□	□
Striated Heron	*Butorides striatus*	□	□	□	✓	✓	□	□	□
Striated Pardalote	*Pardalotus striatus*	✓	□	✓	✓	✓	□	□	□
Striated Thornbill	*Acanthiza lineata*	□	□	□	✓	✓	□	□	□
Stubble Quail	*Coturnix pectoralis*	□	□	□	□	✓	□	□	□
Sulphur-crested Cockatoo	*Cacatua galerita*	✓	✓	✓	✓	✓	✓	□	□
Superb Fairy-wren	*Malurus cyaneus*	✓	✓	✓	✓	✓	□	□	□
Swamp Harrier	*Circus approximans*	✓	□	✓	✓	✓	□	□	□
Tawny Frogmouth	*Podargus strigoides*	□	□	□	✓	✓	□	□	□
Tawny Grassbird	*Megalurus timoriensis*	□	□	□	✓	✓	□	□	□
Topknot Pigeon	*Lopholaimus antarcticus*	□	□	□	✓	✓	□	□	□
Tree Martin	*Petrochelidon nigricans*	✓	□	□	✓	✓	□	□	□
Variegated Fairy-wren	*Malurus lamberti*	□	□	□	✓	✓	□	□	□
Wedge-tailed Eagle	*Aquila audax*	✓	□	□	□	✓	□	□	□
Weebill	*Smicrornis brevirostris*	□	□	□	✓	□	□	□	□
Welcome Swallow	*Hirundo neoxena*	✓	✓	✓	✓	✓	□	□	□
Whiskered Tern	*Chlidonias hybrias*	□	□	□	□	✓	□	□	□
Whistling Kite	*Haliastur sphenurus*	✓	□	□	✓	✓	□	□	□
White-bellied Sea eagle	***Haliaeetus leucogaster***	✓	□	□	✓	✓	□	□	□
White-browed Scrubwren	*Sericornis frontalis*	□	□	□	✓	✓	□	□	□
White-faced Heron	*Egretta novaehollandiae*	✓	✓	✓	✓	✓	□	□	□
White-fronted Chat	*Epthianura albifrons*	□	□	□	✓	✓	□	□	□
White-naped Honeyeater	*Melithreptus lunatus*	□	□	□	□	✓	□	□	□
White-necked Heron	*Ardea pacifica*	□	□	□	✓	✓	□	□	□

Common Name	Scientific Name	ELA 2010	Mills & Associates 1996	Mills & Associates 1997	Burcher 1997	Brandis 2005	URS 2006	DECCW 2010a	ELA 2008
White-throated Gerygone	*Gerygone albogularis*	□	□	□	✓	□	□	□	□
White-throated Needletail	***Hirundapus caudacutus***	□	□	□	✓	✓	□	□	□
White-throated Treecreeper	*Cormobates leucophaea*	✓	□	□	□	✓	□	□	□
White-winged Triller	*Lalage sueurii*	□	□	□	✓	✓	□	□	□
Willie Wagtail	*Rhipidura leucophrys*	✓	□	✓	✓	✓	✓	□	□
Yellow Thornbill	*Acanthiza nana*	□	✓	✓	✓	✓	□	□	□
Yellow-billed Spoonbill	*Platalea flavipes*	□	□	□	✓	✓	□	□	□
Yellow-faced Honeyeater	*Lichenostomus chrysops*	□	✓	✓	✓	✓	□	□	□
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	□	✓	□	✓	✓	□	□	□
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	□	□	□	✓	✓	✓	□	□
Zebra Finch	*Taeniopygia guttata*	□	□	□	□	✓	□	□	□
Threatened species									
Migratory species									
Threatened & migratory species									
✡ Eco Logical survey results for Yallah (not within study area but nearby)									

Table 19: Microchiropteran bats recorded across the study area (ELA 2010)

Date	Species Name	Common Name	Number of calls	Definite	Probable	Possible
Alluvial Swamp Mahogany Forest – Wollingurry Creek Area						
22 /4/010	*Chalinolobus gouldii*	Gould's Wattled Bat	6	1		5
	Miniopterus schreibersii oceanensis	**Eastern Bentwing Bat**	**4**	**2**		**2**
	Mormopterus species 2	Mormopterus species 2	3	1	1	1
	Myotis macropus	**Large-footed Myotis**	**2**			**2**
	Nyctophilus spp.		17			
Artificial Wetland in SW of site						
23/4/2010 & 24/4/2010	*Chalinolobus gouldii*	Gould's Wattled Bat	6	6		
	Chalinolobus morio	Chocolate Wattled Bat	4	3		1
	Miniopterus australis	**Little Bentwing Bat**	**3**	**3**		
	Mormopterus norfolkensis	**East-coast Freetail Bat**	**1**	**1**		
	Mormopterus species 2	Mormopterus species 2	1	1		
	Myotis macropus	**Large-footed Myotis**	**1**	**1**		
	Scotorepens orion	Eastern Broad-nosed Bat	2	2		
	Tadarida australis	White-striped Freetail Bat	4	4		
	Vespadelus darlingtoni	Large Forest Bat	1	1		
	Vespadelus vulturnus	Little Forest Bat	55	1	47	7
Centre of Southern Precinct – Hollow Bearing Tree						
11/10/2010	*Chalinolobus gouldii*	Gould's Wattled Bat	12	6		6
	Mormopterus species 2	Mormopterus species 2	10	4		6
Anabat 1 - Yallah Bay Road						
18/11/2010	*Chalinolobus gouldii*	Gould's Wattled Bat	17	14	1	2
	Chalinolobus morio	Chocolate Wattled Bat	51	37	5	9
	Falsistrellus tasmaniensis	**Eastern False Pipistrelle**	**2**			**2**
	Mormopterus species 2	Mormopterus species 2	1			1
	Miniopterus schreibersii oceanensis	**Eastern Bentwing Bat**	**23**	**21**	**2**	
	Myotis macropus	**Large-footed Myotis**	**8**	**2**	**3**	**3**
	Nyctophilus sp.		2	1		1
	Tadarida australis	White-striped Freetail Bat	7	7		
Anabat 2 – Duck Creek Bridge						
18/11/2010	*Chalinolobus gouldii*	Goulds Wattled Bat	70	60	3	7
	Chalinolobus morio	Chocolate Wattled Bat	19	14		5

Date	Species Name	Common Name	Number of calls	Definite	Probable	Possible
	Falsistrellus tasmaniensis	**Eastern False Pipistrelle**	**6**	**1**	**2**	**3**
	Miniopterus australis	**Little Bent-wing Bat**	**5**	**1**		**4**
	Mormopterus species 2		2	2		
	Miniopterus schreibersii oceanensis	**Eastern Bent-wing Bat**	**47**	**46**		**1**
	Myotis macropus	**Large-footed Myotis**	**113**	**81**	**13**	**19**
	Nyctophilus sp.		27	22		5
Barrons Gully, Mount Brown Area						
21/12/2010 & 22/12/2010	*Chalinolobus gouldii*	Gould's Wattled Bat	3	-	2	1
	Chalinolobus morio	Chocolate Wattled Bat	2	-	2	-
	Miniopterus australis	**Little Bentwing Bat**	13	4	3	6
	Mormopterus norfolkensis	**East-coast Freetail Bat**	1	-	-	1
	Mormopterus species 2	Mormopterus species 2	1	-	-	1
	Tadarida australis	White-striped Freetail Bat	8	4	-	4
	Vespadelus regulus	Southern Forest Bat	6	-	-	6

Bold = Threatened species

Table 20: Amphibian (GGBF) Survey Results

		Species Observed															
		Litoria peronii			*Limnodynastes peronii*			*Litoria fallax*			*Crinia signifera*			*Litoria verreauxii*			*Gambusia*
Site ID	Trip	C	O	T	C	O	T	C	O	T	C	O	T	C	O	T	O
1	1	x						x		x							y
	2	x						x		x							y
	3	x						x									y
	4	x						x									y
2	1	x						x									
	2	x			x		x	x									y
	3	x			x			x									y
	4	x			x			x									y
3	1	x			x			x	x	x							y
	2	x						x	x	x							y
	3	x															y
	4	x						x									y
4	1	x		x	x		x	x		x	x						y
	2	x			x		x	x		x							y
	3	x					x	x		x							y
	4	x			x			x									y
5	1	x	x		x			x			x						
	2						x										
	3	x	x					x	x								
	4	x			x	x		x									
6	1	x	x		x	x					x						
	2						x										
	3	x			x	x		x	x	x							
	4				x												

Species Observed

		Litoria peronii			*Limnodynastes peronii*			*Litoria fallax*			*Crinia signifera*			*Litoria verreauxii*			*Gambusia*
Site ID	**Trip**	**C**	**O**	**T**	**C**	**O**	**T**	**C**	**O**	**T**	**C**	**O**	**T**	**C**	**O**	**T**	**O**
7	1	x			x			x									
	2	x	x		x	x	x	x	x	x							y
	3	x			x		x	x		x							y
	4																y
8	1							x	x	x							
	2							x	x	x							
	3							x	x	x							
	4							x	x	x							
9	1	x	x		x	x					x						
	2									x							
	3	x	x	x				x	x	x				x			
	4	x	x		x	x	x	x	x					x			
10	1	x	x		x									x			
	2	x						x						x			
	3	x			x			x						x			
	4	x	x					x	x					x			
11	1							x									
	2							x	x								
	3							x									
	4							x									
12	1	x		x	x	x		x	x		x						
	2			x		x		x		x							
	3					x	x	x	x	x							
	4				x	x		x	x								
13	1	x			x	x		x	x								

Species Observed

		Litoria peronii			*Limnodynastes peronii*			*Litoria fallax*			*Crinia signifera*			*Litoria verreauxii*			*Gambusia*
Site ID	**Trip**	**C**	**O**	**T**	**C**	**O**	**T**	**C**	**O**	**T**	**C**	**O**	**T**	**C**	**O**	**T**	**O**
	2				x	x		x			x						
	3	x			x	x		x									
	4				x	x		x									

C=Call Playback; O = Observed; T=Tadpole

Site ID - Refer to Figure 13

Appendix C: Threatened Species Likelihood of Occurrence

Table 21: Threatened species recorded within the locality or considered to have the potential to occur

Scientific Name	Common Name	TSC	EPBC	Habitat Associations	Likelihood Occurrence
AMPHIBIANS					
Heleioporus australiacus	Giant Burrowing Frog	V	V	Forages in woodlands, wet heath, dry and wet sclerophyll forest (Ehmann 1997). Associated with semi-permanent to ephemeral sand or rock based streams (Ehmann 1997), where the soil is soft and sandy so that burrows can be constructed (Environment Australia 2000).	Unlikely
Litoria aurea	Green and Golden Bell Frog	E	V	This species has been observed utilising a variety of natural and man-made waterbodies (Pyke & White 1996) such as coastal swamps, marshes, dune swales, lagoons, lakes, other estuary wetlands, riverine floodplain wetlands and billabongs, stormwater detention basins, farm dams, bunded areas, drains, ditches and any other structure capable of storing water (DECC 2007). Fast flowing streams are not utilised for breeding purposes by this species (Mahony 1999). Preferable habitat for this species includes attributes such as shallow, still or slow flowing, permanent and/or widely fluctuating water bodies that are unpolluted and without heavy shading (DECC 2007). Large permanent swamps and ponds exhibiting well-established fringing vegetation (especially bulrushes–Typha sp. and spikerushes–Eleocharis sp.) adjacent to open grassland areas for foraging are preferable (Ehmann 1997; Robinson 1993). Ponds that are typically inhabited tend to be free from predatory fish such as Mosquito Fish (Gambusia holbrooki) (DECC 2007).	Potential, but considered unlikely following exhaustive target survey

Scientific Name	Common Name	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Pseudophryne australis	Red-crowned Toadlet	V	—	Red-crowned Toadlets are found in steep escarpment areas and plateaus, as well as low undulating ranges with benched outcroppings on Triassic sandstones of the Sydney Basin (DECC 2007). Within these geological formations, this species mainly occupies the upper parts of ridges, usually being restricted to within about 100 metres of the ridgetop. However they may also occur on plateaus or more level rock platforms along the ridgetop (DECC 2007). Associated with open forest to coastal heath (Ehmann 1997). Utilises small ephemeral drainage lines which feed water from the top of the ridge to the perennial creeks below for breeding, and are not usually found in the vicinity of permanent water (Ehmann 1997). Breeding sites are often characterised by clay-derived soils and generally found below the first sandstone escarpment in the talus slope (NPWS 1997).	Unlikely
Litoria littlejohni	Littlejohn's Tree Frog, Heath Frog	V	V	This species breeds in the upper reaches of permanent streams and in perched swamps. Non-breeding habitat is heath based forests and woodlands where it shelters under leaf litter and low vegetation, and hunts for invertebrate prey either in shrubs or on the ground (DECCW 2010).	No
Mixophyes balbus	Stuttering Frog	E	V	Found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range. Outside the breeding season adults live in deep leaf litter and thick understorey vegetation on the forest floor (DECCW 2010).	Unlikely
REPTILES					
Hoplocephalus bungaroides	Broad-headed Snake	E	V	Shelters in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring. Moves from the sandstone rocks to shelters in hollows in large trees within 200 m of escarpments in summer (DECCW 2010).	No
BIRDS - DIURNAL					
Botaurus poiciloptilus	Australasian Bittern	V	—	Boggy marsh, wetland margins.	Potential

Scientific Name	Common Name	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Callocephalon fimbriatum	Gang-gang Cockatoo	V	—	During summer in dense, tall, wet forests of mountains and gullies, alpine woodlands (Morcombe 2004). In winter they occur at lower altitudes in drier more open forests and woodlands, particularly box-ironbark assemblages (Shields & Chrome 1992). They sometimes inhabit woodland, farms and suburbs in autumn/winter (Simpson & Day 2004).	Unlikely
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	—	Associated with a variety of forest types containing Allocasuarina species, usually reflecting the poor nutrient status of underlying soils (Environment Australia 2000; NPWS 1997; DECC 2007). Intact drier forest types with less rugged landscapes are preferred (DECC 2007). Nests in large trees with large hollows (Environment Australia 2000).	Unlikely
Circus assimilis	Spotted Harrier	V	—	Found throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Individuals disperse widely in NSW and comprise a single population. Occurs in grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands. (DECC 2007)	Yes
Ephippiorhynchus asiaticus	Black-necked Stork	E	—	Associated with tropical and warm temperate terrestrial wetlands, estuarine and littoral habitats, and occasionally woodlands and grasslands floodplains (Marchant & Higgins 1993). Forages in fresh or saline waters up to 0.5m deep, mainly in open fresh waters, extensive sheets of shallow water over grasslands or sedgeland, mangroves, mudflats, shallow swamps with short emergent vegetation and permanent billabongs and pools on floodplains (Marchant & Higgins 1993; DECC 2007).	Potential
Gygis alba	White Tern	V	—	Subtropical and tropical seas; usually far from land, except in breeding season where it forages over lagoons and reefs around islands (Morcombe 2004).	Unlikely
Haematopus fuliginosus	Sooty Oystercatcher	V	—	Intertidal rocky and coral reefs, mostly on ocean shores, breeds mostly on offshore islands, occasionally frequents sandspits and tidal mudflats.	Yes
Haematopus longirostris	Pied Oystercatcher	V	—	Undisturbed sandy beaches, sandspits and sandbars, tidal mudflats and estuaries, coastal islands.	Yes

Scientific Name	Common Name	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Hieraaetus morphnoides	Little Eagle	V	—	Found throughout the Australian mainland excepting the most densely forested parts of the Dividing Range escarpment. It occurs as a single population throughout NSW. Occupies open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used. (DECC 2007)	Yes
Irediparra gallinacea	Comb-crested Jacana	V	—	Freshwater wetlands, such as lagoons, billabongs, swamps, lakes and reservoirs, generally with abundant floating aquatic vegetation (Marchant and Higgins 1999).	Unlikely
Ixobrychus flavicollis	Black Bittern	V	—	Occurs in both terrestrial and estuarine wetlands generally in areas of permanent water and dense vegetation (DECC 2007). In areas with permanent water it may occur in flooded grassland, forest, woodland, rainforest and mangroves (DECC 2007)	Yes
Lathamus discolor	Swift Parrot	E	E	Breeds in Tasmania between September and January. Migrates to mainland in autumn, where it forages on profuse flowering Eucalypts (Blakers et al. 1984; Schodde and Tidemann 1986). Hence, in this region, autumn and winter flowering eucalypts are important for this species. Favoured feed trees include winter flowering species such as Swamp Mahogany (Eucalyptus robusta), Spotted Gum (Corymbia maculata), Red Bloodwood (C. gummifera), Mugga Ironbark (E. sideroxylon), and White Box (E. albens) (DECC 2007).	Potential
Lophoictinia isura	Square-tailed Kite	V	M	Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses. Appears to occupy large hunting ranges of more than 100km2. Breeding is from July to February, with nest sites generally located along or near watercourses, in a fork or on large horizontal limbs.	Potential
Neophema chrysogaster	Orange-bellied Parrot	CE	CE, M, JAMBA	Typical winter habitat is saltmarsh and strandline/foredune vegetation communities either on coastlines or coastal lagoons. Spits and islands are favoured but they will turn up anywhere within these coastal regions.	Unlikely

Scientific Name	Common Name	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Neophema pulchella	Turquoise Parrot	V	—	Steep rocky ridges and gullies, rolling hills, valleys and river flats and the plains of the Great Dividing Range compromise the topography inhabited by this species (Marchant & Higgins 1993). Spends much of the time on the ground foraging on seed and grasses (DECC 2007). It is associated with coastal scrubland, open forest and timbered grassland, especially low shrub ecotones between dry hardwood forests and grasslands with high proportion of native grasses and forbs (Environment Australia 2000).	Potential
Oxyura australis	Blue-billed Duck	V	-—	The Blue-billed Duck prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation (DECC 2007). The species is completely aquatic, swimming low in the water along the edge of dense cover (DECC 2007). It will fly if disturbed, but prefers to dive if approached (DECC 2007). Blue-billed Ducks are partly migratory, with short-distance movements between breeding swamps and over-wintering lakes with some long-distance dispersal to breed during spring and early summer (DECC 2007). Young birds disperse in April-May from their breeding swamps in inland NSW to non-breeding areas on the Murray River system and coastal lakes (DECC 2007).	Potential
Petroica boodang	Scarlet Robin	V	—	The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. The Scarlet Robin is found from SE Queensland to SE South Australia and also in Tasmania and SW Western Australia. In NSW, it occurs from the coast to the inland slopes. After breeding, some Scarlet Robins disperse to the lower valleys and plains of the tablelands and slopes. Some birds may appear as far west as the eastern edges of the inland plains in autumn and winter	Yes
Petroica rodinogaster	Pink Robin	V	—	Inhabits rainforest and tall, open eucalypt forest, particularly in densely vegetated gullies. On the mainland, the species disperses north and west and into more open habitats in winter	Likely
Polytelis swainsonii	Superb Parrot	V	V	Inhabit Box-Gum, Box-Cypress-pine and Boree Woodlands and River Red Gum Forest. On the South West Slopes nest trees can be in open Box-Gum Woodland or isolated paddock trees. Species known to be used are Blakely's Red Gum, Yellow Box, Apple Box and Red Box. May forage up to 10 km from nesting sites, primarily in grassy box woodland.	Unlikely

Scientific Name	Common Name	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Ptilinopus magnificus	Wompoo Fruit-Dove	V	—	Associated with large, undisturbed patches of tall tropical or subtropical rainforest, at all altitudes, preferably with a diversity of fruit (Marchant and Higgins 1999; DECC 2007). Occasionally located in patches of monsoon rainforest, closed gallery forest, wet sclerophyll forest, tall open forest, and open woodland or vine thickets near rainforest (Marchant and Higgins 1999; DECC 2007).	Unlikely
Sterna fuscata	Sooty Tern	V	—	Forages offshore, usually only observed onshore in breeding season or when storms force them to shelter (DECC 2007)	Potential
Stictonetta naevosa	Freckled Duck	V	—	Associated with a variety of plankton-rich wetlands, such as heavily vegetated, large open lakes and their shores, creeks, farm dams, sewerage ponds and floodwaters (DECC 2007).	Yes
Xanthomyza phrygia	Regent Honeyeater	E	E, M, JAMBA	Associated with temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts, and riparian forests of River Oak (Casuarina cunninghamiana) (Garnett 1993). Areas containing Swamp Mahogany (Eucalyptus robusta) in coastal areas have been observed to be utilised (NPWS 1997). The Regent Honeyeater primarily feeds on nectar from box and ironbark eucalypts and occasionally from banksias and mistletoes (NPWS 1995). As such it is reliant on locally abundant nectar sources with different flowering times to provide reliable supply of nectar (Environment Australia 2000).	Potential
BIRDS - NOCTURNAL					
Ninox connivens	Barking Owl	V	—	Associated with a variety of habitats such as savannah woodland, open eucalypt forests, wetland and riverine forest. The habitat is typically dominated by Eucalypts (often Red Gum species), however often dominated by Melaleuca species in the tropics (DECC 2007). It usually roosts in dense foliage in large trees such as River She-oak (Allocasuarina cunninghamiana), other Casuarina and Allocasuarina, eucalypts, Angophora, Acacia and rainforest species from streamside gallery forests (NPWS 2003). It usually nests near watercourses or wetlands (NPWS 2003) in large tree hollows with entrances averaging 2-29 metres above ground, depending on the forest or woodland structure and the canopy height (Debus 1997).	Likely

Scientific Name	Common Name	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Ninox strenua	Powerful Owl	V	—	Powerful Owls are associated with a wide range of wet and dry forest types with a high density of prey, such as arboreal mammals, large birds and flying foxes (Environment Australia 2000, Debus & Chafer 1994). Large trees with hollows at least 0.5m deep are required for shelter and breeding (Environment Australia 2000).	Potential
Tyto novaehollandiae	Masked Owl	V	—	Associated with forest with sparse, open, understorey, typically dry sclerophyll forest and woodland (DECC 2007) and especially the ecotone between wet and dry forest, and non forest habitat (Environment Australia 2000). Known to utilise forest margins and isolated stands of trees within agricultural land (Hyem 1979) and heavily disturbed forest where its prey of small and medium sized mammals can be readily obtained (Kavanagh & Peake 1993).	Potential
Tyto tenebricosa	Sooty Owl	V	—	Sooty Owls are associated with tall wet old growth forest on fertile soil with a dense understorey and emergent tall Eucalyptus species (Environment Australia 2000, Debus 1994). Pairs roost in the daytime amongst dense vegetation, in tree hollows and sometimes in caves. The Sooty Owl is typically associated with an abundant and diverse supply of prey items and a selection of large tree hollows (Debus 1994, Garnett 1993, Hyem 1979).	Unlikely
MAMMALS - (EXCLUDING BATS)					
Dasyurus maculatus	Spotted-tailed Quoll (SE Mainland Population)		E	The Spotted-tailed Quoll inhabits a range of forest communities including wet and dry sclerophyll forests, coastal heathlands and rainforests (Mansergh 1984; DECC 2007j), more frequently recorded near the ecotones of closed and open forest. This species requires habitat features such as maternal den sites, an abundance of food (birds and small mammals) and large areas of relatively intact vegetation to forage in (DECC 2007). Maternal den sites are logs with cryptic entrances; rock outcrops; windrows; burrows (Environment Australia 2000).	Unlikely
Isoodon obesulus	Southern Brown Bandicoot	E	E	This species is associated with heath, coastal scrub, heathy forests (Menkhorst & Knight 2004), shrubland and woodland on well drained soils. This species is thought to display a preference for newly regenerating heathland and other areas prone to fire (Menkhorst & Seebeck 1990).	No

Scientific Name	Common Name	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Potorous tridactylus tridactylus	Long-nosed Potoroo (SE mainland) Long-nosed Potoroo	V	V	Inhabits coastal heaths and dry and wet sclerophyll forests. Dense understorey with occasional open areas is an essential part of habitat, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas. A sandy loam soil is also a common feature (DECCW 2010).	No
MAMMALS - (BATS)					
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	The Large-eared Pied Bat has been recorded in a variety of habitats, including dry sclerophyll forests, woodland, sub-alpine woodland, edges of rainforests and wet sclerophyll forests (Churchill 1998; DECC 2007). This species roosts in caves, rock overhangs and disused mine shafts and as such is usually associated with rock outcrops and cliff faces (Churchill 1998; DECC 2007).	Yes
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	—	Prefers moist habitats with trees taller than 20m (DECC 2007). Roosts in tree hollows but has also been found roosting in buildings or under loose bark (DECC 2007).	Yes
Miniopterus australis	Little Bentwing-bat	V	—	Prefers well-timbered areas including rainforest, wet and dry sclerophyll forests, Melaleuca swamps and coastal forests (Churchill 1998). This species shelter in a range of structures including culverts, drains, mines and caves (Environment Australia 2000). Relatively large areas of dense vegetation of either wet sclerophyll forest, rainforest or dense coastal banksia scrub are usually found adjacent to caves in which this species is found (DECC 2007). Breeding occurs in caves, usually in association with M. schreibersii (Environment Australia 2000, DECC 2007).	Yes
Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat	V	—	Associated with a range of habitats such as rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and open grassland (Churchill 1998). It forages above and below the tree canopy on small insects (AMBS 1995, Dwyer 1995, Dwyer 1981). Will utilise caves, old mines, and stormwater channels, under bridges and occasionally buildings for shelter (Environment Australia 2000, Dwyer 1995).	Yes

Scientific Name	Common Name	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Mormopterus norfolkensis	Eastern Freetail Bat	V	—	Most records of this species are from dry eucalypt forest and woodland east of the Great Dividing Range (Churchill 1998). Individuals have, however, been recorded flying low over a rocky river in rainforest and wet sclerophyll forest and foraging in clearings at forest edges (Environment Australia 2000; Allison & Hoye 1998). Primarily roosts in hollows or behind loose bark in mature eucalypts, but have been observed roosting in the roof of a hut (Environment Australia 2000; Allison & Hoye 1998).	Yes
Myotis macropus	Large-footed Myotis	V	—	A range of habitats close to water from lakes, small creeks to large lakes and mangrove lined estuaries.	Yes
Pteropus poliocephalus	Grey-headed Flying-Fox	V	V	Inhabits a wide range of habitats including rainforest, mangroves, paperbark forests, wet and dry sclerophyll forests and cultivated areas (Churchill 1998, Eby 1998). Camps are often located in gullies, typically close to water, in vegetation with a dense canopy (Churchill 1998).	Yes
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	—	Found in almost all habitats, from wet and dry sclerophyll forest, open woodland (Churchill 1998). Roosts in tree hollows; may also use caves; has also been recorded in a tree hollow in a paddock (Environment Australia 2000) and in abandoned sugar glider nests (Churchill 1998). The Yellow-bellied Sheathtail-bat is dependent on suitable hollow-bearing trees to provide roost sites, which may be a limiting factor on populations in cleared or fragmented habitats (Environment Australia 2000).	Yes
Scoteanax rueppellii	Greater Broad-nosed Bat	V	—	Associated with moist gullies in mature coastal forest, or rainforest, east of the Great Dividing Range (Churchill, 1998), tending to be more frequently located in more productive forests (Hoye & Richards 1998). Within denser vegetation types use is made of natural and man made openings such as roads, creeks and small rivers, where it hawks backwards and forwards for prey (Hoye & Richards 1998).	Potential
FISH					
Macquaria australasica	Macquarie Perch	V	E	Occurs widely in riverine and lake habitats. In Sydney basin only known from Cataract and Cordeaux River catchments. Upland streams and migrates upstream to gravel beds to spawn.	Unlikely
Prototroctes maraena	Australian Grayling	V	V	Freshwater streams and rivers draining to the sea. Clear gravely streams and from estuarine reaches substantial distances inland.	Unlikely

Scientific Name	Common Name	TSC	EPBC	Habitat Associations	Likelihood Occurrence
MIGRATORY - Terrestrial					
Haliaeetus leucogaster	White-bellied Sea-Eagle	—	M, CAMBA	Forages over large open fresh or saline waterbodies, coastal seas and open terrestrial areas (Marchant & Higgins 1993, Simpson & Day 1999). Breeding habitat consists of tall trees, mangroves, cliffs, rocky outcrops, silts, caves and crevices and is located along the coast or major rivers. Breeding habitat is usually in or close to water, but may occur up to a kilometre away (Marchant & Higgins 1993).	Yes
Hirundapus caudacutus	White-throated Needletail	—	M, CAMBA	Forages aerially over a variety of habitats usually over coastal and mountain areas, most likely with a preference for wooded areas (Marchant & Higgins 1993; Simpson & Day 1999). Has been observed roosting in dense foliage of canopy trees, and may seek refuge in tree hollows in inclement weather (Marchant & Higgins 1993).	Yes
Merops ornatus	Rainbow Bee-eater	—	M, JAMBA	Resident in coastal and subcoastal northern Australia; regular breeding migrant in southern Australia, arriving September to October, departing February to March, some occasionally present April to May (Pizzey and Doyle 1988). Occurs in open country, chiefly at suitable breeding places in areas of sandy or loamy soil: sand-ridges, riverbanks, road-cuttings, sand-pits, occasionally coastal cliffs (*ibid*). Nest is a chamber a the end of a burrow, up to 1.6 m long, tunnelled in flat or sloping ground, sandy back or cutting (*ibid*).	Potential
Monarcha melanopsis	Black-faced Monarch	—	M, Bonn	Rainforest and eucalypt forests, feeding in tangled understorey (Blakers et al. 1984).	Yes
Myiagra cyanoleuca	Satin Flycatcher	—	M, Bonn	Associated with drier eucalypt forests, absent from rainforests (Blakers et al. 1984), open forests, often at height (Simpson & Day 1999).	Likely
Numenius minutes	Little Curlew		M, Bonn, CAMBA , JAMBA, ROKAMBA	Little Curlews may gather in large flocks on coastal and inland grasslands and black soil plains in northern Australia, near swamps and flooded areas. They also feed on playing fields, paddocks and urban lawns (Birds In Backyards 2010a)	Potential

Scientific Name	Common Name	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Numenius phaeopus	Whimbrel	—	M, Bonn, CAMBA, JAMBA, ROKAMBA	Whimbrel is often found on the intertidal mudflats of sheltered coasts. It is also found in harbours, lagoons, estuaries and river deltas, often those with mangroves, but also open, unvegetated mudflats. It is occasionally found on sandy or rocky beaches, on coral or rocky islets, or on intertidal reefs and platforms. It has been infrequently recorded using saline or brackish lakes near coastal areas. It also used saltflats with saltmarsh, or saline grasslands with standing water left after high spring-tides, and in similar habitats in sewage farms and saltfields (DEWHA 2010).	Potential
Rhipidura rufifrons	Rufous Fantail	—	M, Bonn	The Rufous Fantail is a summer breeding migrant to southeastern Australia (Morcombe, 2004). The Rufous Fantail is found in rainforest, dense wet eucalypt and monsoon forests, paperbark and mangrove swamps and riverside vegetation (Morcombe, 2004). Open country may be used by the Rufous Fantail during migration (Morcombe, 2004).	Yes
MIGRATORY - Marine					
Apus pacificus	Fork-tailed Swift	—	M, CAMBA, JAMBA, ROKAMBA	Aerial, over open country, from semi-deserts to coasts, sometimes forests and cities.	Potential
Ardea alba	Great Egret	—	M, CAMBA, JAMBA	The Great Egret is common and widespread in Australia (McKilligan, 2005). It forages in a wide range of wet and dry habitats including permanent and ephemeral freshwaters, wet pasture and estuarine mangroves and mudflats (McKilligan, 2005).	Yes
Ardea ibis	Cattle Egret	—	M, CAMBA, JAMBA	Cattle Egrets forage on pasture, marsh, grassy road verges, rain puddles and croplands, but not usually in the open water of streams or lakes and they avoid marine environments (McKilligan, 2005). Some individuals stay close to the natal heronry from one nesting season to the next, but the majority leave the district in autumn and return the next spring. Cattle Egrets are likely to spend the winter dispersed along the coastal plain and only a small number have been recovered west of the Great Dividing Range (McKilligan, 2005).	Yes
Calidris alba	Sanderling	V	M, Bonn, CAMBA, JAMBA, ROKAMBA	Migrant. Coastal beaches	Potential
Calidris acuminata	Sharp-tailed Sandpiper	—	M, Bonn, CAMBA, JAMBA, ROKAMBA	It prefers the grassy edges of shallow inland freshwater wetlands. It is also found around sewerage treatment ponds, flooded grasslands, mudflats, mangroves, rocky shores and beaches.	Yes

Scientific Name	Common Name	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Calidris canutus	Red Knot	—	M, Bonn, CAMBA, JAMBA, ROKAMBA	Gather in large flocks on the coast in sandy estuaries with tidal mudflats (Birds in Backyards 2010)	Potential
Calidris ferruginea	Curlew Sandpiper	—	M, Bonn, CAMBA, JAMBA, ROKAMBA	Intertidal mudflats of estuaries, lagoons, mangrove channels; around lakes, dams, floodwaters, flooded saltbush surrounds of inland lakes (Morcombe, 2004).	Yes
Calidris ruficollis	Red-necked Stint	—	M Bonn, CAMBA, JAMBA, ROKAMBA	They are mostly found in coastal areas, including in sheltered inlets, bays, lagoons and estuaries with intertidal mudflats, often near spits, islets and banks and, sometimes, on protected sandy or coralline shores. Occasionally they have been recorded on exposed or ocean beaches, and sometimes on stony or rocky shores, reefs or shoals. They also occur in saltworks and sewage farms; saltmarsh; ephemeral or permanent shallow wetlands near the coast or inland, including lagoons, lakes, swamps, riverbanks, waterholes, bore drains, dams, soaks and pools in saltflats (DEWHA 2010e)	Yes
Calidris tenuirostris	Great Knot	V	M Bonn, CAMBA, JAMBA, ROKAMBA	Occurs within sheltered, coastal habitats containing large, intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons.	Potential
Charadrius bicinctus	Double-banded Plover	—	M, Bonn	Found on littoral, estuarine and fresh or saline terrestrial wetlands and also saltmarsh, grasslands and pasture. It occurs on muddy, sandy, shingled or sometimes rocky beaches, bays and inlets, harbours and margins of fresh or saline terrestrial wetlands such as lakes, lagoons and swamps, shallow estuaries and rivers (DEWHA 2010c)	Yes
Charadrius leschenaultii	Greater Sand-plover	V	M Bonn, CAMBA, JAMBA, ROKAMBA	Almost entirely restricted to coastal areas on sheltered sandy, shelly or muddy beaches or estuaries with large intertidal mudflats or sandbanks. (DEWHA 2010d)	Potential
Charadrius mongolus	Lesser Sand-plover	V	M Bonn, CAMBA, JAMBA, ROKAMBA	Tidal mudflats and sandflats, gently sloping sandy and shelly beaches, saltmarsh, estuaries, mangroves.	Potential
Diomedea exulans	Wandering Albatross	E	V, M, Bonn, JAMBA	Marine forager	Unlikely
Gallinago hardwickii	Latham's Snipe	—	M Bonn, CAMBA, JAMBA, ROKAMBA	A variety of permanent and ephemeral wetlands, preferring open fresh water wetlands with nearby cover (Marchant and Higgins 1999). Occupies a variety of vegetation around wetlands (Marchant and Higgins 1999) including wetland grasses and open wooded swamps (Simpson and Day 1999).	Yes

Scientific Name	Common Name	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Heteroscelus brevipes *Bonn as Heteroscelus brevipes, CAMBA as Tringa brevipes, JAMBA as Heteroscelus brevipes, ROKAMBA as Tringa brevipes*	Grey-tailed Tattler	—	M Bonn, CAMBA, JAMBA, ROKAMBA	Usually seen in small flocks on sheltered coasts with reefs and rock platforms or with intertidal mudflats (Birds in Backyards 2008)	Potential
Limicola falcinellus	Broad-billed Sandpiper	V	M Bonn, CAMBA, JAMBA, ROKAMBA	Estuarine sandflats and mudflats, harbours, embayments, lagoons, saltmarshes and reefs as feeding and roosting habitat.	Potential
Limosa lapponica	Bar-tailed Godwit	—	M Bonn, CAMBA, JAMBA, ROKAMBA	Bar-tailed Godwits inhabit estuarine mudflats, beaches and mangroves. They are common in coastal areas around Australia (Birds in Backyards 2008)	Yes
Limosa limosa	Black-tailed Godwit	V	M Bonn, CAMBA, JAMBA, ROKAMBA	Primarily a coastal species, usually found in sheltered bays, estuaries and lagoons with large intertidal mudflats and/or sandflats.	Potential
Numenius madagascariensis	Eastern Curlew	—	M Bonn, CAMBA, JAMBA, ROKAMBA	Estuaries, mudflats and soft sandy beaches.	Potential
Pandion haliaetus	Osprey	V	M, Bonn	Coasts, estuaries, bays, inlets, islands and surrounding waters.	Yes
Pluvialis fulva	Pacific Golden Plover	—	M Bonn, CAMBA, JAMBA, ROKAMBA	Primarily a coastal species, usually found in sheltered bays, estuaries and lagoons with large intertidal mudflats and/or sandflats. Non-breeding summer migrant.	Yes
Rostratula benghalensis s. lat.	Painted Snipe	E1	M, CAMBA	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber (DECC 2007). Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds (*ibid.*). Breeding is often in response to local conditions; generally occurs from September to December (DECC 2007). Roosts during the day in dense vegetation (NSW Scientific Committee 2004). Forages nocturnally on mud-flats and in shallow water (DECC 2007). Feeds on worms, molluscs, insects and some plant-matter (*ibid.*).	Potential
Sterna albifrons	Little Tern	E	M Bonn, CAMBA, JAMBA, ROKAMBA	Coastal waters, bays, inlets, saline or brackish lakes.	Potential
Sterna caspia	Caspian Tern	—	M, CAMBA, JAMBA	Marine forager	Yes

Scientific Name	Common Name	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Thinornis rubricollis	Hooded Plover	CE	M	In south-eastern Australia this species uses long stretches of sandy shore, backed by tussock and creeper-covered dunes with nearby inland lakes (DECC 2007). Preferred habitat is beaches with a wide wash zone with seaweed mounds for feeding (Murlis 1989).	Potential
Tringa stagnatilis	Marsh Sandpiper	—	M Bonn, CAMBA, JAMBA, ROKAMBA	Coastal - Permanent or ephemeral wetlands of varying degrees of salinity, commonly inland (DECC 2007). Breeds Eastern Europe to Eastern Siberia (*ibid*).	Yes
Xenus cinereus	Terek Sandpiper	V	M Bonn, CAMBA, JAMBA, ROKAMBA	Coastal on tidal mudflats, estuaries, shoes and reefs of islands, coastal swamps.	Potential
PLANTS					
Boronia deanei	Deane's Boronia	V	V	Grows in wet heath, often at the margins of open forest adjoining swamps or along streams	No
Caladenia tessellata	Thick-lipped Spider-orchid	E	V	Occurs in grassy sclerophyll woodland, often growing in well-structured clay loams or sandy soils south from Swansea (DECC 2007). Usually in sheltered moist places, in areas of increased sunlight. It flowers from September to November (DECC 2007).	Potential but not found during extensive target survey
Chorizema parvifolium	Chorizema parviflorum population in the Wollongong LGA	EP	—	Found in heathy country and scattered on sandstone.	Yes
Cryptostylis hunteriana	Leafless Tongue-orchid	V	V	It is known from a range of vegetation communities including swamp-heath and woodland (DECC 2007). The larger populations typically occur in woodland dominated by Scribbly Gum (*Eucalyptus sclerophylla*), Silvertop Ash (*E. sieberi*), Red Bloodwood (*Corymbia gummifera*) and Black Sheoak (*Allocasuarina littoralis*); where it appears to prefer open areas in the understorey of this community and is often found in association with the Large Tongue Orchid (*C. subulata*) and the Tartan Tongue Orchid (*C. erecta*) (DECC 2007). (Bell 2001) has identified Coastal Plains Scribbly Gum Woodland and Coastal Plains Smoothed-barked Apple Woodland as potential habitat on the Central Coast. Flowers between November and February, although may not flower regularly (DECC 2007; Bell 2001).	Potential but not found during extensive target survey

Scientific Name	Common Name	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Cynanchum elegans	White-flowered Wax Plant	E	E	Occurs mainly at the ecotone between dry subtropical rainforest and sclerophyll forest/woodland communities. It is a clonal species and suckers in response to disturbance.	Potential but not found during extensive target survey
Daphnandra sp. C Illawarra	Illawarra Socketwood	E	E	Occupies the rocky hillslopes and gully slopes of the Illawarra lowlands, occasionally extending onto the upper escarpment slopes. Associated soils are loams and clay loams.	Potential but not found during extensive target survey
Haloragis exalata subsp. *exalata* var. *laevis*	Square Raspwort	V	V	Square Raspwort appears to require protected and shaded damp situations in riparian habitats.	Potential but not found during extensive target survey
Irenepharsus trypherus	Illawarra Irene	E	E	Occupies steep slopes and cliff lines at the ecotone of sclerophyll forest and rainforest	Unlikely
Lespedeza juncea subsp. *sericea*	*Lespedeza juncea* subsp. *sericea* population in Wollongong LGA	EP	—	Grassland and woodland, often in disturbed sites.	Potential but not found during extensive target survey
Melaleuca biconvexa	Biconvex Paperbark	V	V	Biconvex Paperbark generally grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects. Flowering occurs over just 3-4 weeks in September and October (DECCW 2010).	Potential but not found during extensive target survey
Pimelea spicata	Pimelea spicata	E	E	Occurs on undulating topography on substrates derived from Wianamatta Shale in areas of Cumberland Plain Woodland Vegetation Community. Recorded from shale hills woodland and shale plains woodland.	No
Pterostylis gibbosa	Illawarra Greenhood	E	E	Known from a small number of populations in the Hunter region (Milbrodale), the Illawarra region (Albion Park and Yallah) and the Shoalhaven region (near Nowra). All known populations grow in open forest or woodland, on flat or gently sloping land with poor drainage.	Potential but not found during extensive target survey
Pultenaea aristata		V	V	Uncommon species known from the Woronora Plateau from Helensburgh to Mt Kiera. Occurs on exposed sandstone soils and from adjacent to wet seeps.	Unlikely
Solanum celatum	-	E	—	Shrub to 2.5m high. Grows on hills and slopes in eucalypt woodland; commonly found after fire or disturbance. Flowering August to October.	Potential but not found during extensive target survey

Scientific Name	Common Name	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Thesium australe	Austral Toadflax	V	V	Austral Toad-flax has a wide *ecological* tolerance. However, it is largely confined to grasslands, grassy woodlands or sub-alpine grassy heathlands.	Potential but not found during extensive target survey
Zieria granulata	Hill Zieria	E	E	Shrub on basaltic hillsides near rainforest, recorded west of Kiama. Flowers August - October	Unlikely

Disclaimer: Data extracted from the Atlas of NSW Wildlife (DECCW 2010a) and DEWHA (DEWHA 2010a) Protected Matters Report are only indicative and cannot be considered a comprehensive inventory.

Additional records from Burcher 1997, Brandis 2010, Turton 1996, Richards 1997a, Richards 1997a, URS 2006 and the current ELA study have been included in this table.

E = Endangered; EP = Endangered Population; V = Vulnerable; M = Migratory

Appendix D: Anabat Call Analysis

April 2010 – Analysis by Alicia Lyon

Bat calls were analysed using the program AnalookW (Version 3.3q 03 October 2006, written by Chris Corben, www.hoarybat.com). Call identifications were made using regional based guides to the echolocation calls of microbats in New South Wales (Pennay et al. 2004); and south-east Queensland and north-east New South Wales (Reinhold et al. 2001) and the accompanying reference library of over 200 calls from north-eastern NSW (http://www.forest.nsw.gov.au/research/bats/default.asp).

Bat calls are analysed using species-specific parameters of the call profile such as call shape, characteristic frequency, initial slope and time between calls (Rinehold et al. 2001). To ensure reliable and accurate results the following protocols (adapted from Lloyd et. al. 2006) were followed:

1. Recordings containing less than three pulses were not analysed (Law et al. 1999).

2. Only search phase calls were analysed (McKenzie et al. 2002).

3. Four categories of confidence in species identification were used (Mills et al. 1996):

    a. definite – identity not in doubt

    b. probable – low probability of confusion with species of similar calls

    c. possible – medium to high probability of confusion with species with similar calls; and

    d. unidentifiable – calls made by bats which cannot be identified to even a species group.

4. *Nyctophilus* spp. are difficult to identify confidently from their calls and no attempt was made to identify this genus to species level (Pennay et al. 2004).

Results and Discussion

A total of 673 call sequences were recorded within the study area over 4 nights. Of these, 109 (16%) of the sequences could be identified confidently to species or genus level (see Table X.). The calls of twelve species were recorded from the Tallawarra recordings. Example call profiles for these species are shown below.

Bat activity within the study area was moderate, however few feeding buzzes were recorded. A large number of call sequences were of cruise phase calls and were too short to be reliably identified or of low quality. Bats generally emit cruise phase calls when commuting between sites rather than the search phase calls used for identification purposes whilst foraging. Importantly, calls were recorded on dusk and just prior to sunrise indicating that bats were roosting nearby, and likely to be roosting in tree hollows and potentially within buildings or other man-made structures in the study area.

Notes

The calls of *Miniopterus schreibersii oceanensis* can often display very similar characteristics to other species such as *Vespadelus darlingtoni*. Calls of *M. schreibersii oceanensis* were distinguished by the

irregular pulse shape and time between calls, lack of an up-sweeping tail and drop in frequency of the pre-characteristic section of more than 2kHz.

The calls of *Myotis macropus* are very similar to those produced by the Nyctophilus group of species and it is often difficult to separate these species. *Myotis macropus* calls generally display values of less than 75ms between calls (TBC) whilst Nyctophilus calls generally have a TBC of greater than 95ms. If between these two values, M. macropus have an initial slope (OPS) of greater than 400 and Nyctophilus have an initial slope of less than 300. If the values for TBC and OPS fall between these it is not possible to identify which genus is responsible for the call.

The calls of *Scotorepens orion* overlap with those of several other species, including *Scoteanax rueppellii*. . In this case calls were identified as S*. orion* based upon a drop of less than 3kHz in the pre-characteristic section despite the fact that the frequency of the knee, another distinguishing factor was not greater than 37kHz.

The calls of *Vespadelus vulturnus* and *Vespadelus troughtoni* are difficult to separate based upon call characteristics alone. Identification of *V. vulturnus* calls in the Anabat files submitted relies upon the distributional differences between these species with records of *V. troughtoni* restricted to northern NSW.

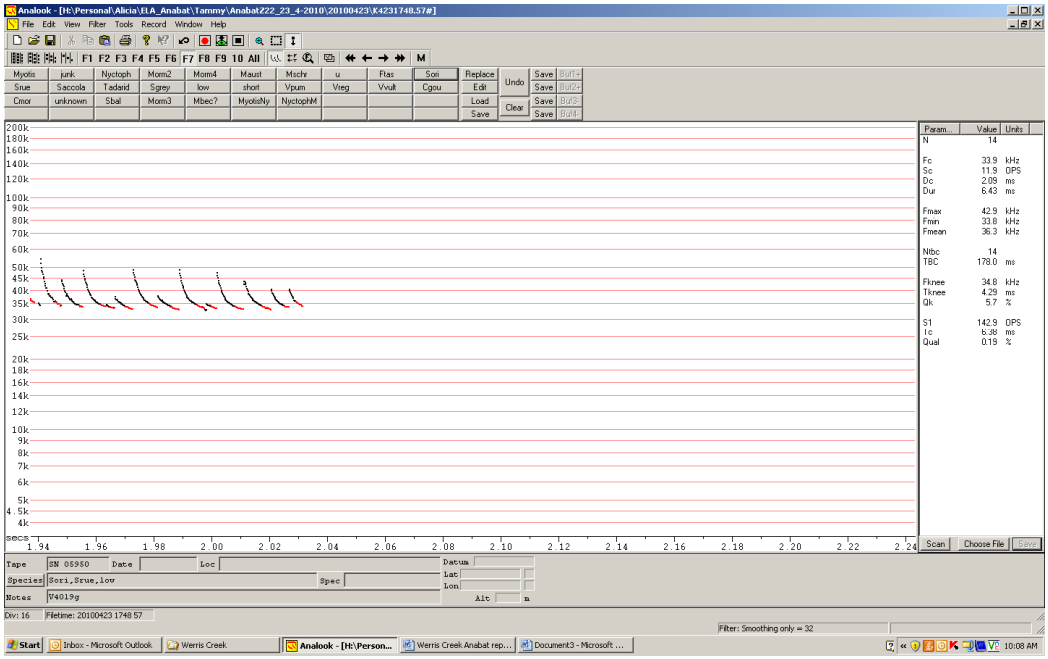

Figure 1: Call profile of *Scotorepens orion* recorded at 17:48h on 23 April 2010, Tallawarra, NSW.

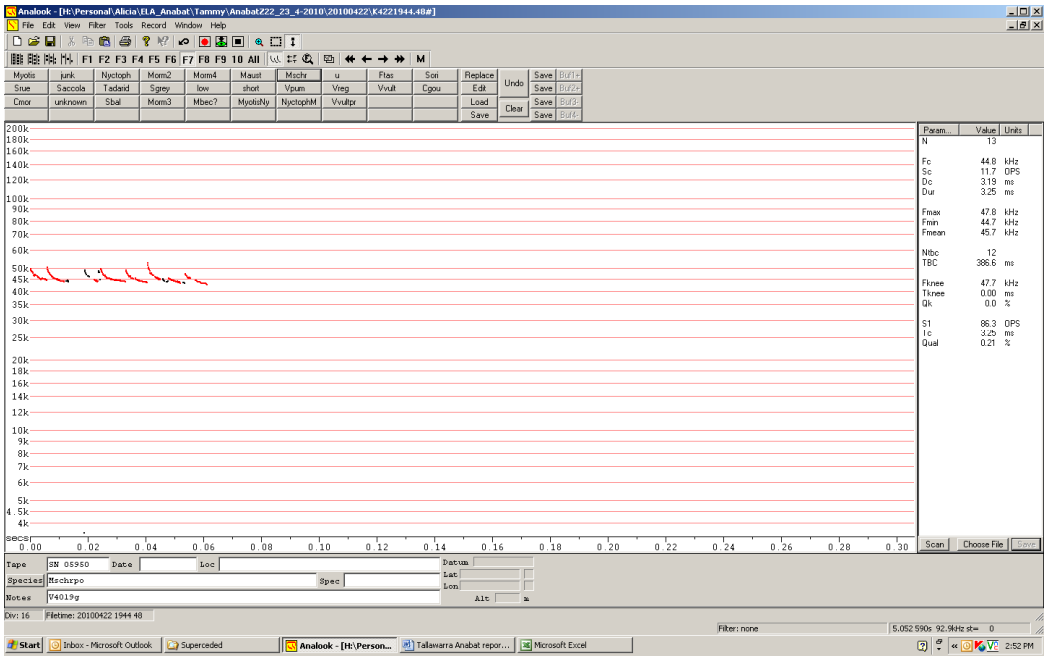

Figure 2: Possible call profile of the threatened *Miniopterus schreibersii oceanensis* (Vulnerable, TSC Act) recorded at 19:44h on 22 April 2010, Tallawarra, NSW.

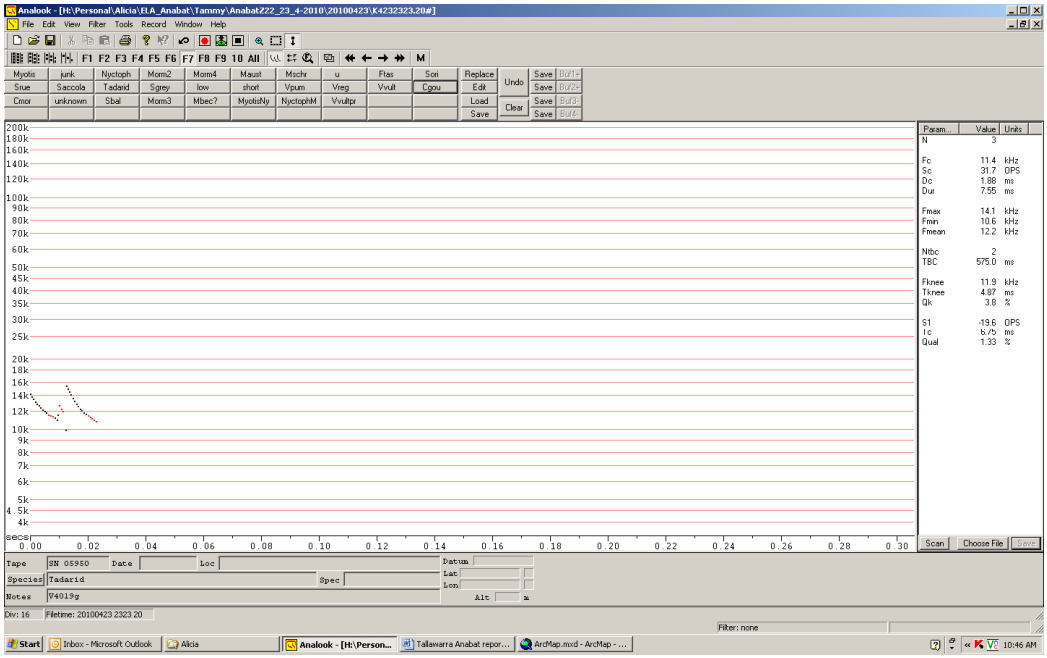

Figure 3: Call profile of *Tadarida australis* recorded at 23:23h on 23 April 2010, Tallawarra, NSW.

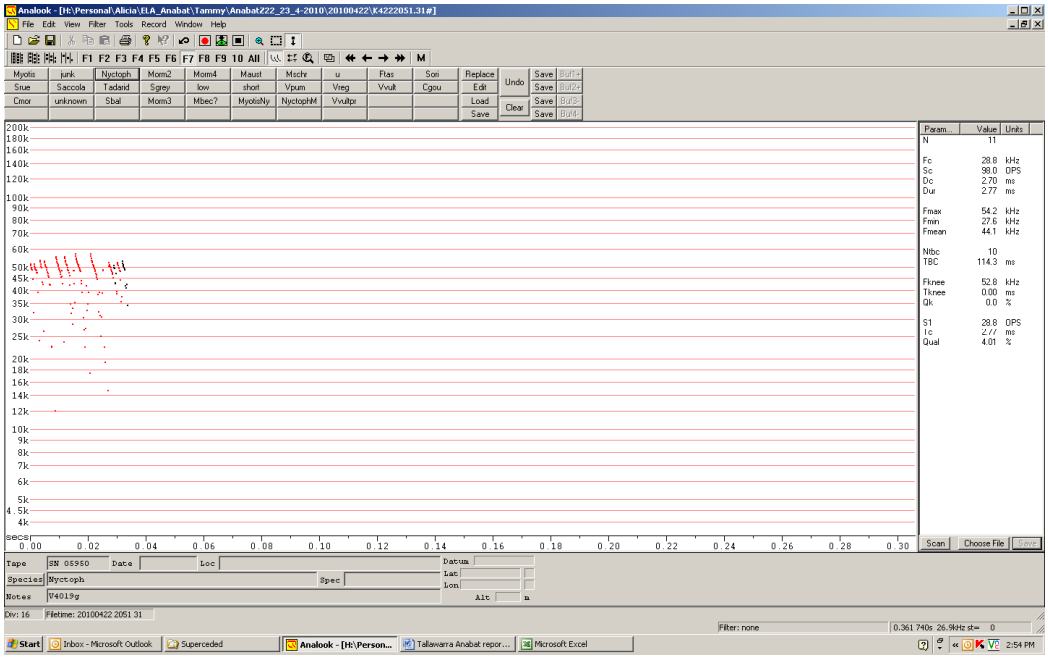

Figure 4: Call profile of *Nyctophilus* sp. recorded at 20:51h on 22 April 2010, Tallawarra, NSW.

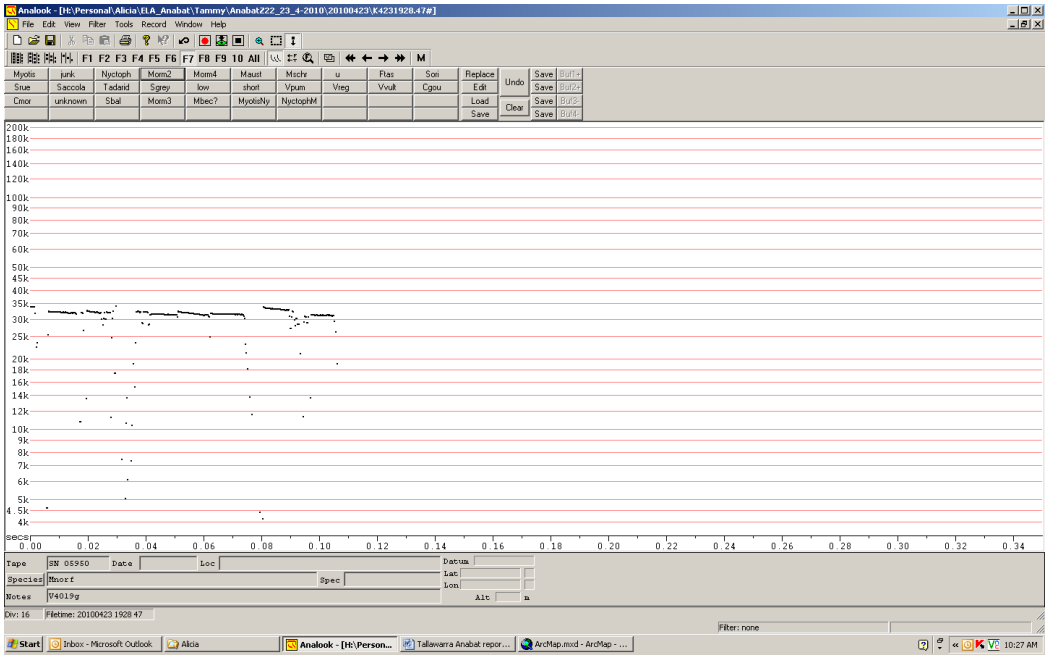

Figure 5: Call profile of the threatened *Mormopterus norfolkensis* (Vulnerable, TSC Act) recorded at 19:28h on 23 April 2010, Tallawarra, NSW.

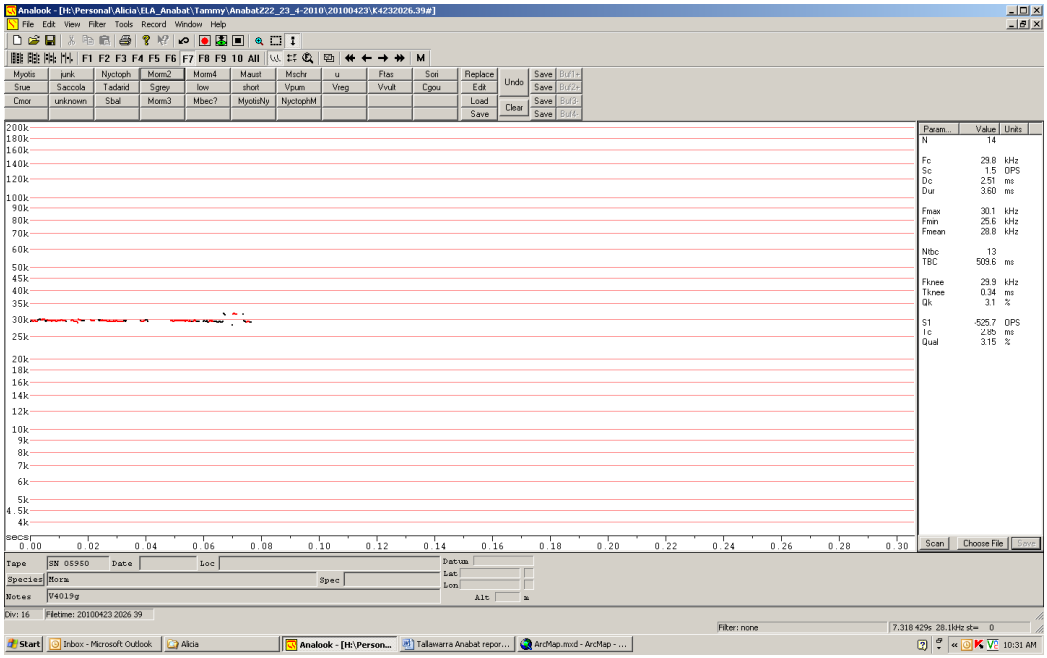

Figure 6: Call profile of *Mormopterus* species 2 recorded at 20:26h on 23 April 2010, Tallawarra, NSW.

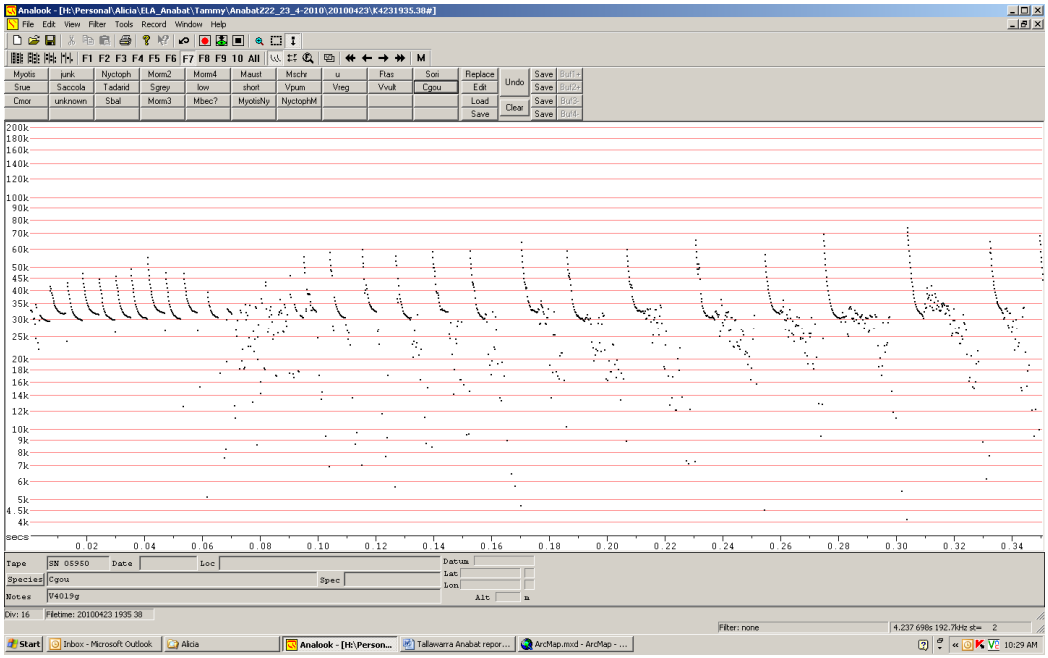

Figure 7: Call profile of *Chalinolobus gouldii* recorded at 19:35h on 23 April 2010, Tallawarra, NSW

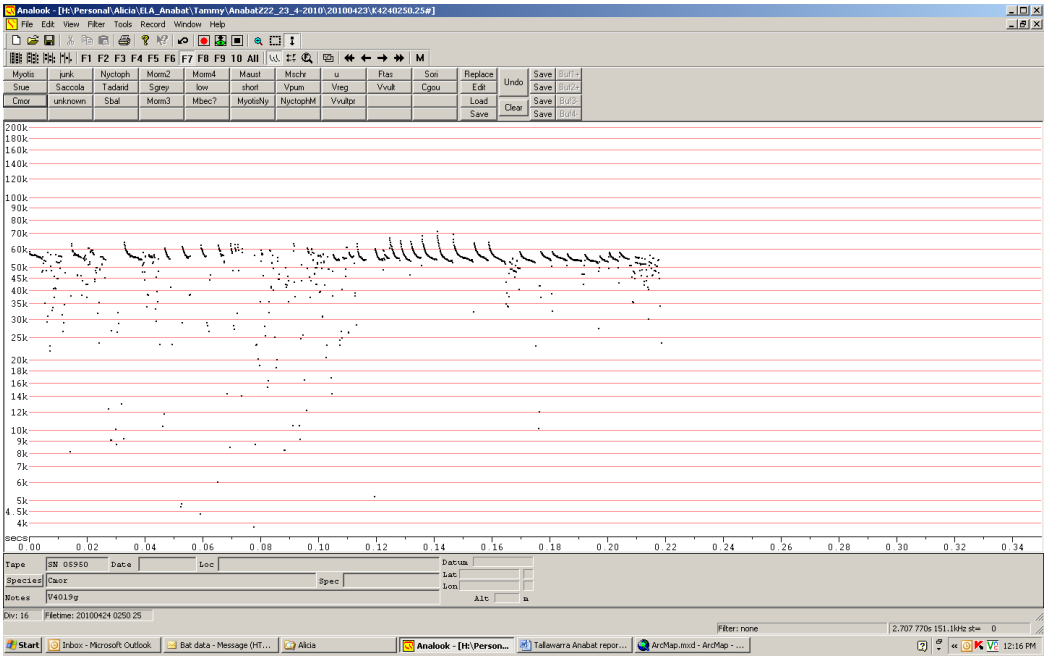

Figure 8: Call profile of the threatened *Miniopterus australis* (Vulnerable, TSC Act) recorded at 02:50h on 24 April 2010, Tallawarra, NSW.

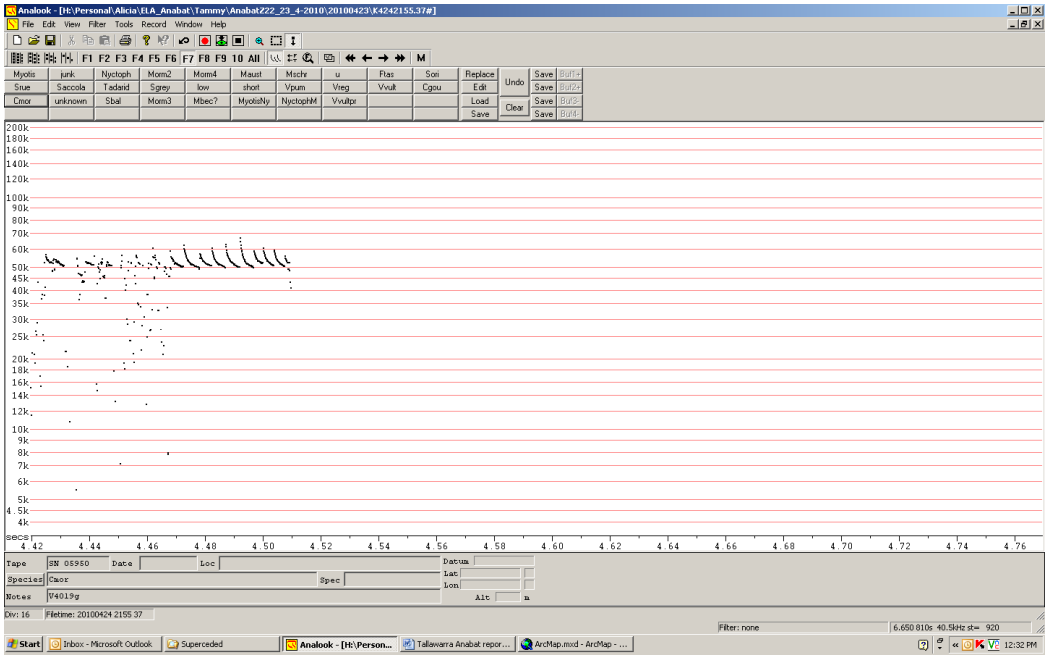

Figure 9: Call profile of *Chalinolobus morio* recorded at 21:55h on 24 April 2010, Tallawarra, NSW.

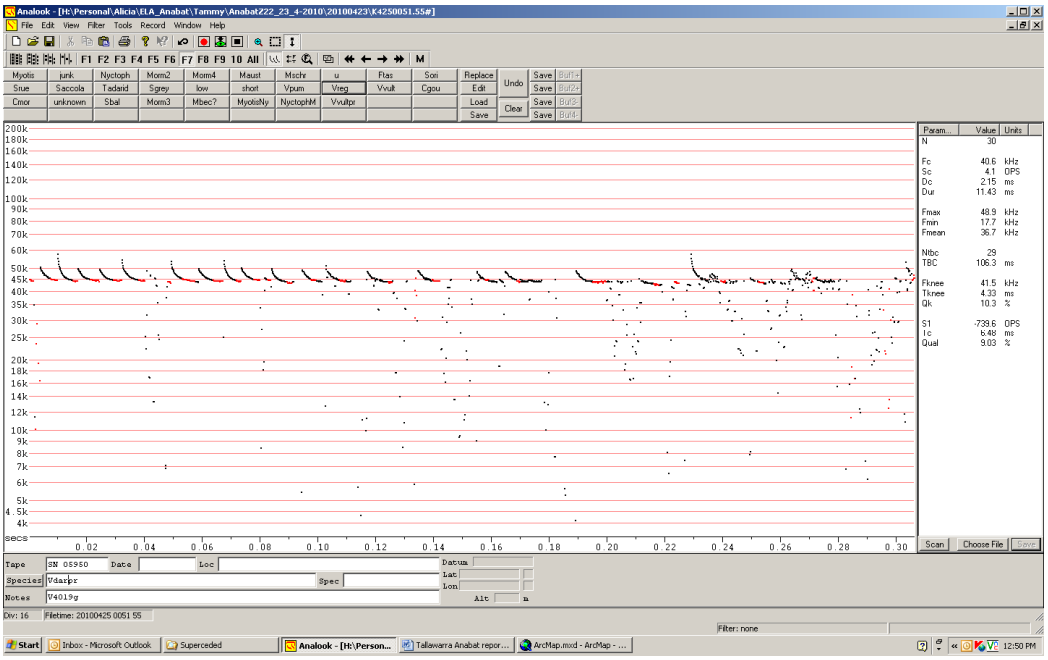

Figure 10: Call profile of *Vespadelus darlingtoni* recorded at 00:51h on 25 April 2010, Tallawarra, NSW.

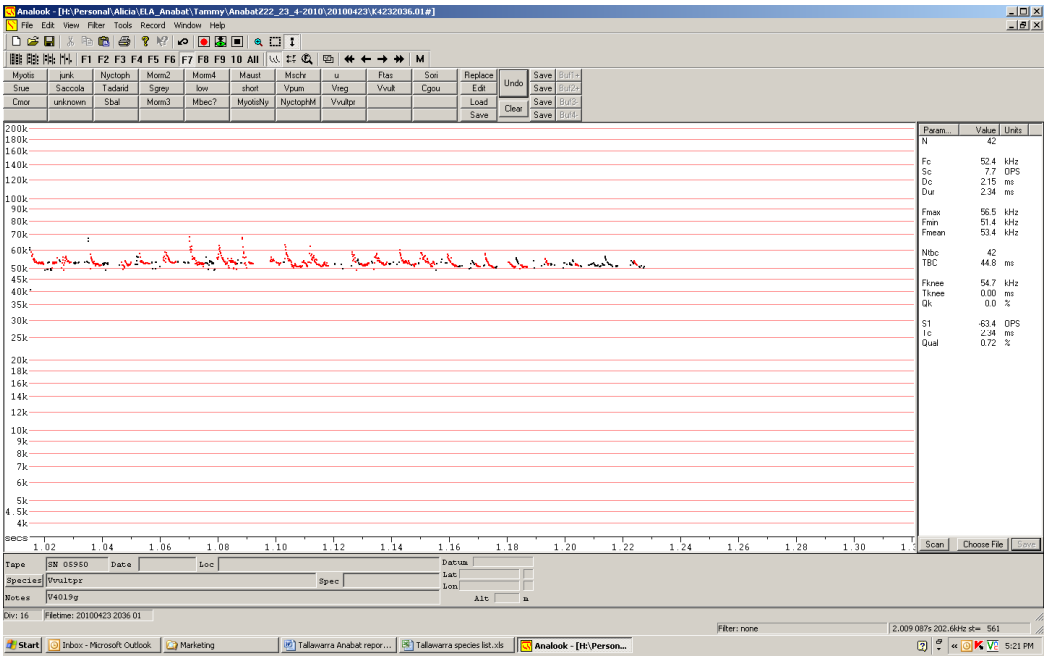

Figure 11: Call profile of *Vespadelus vulturnus* recorded at 20:36h on 23 April 2010, Tallawarra, NSW.

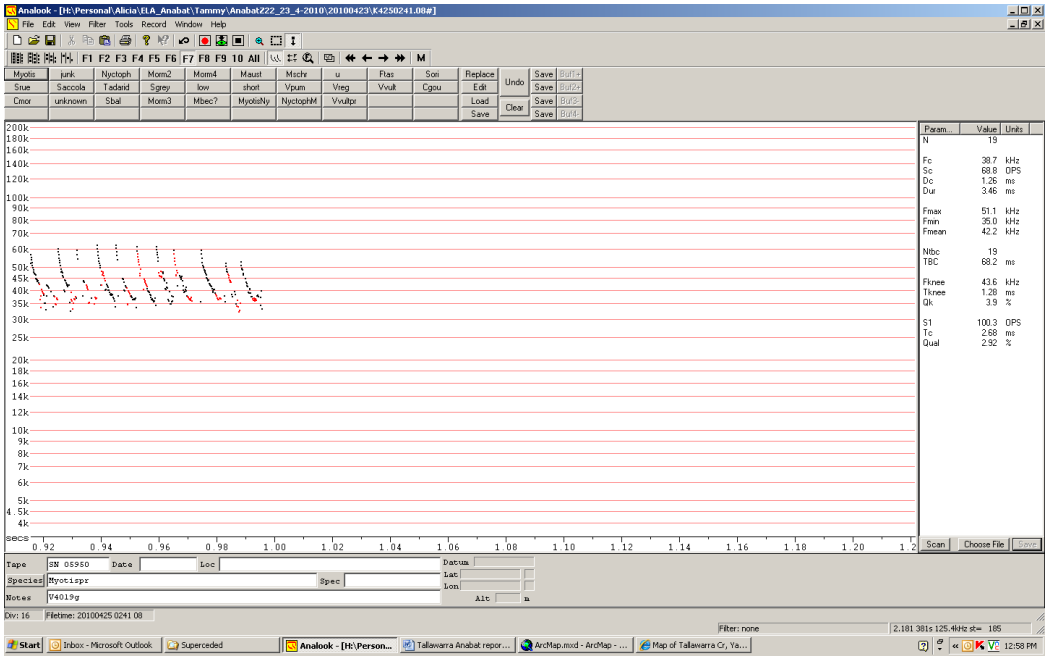

Figure 12: Call profile of the threatened *Myotis macropus* (Vulnerable TSC Act) recorded at 02:41h on 25 April 2010, Tallawarra, NSW.

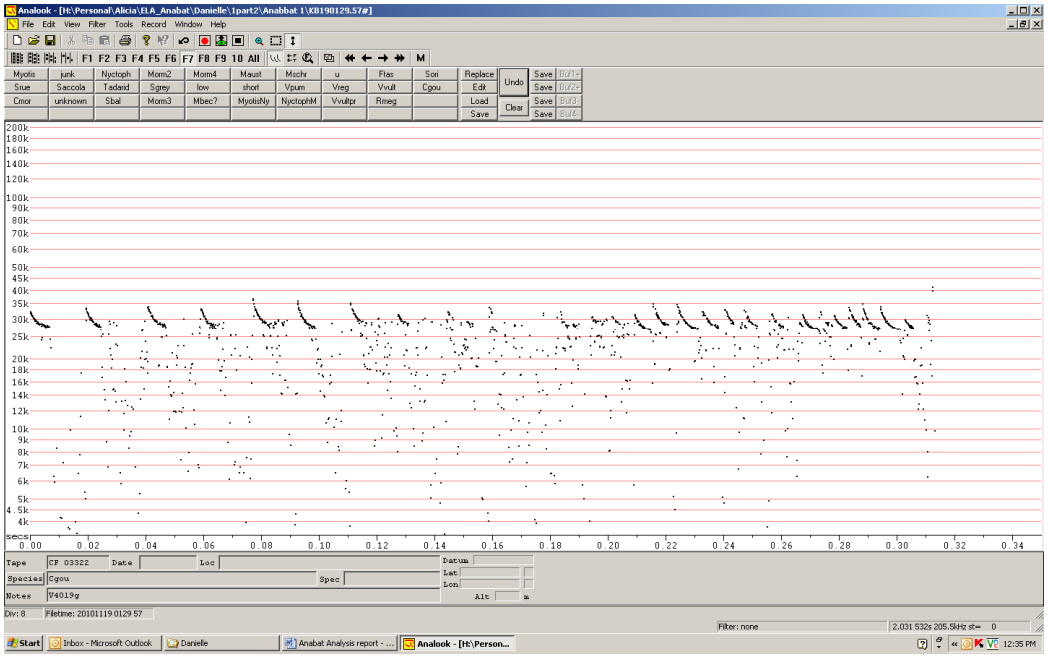

Figure 13: Call profile of *Chalinolobus gouldii* recorded at 01:29h on 19 November 2010, Tallawarra, NSW.

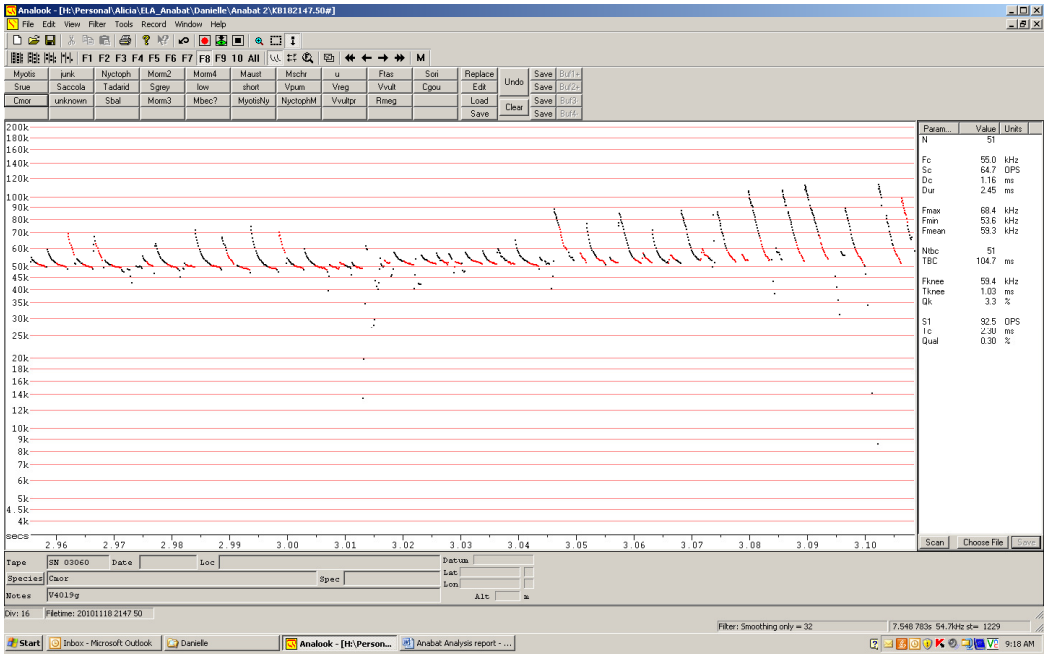

Figure 14: Call profile of *Chalinolobus morio* recorded at 21:47h on 18 November 2010, Tallawarra, NSW.

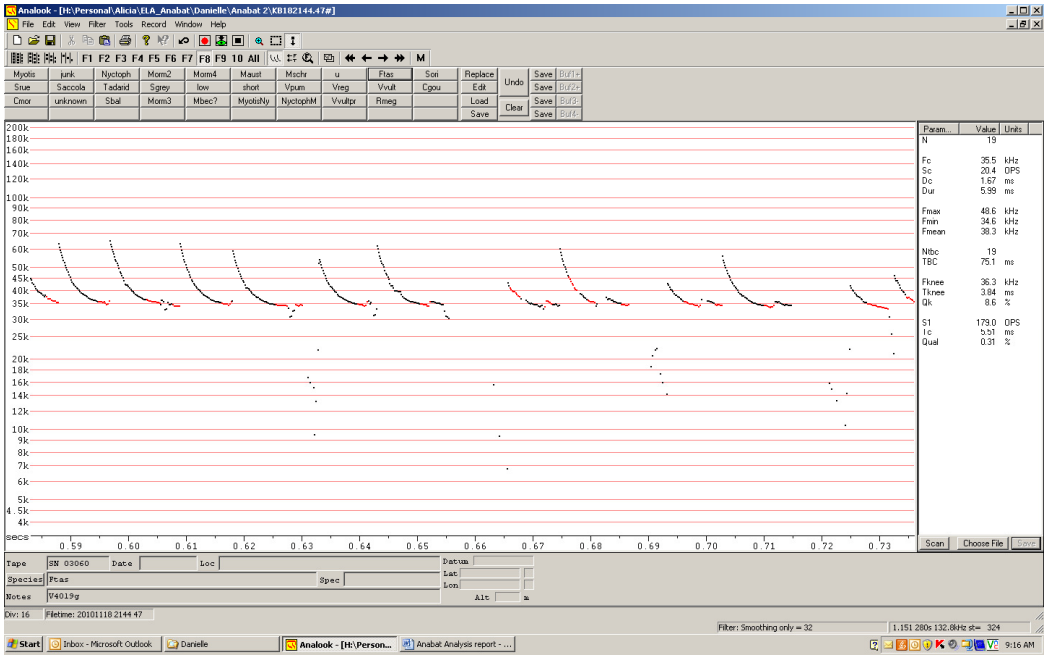

Figure 15: Call profile of the threatened *Falsistrellus tasmaniensis* (Vulnerable, TSC Act) recorded at 21:44h on 18 November 2010, Tallawarra, NSW.

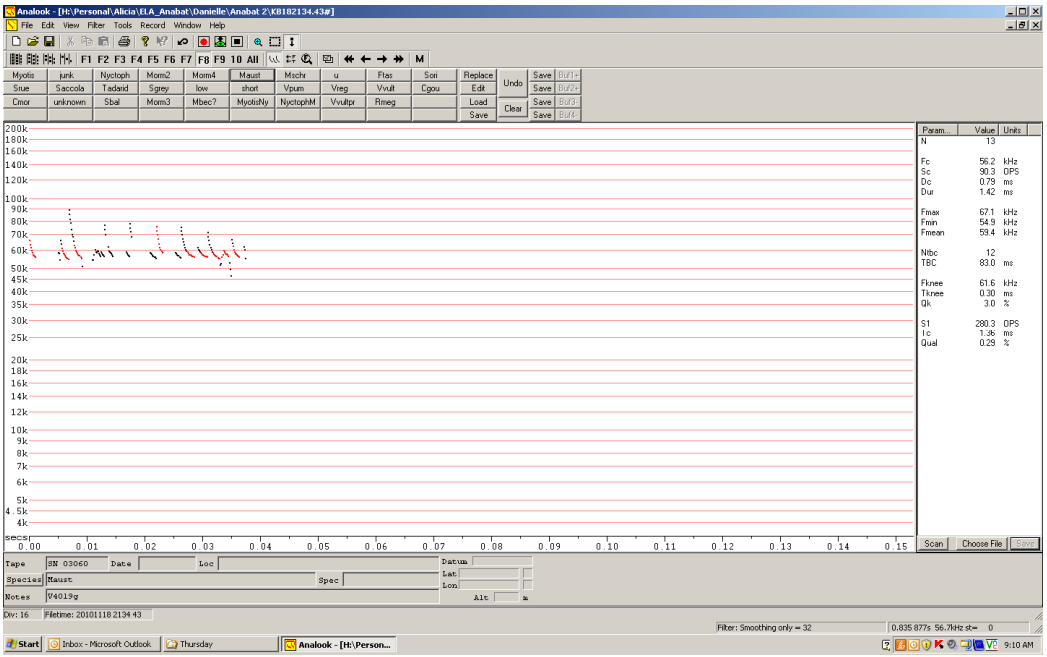

Figure 16: Call profile of the threatened *Miniopterus australis* (Vulnerable, TSC Act) recorded at 21:34h on 18 November 2010, Tallawarra, NSW.

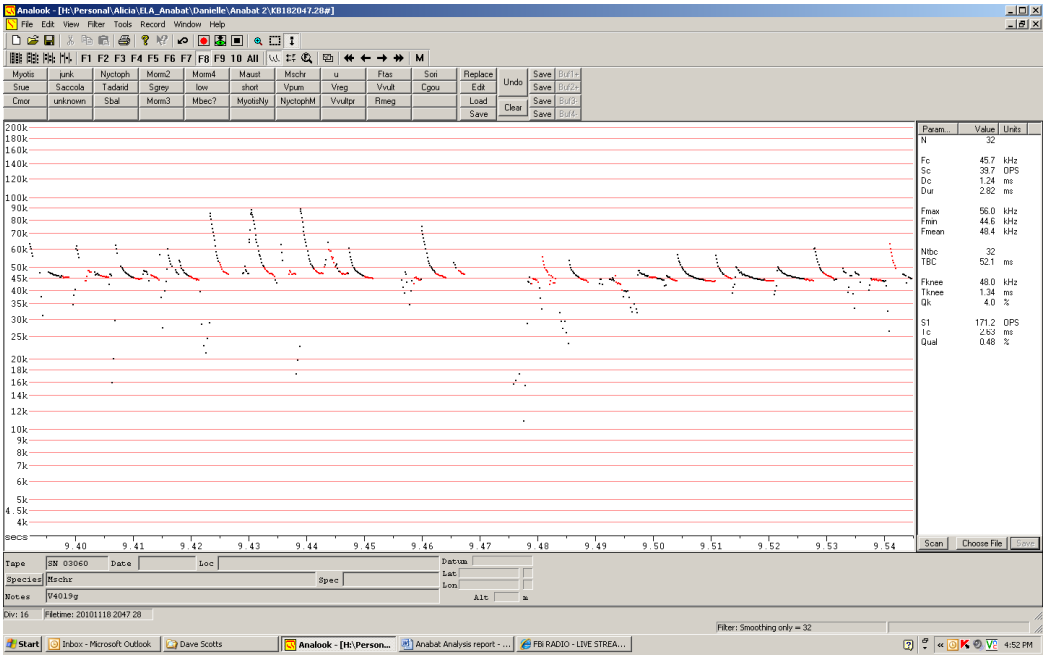

Figure 17: Call profile of the threatened *Miniopterus schreibersii oceanensis* (Vulnerable, TSC Act) recorded at 20:47h on 18 November 2010, Tallawarra, NSW.

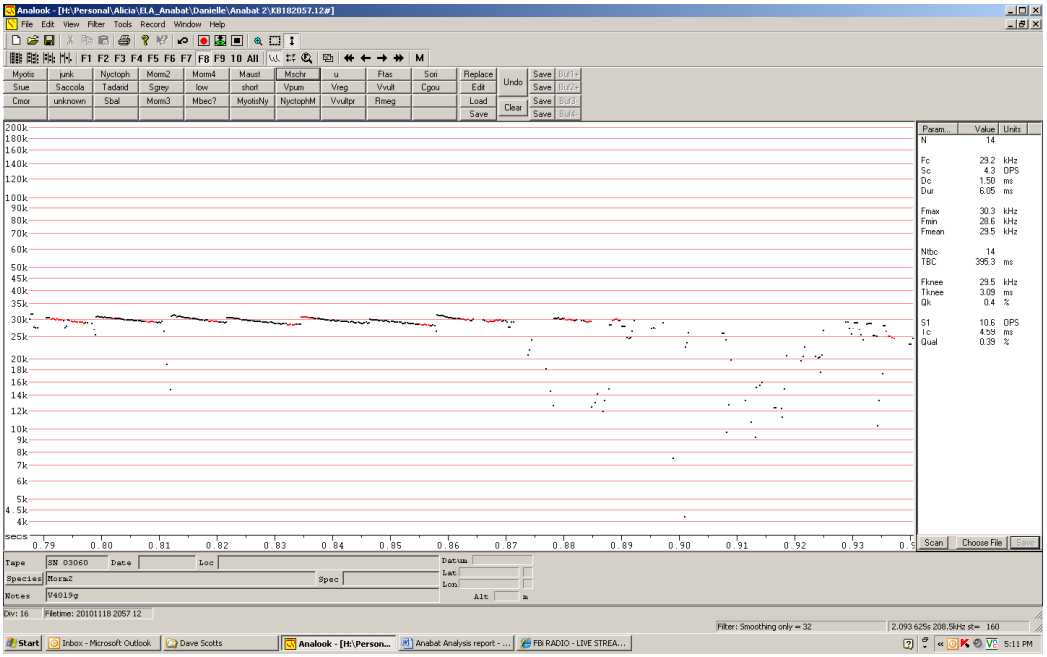

Figure 18: Call profile of *Mormopterus species 2* recorded at 20:57h on 18 November 2010, Tallawarra, NSW.

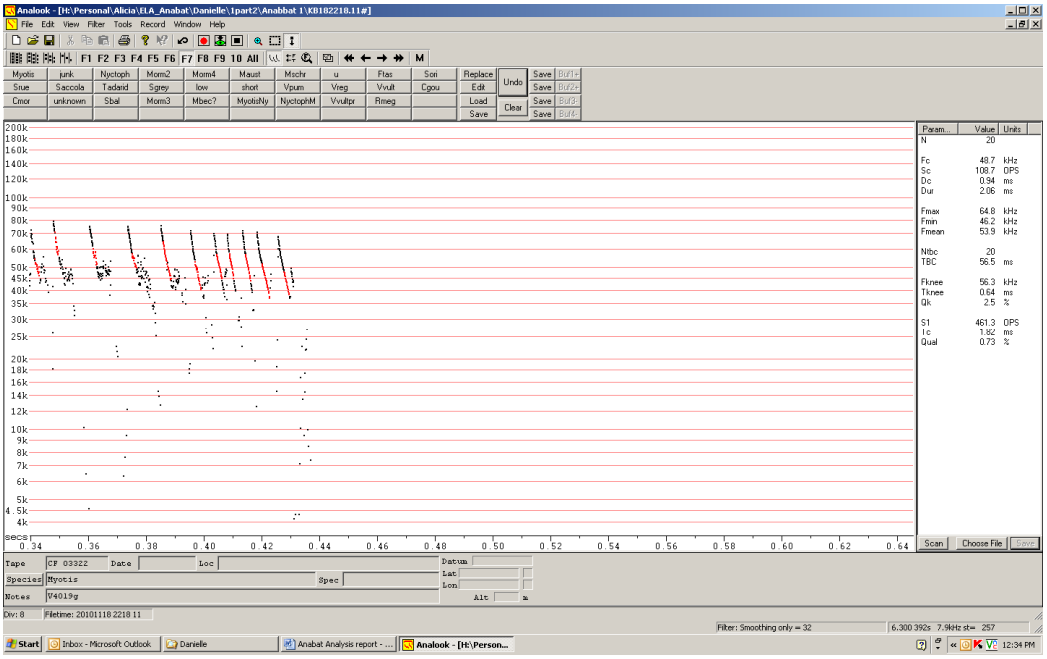

Figure 19: Call profile of the threatened *Myotis macropus* (Vulnerable, TSC Act) recorded at 22:18h on 18 November 2010, Tallawarra, NSW.

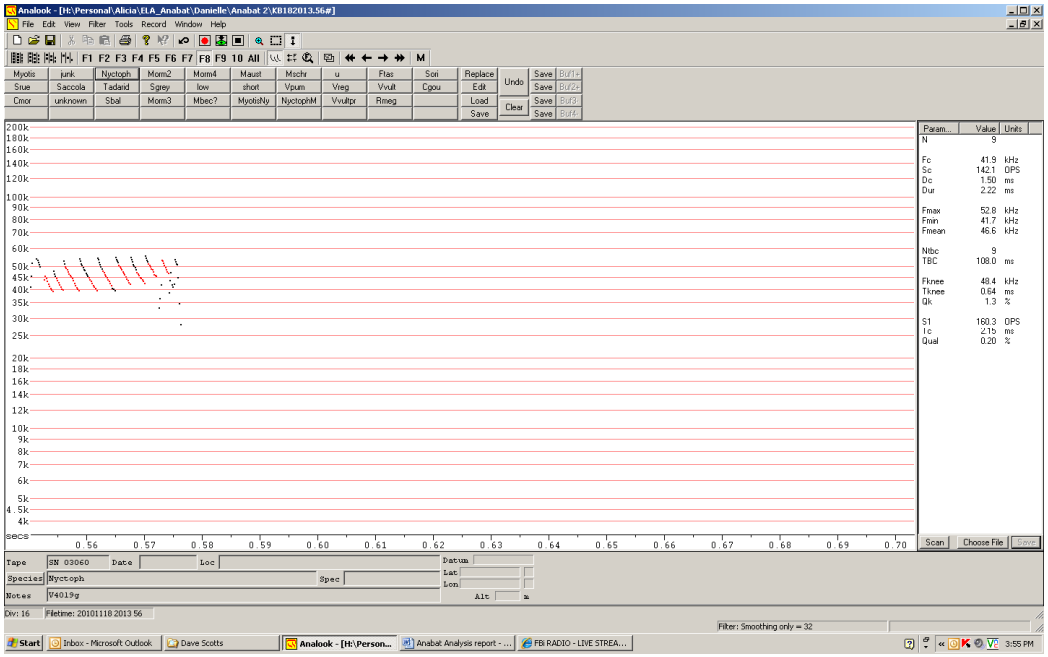

Figure 20: Call profile of Nyctophilus *sp.* recorded at 20:13h on 18 November 2010, Tallawarra, NSW.

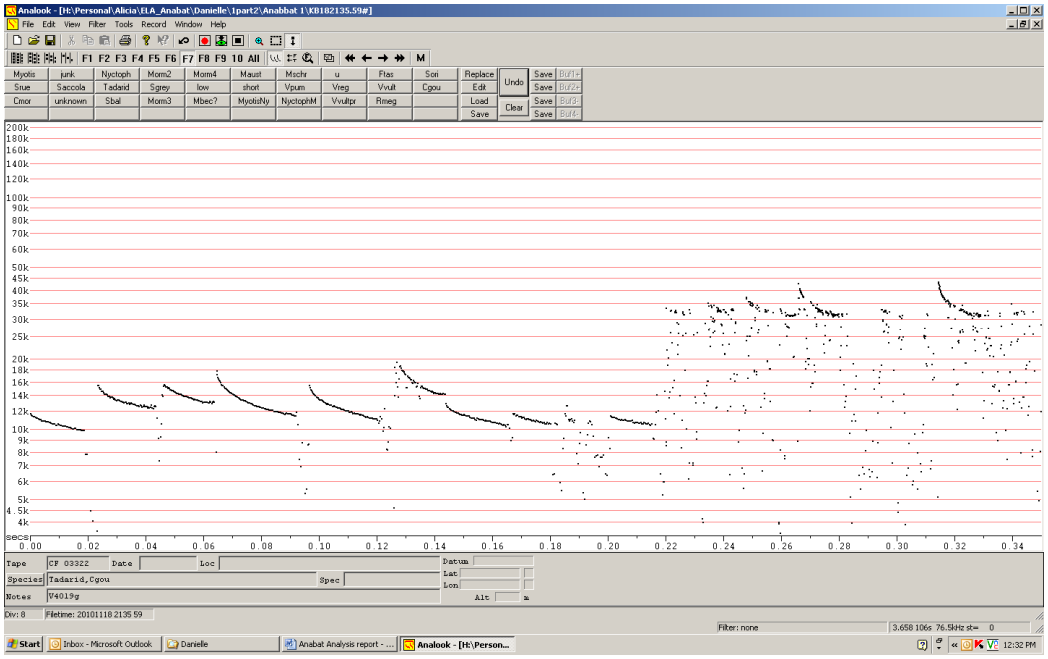

Figure 21: Call profile of *Tadarida australis* recorded at 21:35h on 18 November 2010, Tallawarra, NSW.

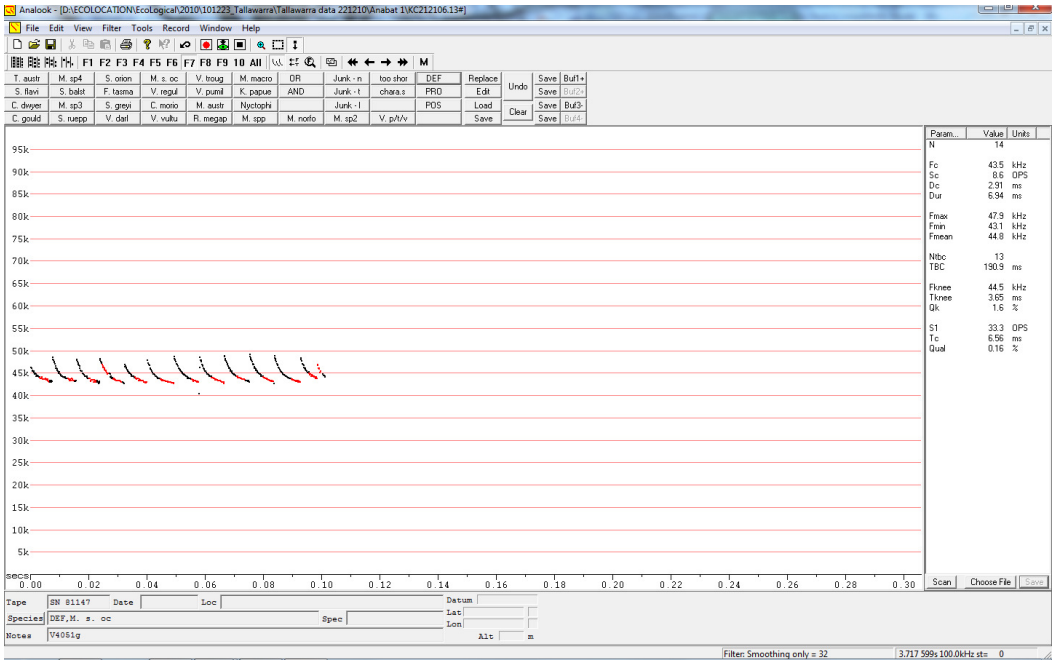

Figure 22: A definite *Miniopterus schreibersii* oceanensis call recorded during 21-22 December 2010 survey (Anna Lloyd)

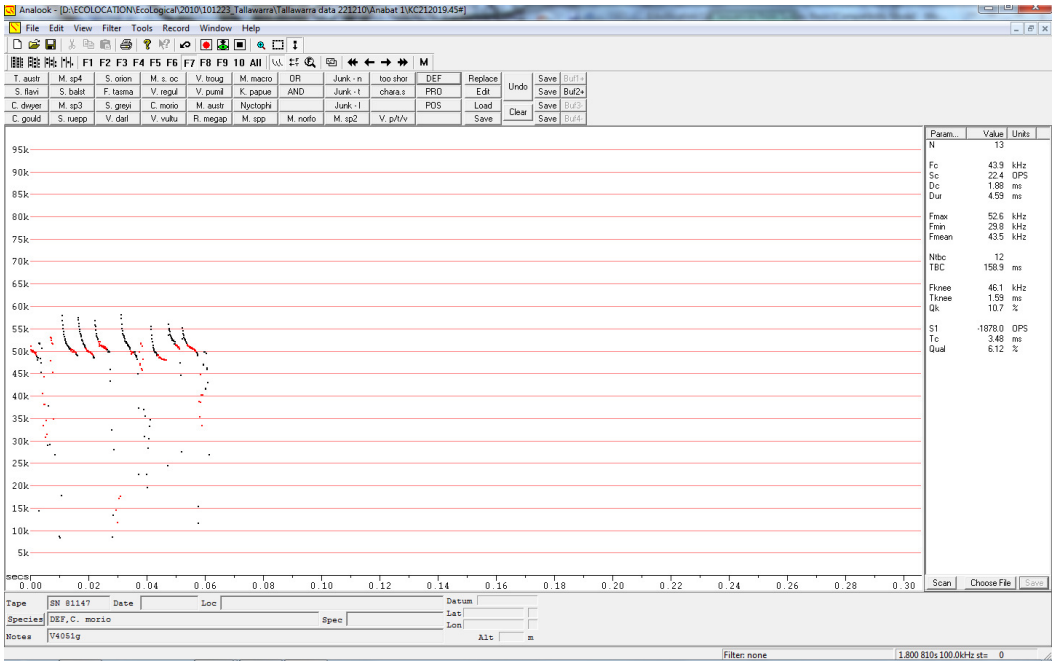

Figure 23: A definite *Chalinolobus morio* call recorded during 21-22 December 2010 survey (Anna Lloyd)

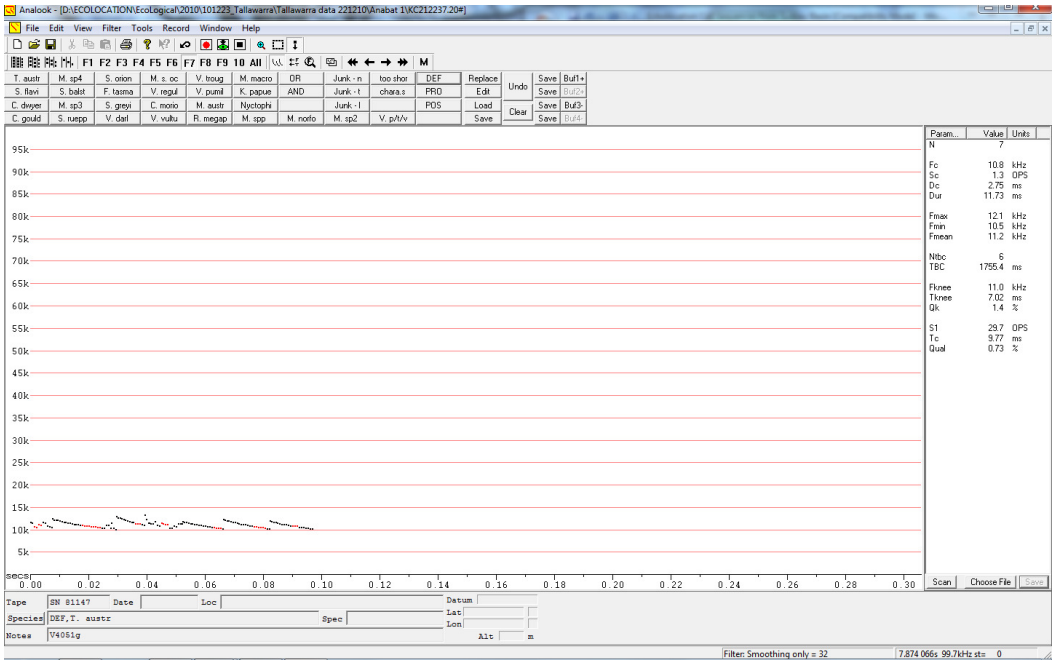

Figure 24: A definite *Tadarida australis* call recorded during 21-22 December 2010 survey (Anna Lloyd)

References

Law, B. S., Anderson, J., and Chidel, M. 1999. *Bat communities in a fragmented forest landscape on the south-west slopes of New South Wales, Australia*. Biological Conservation 88, 333-345.

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McKenzie, N. L., Stuart, A. N., and Bullen, R. D. 2002. *Foraging ecology and organisation of a desert bat faun*a. Australian Journal of Zoology 50, 529-548.

Mills, D. J., Norton, T. W., Parnaby, H. E., Cunningham, R. B., and Nix, H. A. 1996. *Designing surveys for microchiropteran bats in complex forest landscapes - a pilot study from south-east Australia*. Special issue: Conservation of biological diversity in temperate and boreal forest ecosystems 85, 149-161.

Parnaby, H. 1992. *An interim guide to identification of insectivorous bats of south-eastern Australia*. Technical Reports of the Australian Museum Number 8.

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

Reinhold, L., Law, B., Ford, G., and Pennay, 2001. M. *Key to the bat calls of south-east Queensland and north-east New South Wales*. Queensland, DNR.

October 2010 – Analysis by Anna Lloyd

Introduction and Methodology

Bat calls were analysed using the program AnalookW (Version 3.3q 03 October 2006, written by Chris Corben, www.hoarybat.com). Identifications were made using a regional based guide to the echolocation calls of microbats in New South Wales NSW (Pennay *et al.* 2004) and the accompanying reference library of over 200 calls from the Sydney Basin area of NSW (http://www.forest.nsw.gov.au/research/bats/default.asp). In addition, a reference library of 269 calls from NSW (Law, State Forests of NSW) and a local reference library consisting of 42 calls recorded within 150km of Coffs Harbour (Lloyd & Tolhurst).

Bat calls can be difficult to identify due to intra-specific and geographic variation, therefore a reference library of local calls is a valuable tool for bat call identification.

Bat call analysis is reliant upon the presence of species-specific parameters such as call shape, characteristic frequency, initial slope and time between calls (de Oliveira 1998, Rinehold *et al.* 2001). Without the presence of definitive species-specific characteristics, a definite identification cannot be made. In addition, some species can never be distinguished (eg. *Nyctophilus* species), while others, such as *Rhinolophus megaphyllus,* are distinctive.

To ensure reliable and accurate results the following protocols *(*adapted from *Lloyd et. al. 2006)* were followed:

1. Recordings containing less than three pulses were not analysed (Law *et al.* 1999, Law & Chidel 2002).

2. Only search phase calls were analysed (McKenzie *et al.* 2002).

3. Four categories of confidence in species identification were used (Mills *et al.* 1996):

    a. definite – identity not in doubt

    b. probable – low probability of confusion with species of similar calls

    c. possible – medium to high probability of confusion with species with similar calls; and

    d. unknown bat – calls made by bats which cannot be identified to even a species group.

4. *Nyctophilus* spp. are difficult to identify confidently from their calls and no attempt was made to identify this genus to species level (Pennay *et al.* 2004, Law & Chidel 2002).

5. Other species found within the Sydney Basin Region of NSW are difficult to differentiate confidently on recordings of poor quality. These calls are assigned to the following species groups (Mills *et al.* 1996, Pennay *et al.* 2004) and are included under each species as a possible call:

    a. Miniopterus schreibersii oceanensis / Vespadelus darlingtoni

    b. Miniopterus schreibersii oceanensis/ Vespadelus regulus

    c. Vespadelus regulus / Vespadelus darlingtoni

    d. Vespadelus troughtoni / Vespadelus vulturnus / Vespadelus pumilus

e. Chalinolobus gouldii / Mormopterus spp.

f. Mormopterus sp.2 / Mormopterus norfolkensis

g. Nyctophilus spp. / Myotis macropus

h. Scotorepens orion / Scoteanax rueppellii

i. Scotorepens orion / Falsistrellus tasmaniensis

Results and Discussion

A total of 19 files were submitted for identification. Of these, 3 contained no bat calls. There were no calls that were too short and none were of too low a quality to attempt identification. There were no feeding buzzes recorded. Table 1 below shows a summary of the species recorded.

Table 1: Species identified from Anabat recordings on 08/09/2010.

	Identification confidence		
Species	Definite	Probable	Possible
Chalinolobus gouldii	6	-	6
Mormopterus sp.2	4	-	6

The following figures show the species confidently identified.

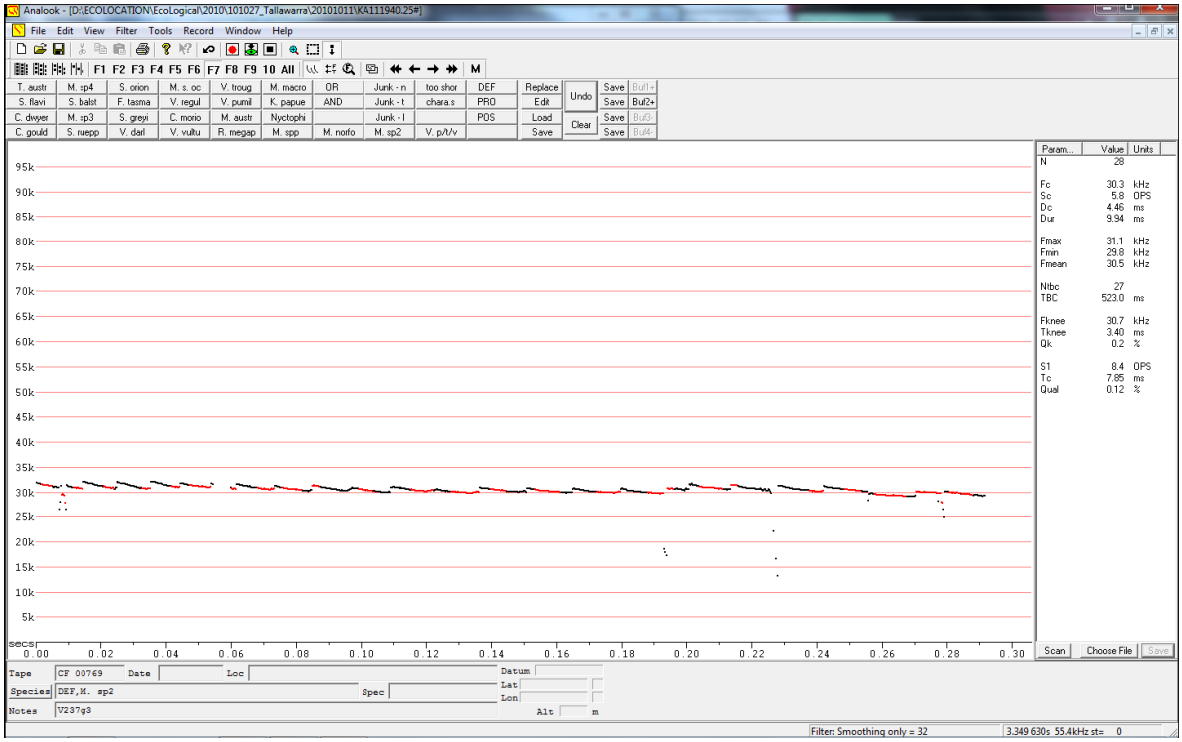

Figure 1: A definite Mormopterus sp.2 call recorded during this survey.

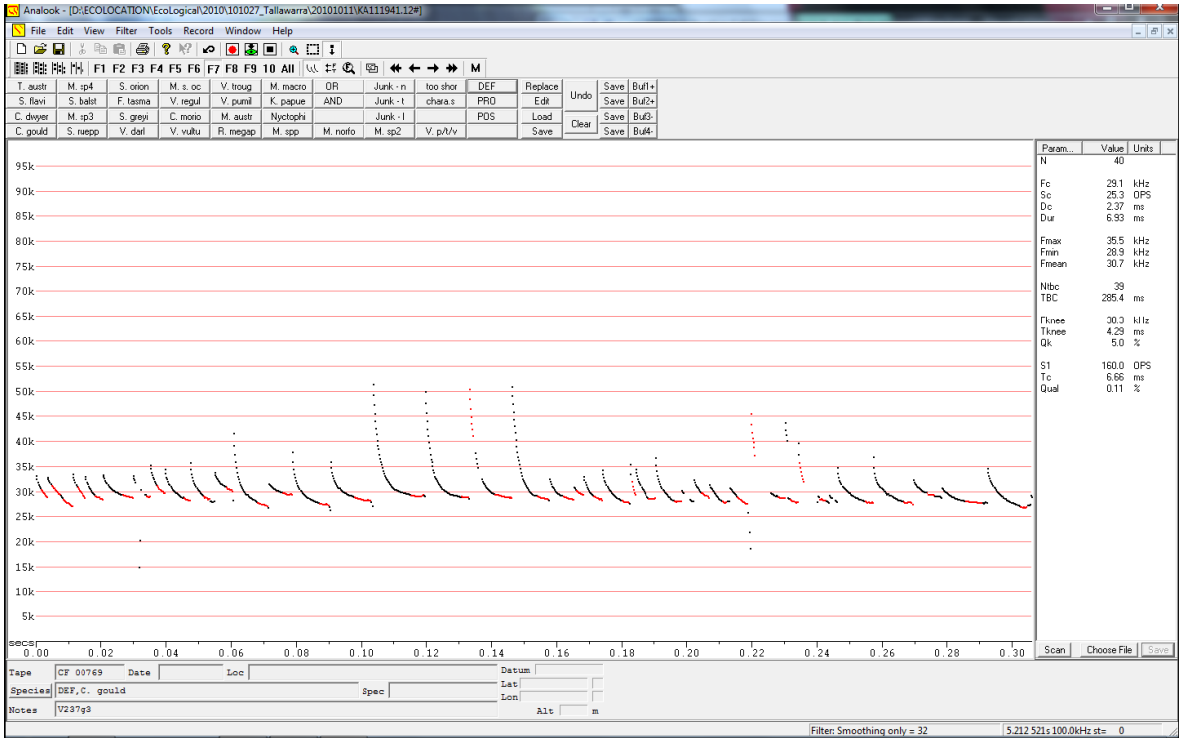

Figure 2: A definite Chalinolobus gouldii call recorded during this survey.

References

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Lloyd, A.M., Law, B.S., and Goldingay, R. (2006) Bat activity on riparian zones and upper slopes in Australian timber production forests and the effectiveness of riparian buffers. Biological Conservation 129, 207-220.

McKenzie, N. L., Stuart, A. N., and Bullen, R. D. (2002). Foraging ecology and organisation of a desert bat fauna. Australian Journal of Zoology 50, 529-548.

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Parnaby, H. (1992). An interim guide to identification of insectivorous bats of south-eastern Australia. Technical Reports of the Australian Museum Number 8.

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

Reinhold, L., Law, B., Ford, G., and Pennay, M. Key to the bat calls of south-east Queensland and north-east New South Wales. 2001. Queensland, DNR.

November 2010 – Analysis by Alicia Lyon

Bat calls were analysed using the program AnalookW (Version 3.3q 03 October 2006, written by Chris Corben, www.hoarybat.com). Call identifications were made using regional based guides to the echolocation calls of microbats in New South Wales (Pennay et al. 2004); and south-east Queensland and north-east New South Wales (Reinhold et al. 2001) and the accompanying reference library of over 200 calls from north-eastern NSW (http://www.forest.nsw.gov.au/research/bats/default.asp). In addition, reference was made to an extensive library of calls of *Myotis macropus* recorded at a known maternity roost site in Northern NSW and compiled by Alicia Lyon from ELA between 2007 and 2010.

Bat calls are analysed using species-specific parameters of the call profile such as call shape, characteristic frequency, initial slope and time between calls (Rinehold et al. 2001). To ensure reliable and accurate results the following protocols (adapted from Lloyd et. al. 2006) were followed:

1. Recordings containing less than three pulses were not analysed (Law et al. 1999).

2. Only search phase calls were analysed (McKenzie et al. 2002).

3. Four categories of confidence in species identification were used (Mills et al. 1996):

    a. definite – identity not in doubt

    b. probable – low probability of confusion with species of similar calls

    c. possible – medium to high probability of confusion with species with similar calls; and

    d. unknown – calls made by bats which cannot be identified to even a species group.

4. Nyctophilus spp. are difficult to identify confidently from their calls and no attempt was made to identify this genus to species level (Pennay et al. 2004).

Results and Discussion

A total of 805 Anabat sequences were submitted for analysis from recordings made on two Anabat detectors during the night of 18 November 2010 at Tallawarra, NSW. There were 55 (7%) of sequences that did not contain any microbat calls. Of the remaining sequences, 400 (53%) could be identified confidently to species or genus level (Tables 1 and 2).

The calls of nine species, including four threatened species, were identified in the Tallawarra recordings. Example call profiles for these species are shown below.

The calls of *Falsistrellus tasmaniensis* often display very similar characteristics to other species such as *Scotorepens orion*, *S. greyii* and *S. sp* as well as *Scoteanax rueppellii*. Calls of *F. tasmaniensis* were distinguished by the characteristic frequency, frequency of the knee, lack of an up-sweeping tail and length of pre-characteristic section.

The calls of *Miniopterus schreibersii oceanensis* can often display very similar characteristics to other species such as *Vespadelus darlingtonii* and *Vespadelus regulus*. Calls of *M. s. oceanensis* were distinguished by the irregular pulse shape and time between calls, lack of an up-sweeping tail and drop in frequency of the pre-characteristic section of more than 2kHz.

The calls of *Myotis macropus* are very similar to Nyctophilus species and it is often difficult to separate these species. Calls were identified as *M. macropus* when the time between calls (TBC) was less than

75ms and the initial slope (S1) was greater than 400 OPS; and as Nyctophilus sp. when the TBC was greater than 95ms and the S1 was less than 300 OPS.

The most commonly recorded species was *M. macropus* followed by *Chalinolobus gouldii*, *C. morio, M. s. oceanensis*, and Nyctophilus sp. Many calls were unable to be positively identified to species or genus level due to the low quality or short length of the sequences. Call sequences indicative of foraging activity (feeding buzzes) were regularly recorded. Relative microbat activity levels, as estimated by number of Anabat call sequences recorded, were moderate.

Table 1. Results from Anabat 1, with threatened species highlighted in grey.

Date	Species Name	Common Name	Number of calls	Definite	Probable	Possible
18/11/2010	*Chalinolobus gouldii*	Goulds Wattled Bat	17	14	1	2
18/11/2010	*Chalinolobus morio*	Chocolate Wattled Bat	51	37	5	9
18/11/2010	*Falsistrellus tasmaniensis*	Eastern False Pipistrelle	2			2
18/11/2010	*Mormopterus species 2*		1			1
18/11/2010	*Miniopterus schreibersii oceanensis*	Eastern Bent-wing Bat	23	21	2	
18/11/2010	*Myotis macropus*	Large-footed Myotis	8	2	3	3
18/11/2010	Nyctophilus sp.		2	1		1
18/11/2010	*Tadarida australis*	White-striped Freetail Bat	7	7		
18/11/2010	Calls too short to identify		21			
18/11/2010	Junk		39			
18/11/2010	Low quality calls		160			
		Total Anabat sequences	331			

Table 2. Results from Anabat 2, with threatened species highlighted in bold.

Date	Species Name	Common Name	Number of calls	Definite	Probable	Possible
18/11/2010	*Chalinolobus gouldii*	Goulds Wattled Bat	70	60	3	7
18/11/2010	*Chalinolobus morio*	Chocolate Wattled Bat	19	14		5
18/11/2010	*Falsistrellus tasmaniensis*	Eastern False Pipistrelle	6	1	2	3
18/11/2010	*Miniopterus australis*	Little Bent-wing Bat	5	1		4
18/11/2010	*Mormopterus species 2*		2	2		
18/11/2010	*Miniopterus schreibersii oceanensis*	Eastern Bent-wing Bat	47	46		1
18/11/2010	*Myotis macropus*	Large-footed Myotis	113	81	13	19
18/11/2010	Nyctophilus sp.		27	22		5
18/11/2010	Calls too short to identify		64			
18/11/2010	Junk		16			
18/11/2010	Low quality calls		102			
18/11/2010	Unknown		3			
		Total Anabat sequences	474			

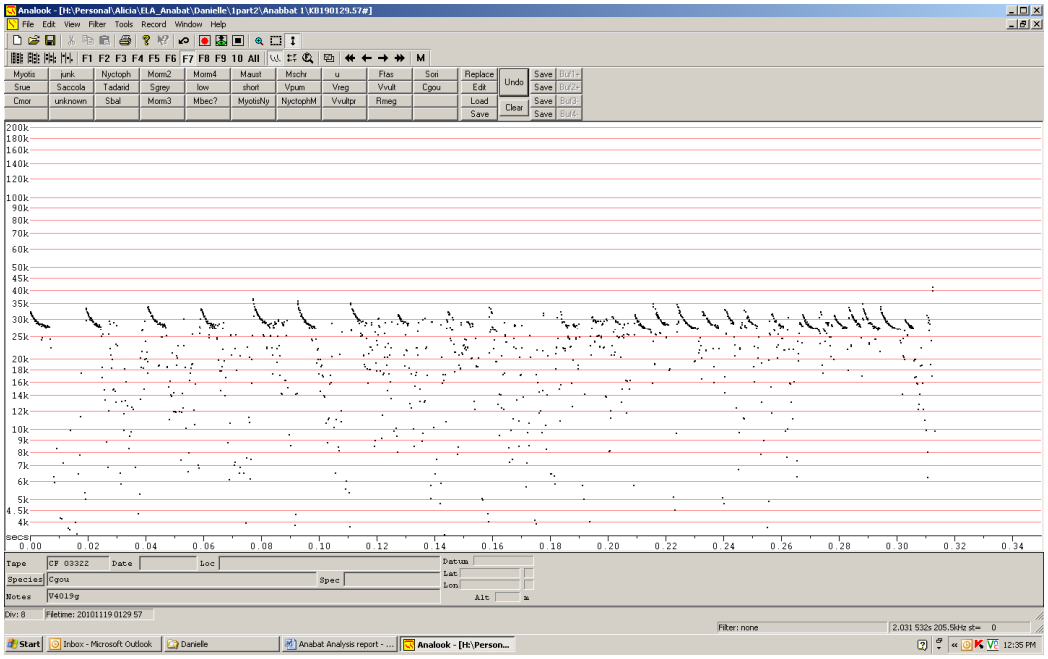

Figure 1: Call profile of *Chalinolobus gouldii* recorded at 01:29h on 19 November 2010, Tallawarra, NSW.

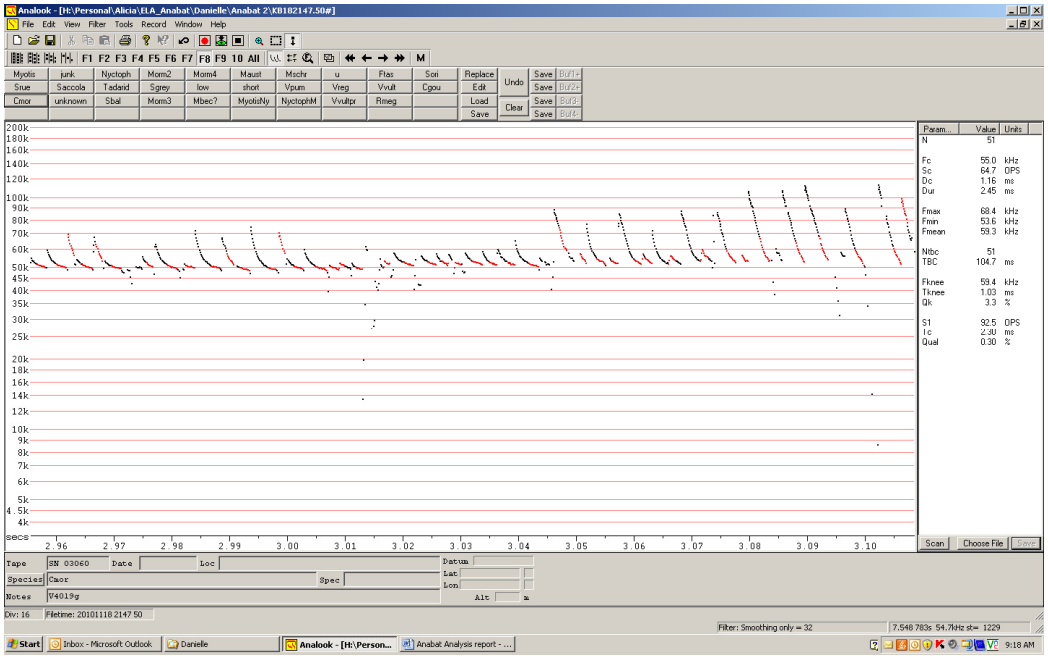

Figure 2: Call profile of *Chalinolobus morio* recorded at 21:47h on 18 November 2010, Tallawarra, NSW.

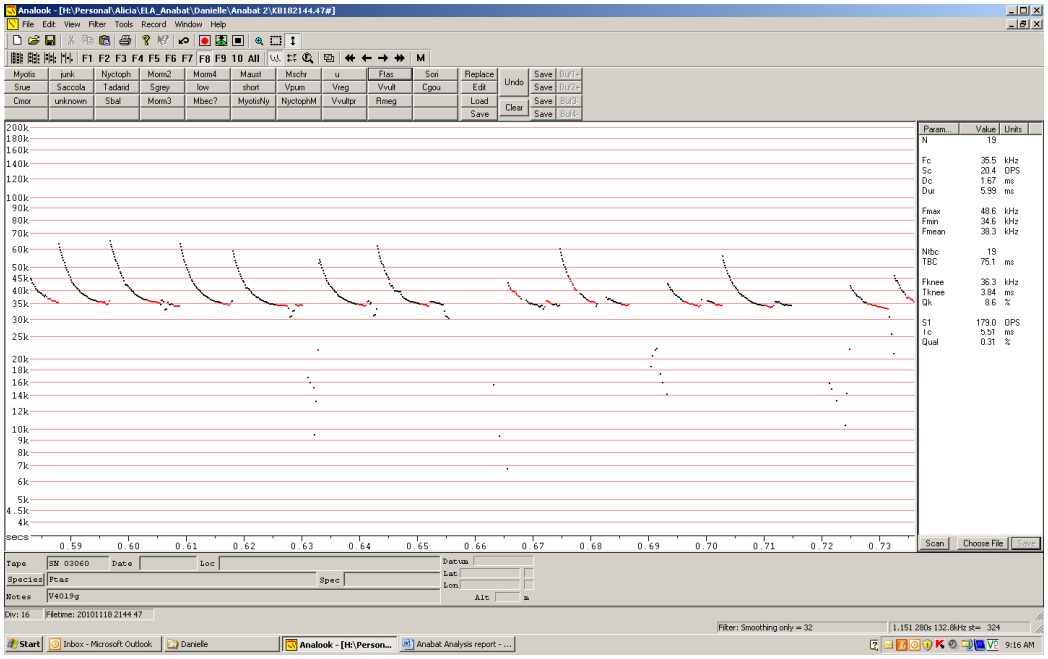

Figure 3: Call profile of the threatened *Falsistrellus tasmaniensis* (Vulnerable, TSC Act) recorded at 21:44h on 18 November 2010, Tallawarra, NSW.

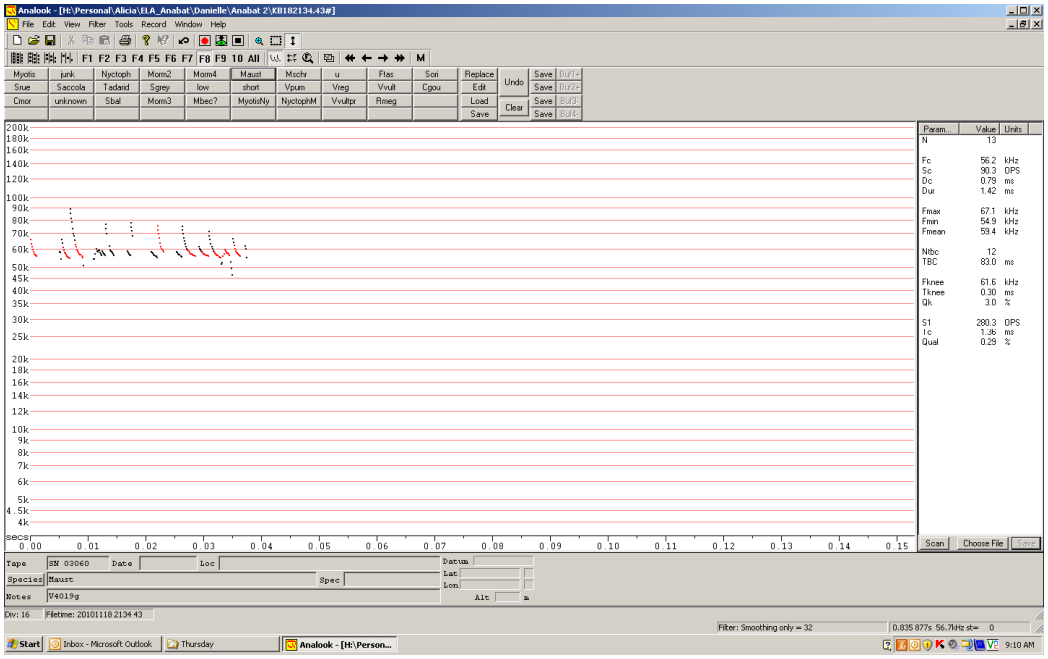

Figure 4: Call profile of the threatened *Miniopterus australis* (Vulnerable, TSC Act) recorded at 21:34h on 18 November 2010, Tallawarra, NSW.

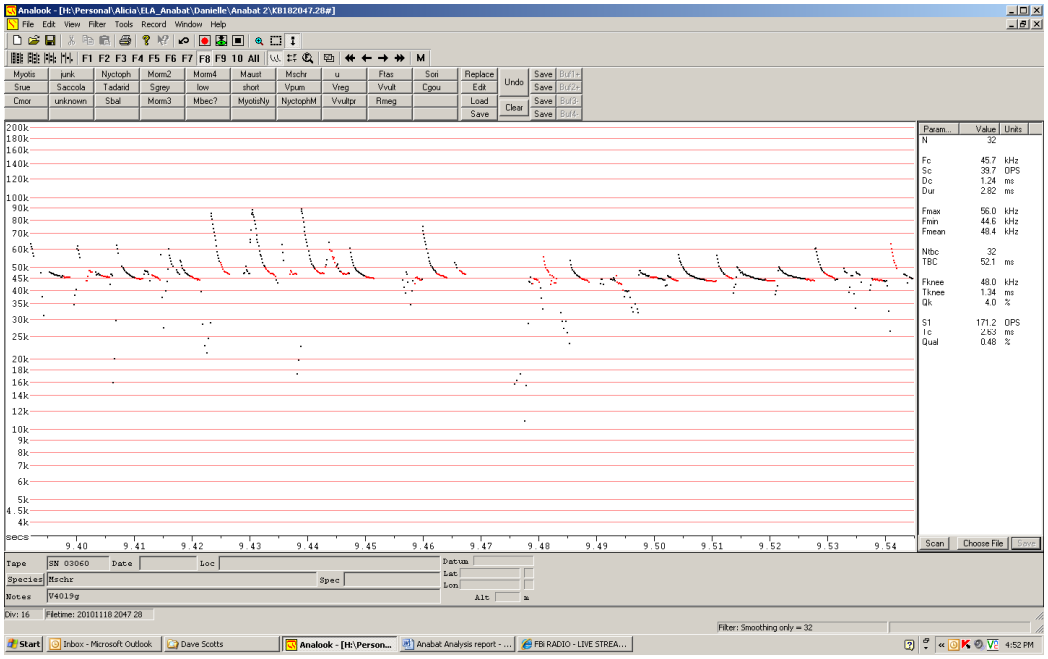

Figure 5: Call profile of the threatened *Miniopterus schreibersii oceanensis* (Vulnerable, TSC Act) recorded at 20:47h on 18 November 2010, Tallawarra, NSW.

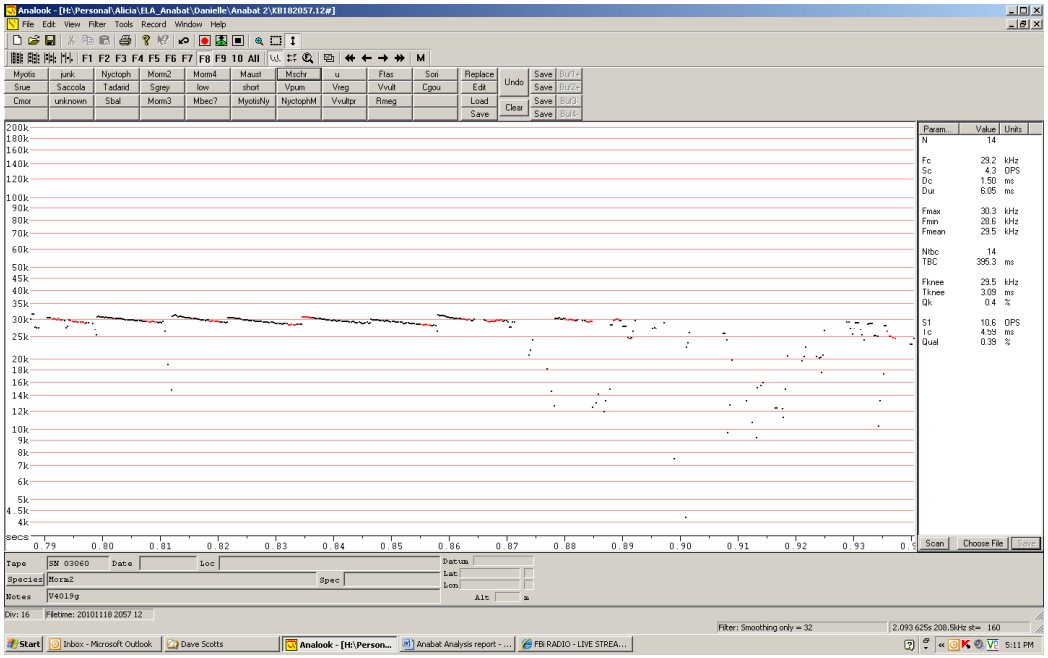

Figure 6: Call profile of *Mormopterus species 2* recorded at 20:57h on 18 November 2010, Tallawarra, NSW.

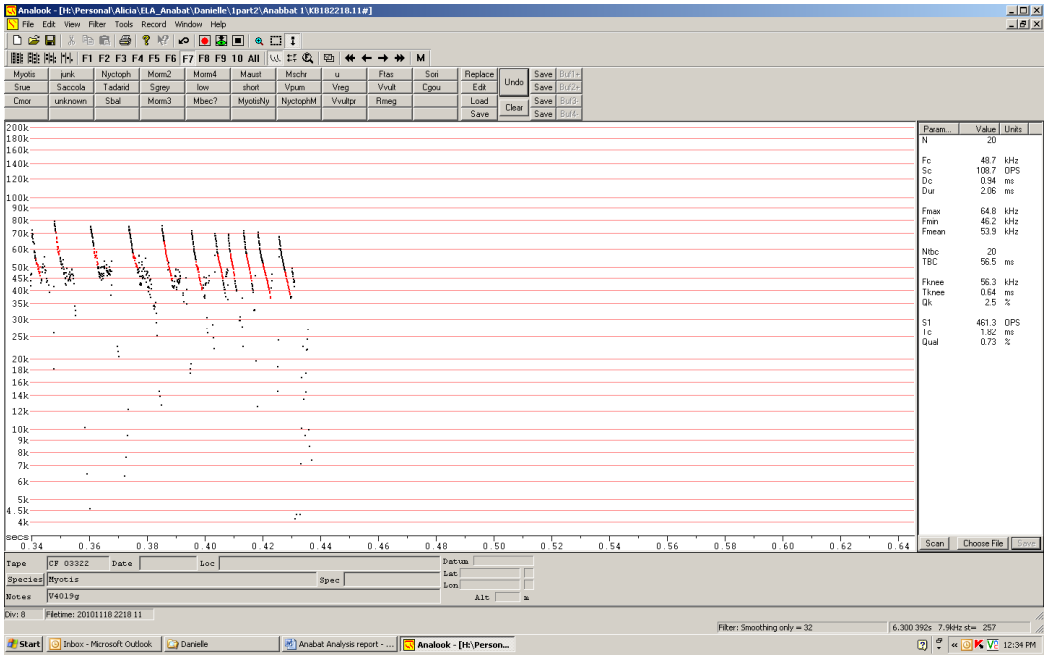

Figure 7: Call profile of the threatened *Myotis macropus* (Vulnerable, TSC Act) recorded at 22:18h on 18 November 2010, Tallawarra, NSW.

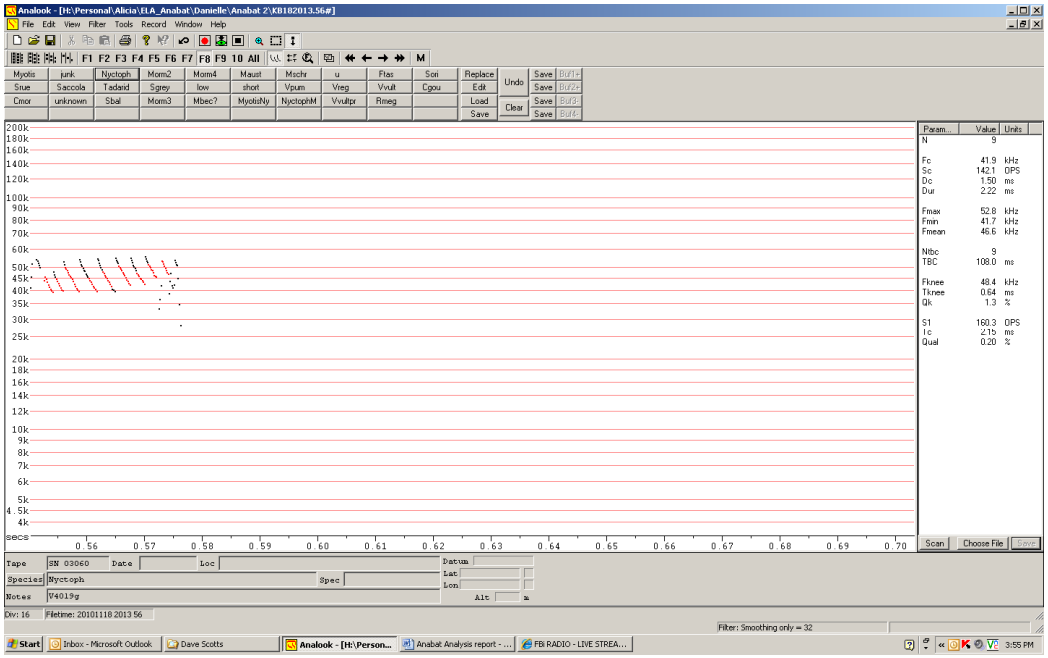

Figure 8: Call profile of Nyctophilus *sp.* recorded at 20:13h on 18 November 2010, Tallawarra, NSW.

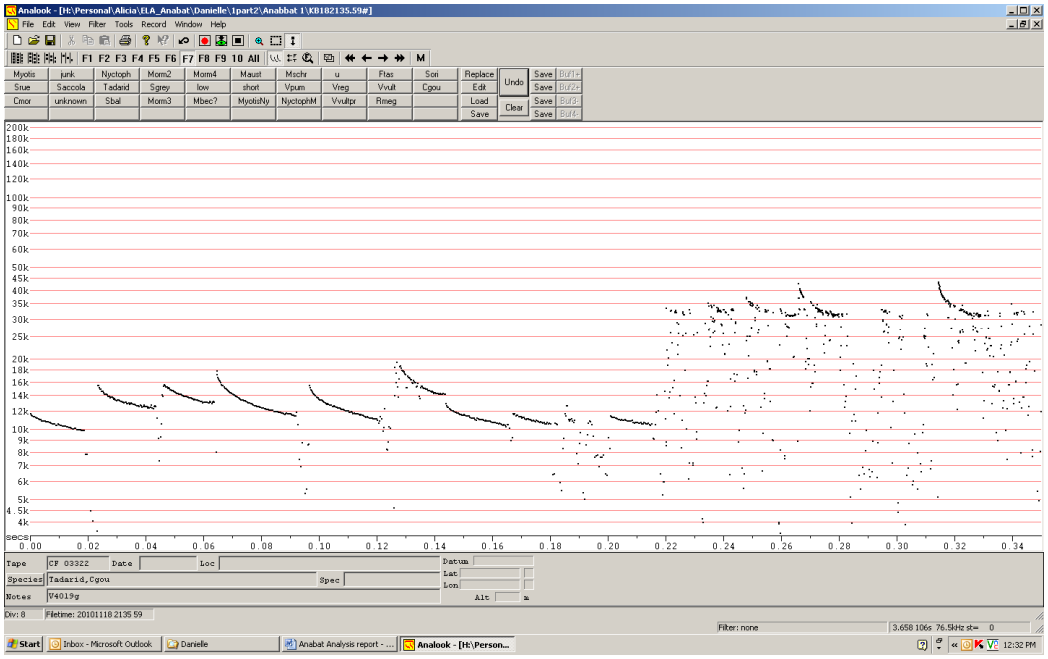

Figure 9: Call profile of *Tadarida australis* recorded at 21:35h on 18 November 2010, Tallawarra, NSW.

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December 2010 – Analysis by Anna Llyod

Introduction and Methodology

Bat calls were analysed using the program AnalookW (Version 3.3q 03 October 2006, written by Chris Corben, www.hoarybat.com). Identifications were made using a regional based guide to the echolocation calls of microbats in New South Wales NSW (Pennay *et al.* 2004) and the accompanying reference library of over 200 calls from the Sydney Basin area of NSW (http://www.forest.nsw.gov.au/research/bats/default.asp). In addition, a reference library of 269 calls from NSW (Law, State Forests of NSW) and a local reference library consisting of 42 calls recorded within 150km of Coffs Harbour (Lloyd & Tolhurst).

Bat calls can be difficult to identify due to intra-specific and geographic variation, therefore a reference library of local calls is a valuable tool for bat call identification.

Bat call analysis is reliant upon the presence of species-specific parameters such as call shape, characteristic frequency, initial slope and time between calls (de Oliveira 1998, Rinehold *et al.* 2001). Without the presence of definitive species-specific characteristics, a definite identification cannot be made. In addition, some species can never be distinguished (eg. *Nyctophilus* species), while others, such as *Rhinolophus megaphyllus,* are distinctive.

To ensure reliable and accurate results the following protocols *(*adapted from *Lloyd et. al. 2006)* were followed:

1. Recordings containing less than three pulses were not analysed (Law *et al.* 1999, Law & Chidel 2002).

2. Only search phase calls were analysed (McKenzie *et al.* 2002).

3. Four categories of confidence in species identification were used (Mills *et al.* 1996):

    a. definite – identity not in doubt

    b. probable – low probability of confusion with species of similar calls

    c. possible – medium to high probability of confusion with species with similar calls; and

    d. unknown bat – calls made by bats which cannot be identified to even a species group.

4. *Nyctophilus* spp. are difficult to identify confidently from their calls and no attempt was made to identify this genus to species level (Pennay *et al.* 2004, Law & Chidel 2002).

5. Other species found within the Sydney Basin Region of NSW are difficult to differentiate confidently on recordings of poor quality. These calls are assigned to the following species groups (Mills *et al.* 1996, Pennay *et al.* 2004) and are included under each species as a possible call:

    a. Miniopterus schreibersii oceanensis / Vespadelus darlingtoni

    b. Miniopterus schreibersii oceanensis/ Vespadelus regulus

    c. Vespadelus regulus / Vespadelus darlingtoni

    d. Vespadelus troughtoni / Vespadelus vulturnus / Vespadelus pumilus

e. Chalinolobus gouldii / Mormopterus spp.

f. Mormopterus sp.2 / Mormopterus norfolkensis

g. Nyctophilus spp. / Myotis macropus

h. Scotorepens orion / Scoteanax rueppellii

i. Scotorepens orion / Falsistrellus tasmaniensis

Results and Discussion

A total of 55 files were submitted for identification. All files were recorded by Anabat 1. Of these, four contained no bat calls. There were 15 calls that were too short and one was of too low a quality to attempt identification. There were no feeding buzzes recorded. Table 1 below shows a summary of the species recorded.

Table 1: Species identified from Anabat recordings on 21-22/12/2010.

	Identification confidence		
Species	Definite	Probable	Possible
Chalinolobus gouldii	-	2	1
Chalinolobus morio	-	2	-
Miniopterus schreibersii oceanensis	4	3	6
Mormopterus norfolkensis	-	-	1
Mormopterus sp.2	-	-	1
Tadarida australis	4	-	4
Vespadelus regulus	-	-	6

The following figures show the species confidently identified.

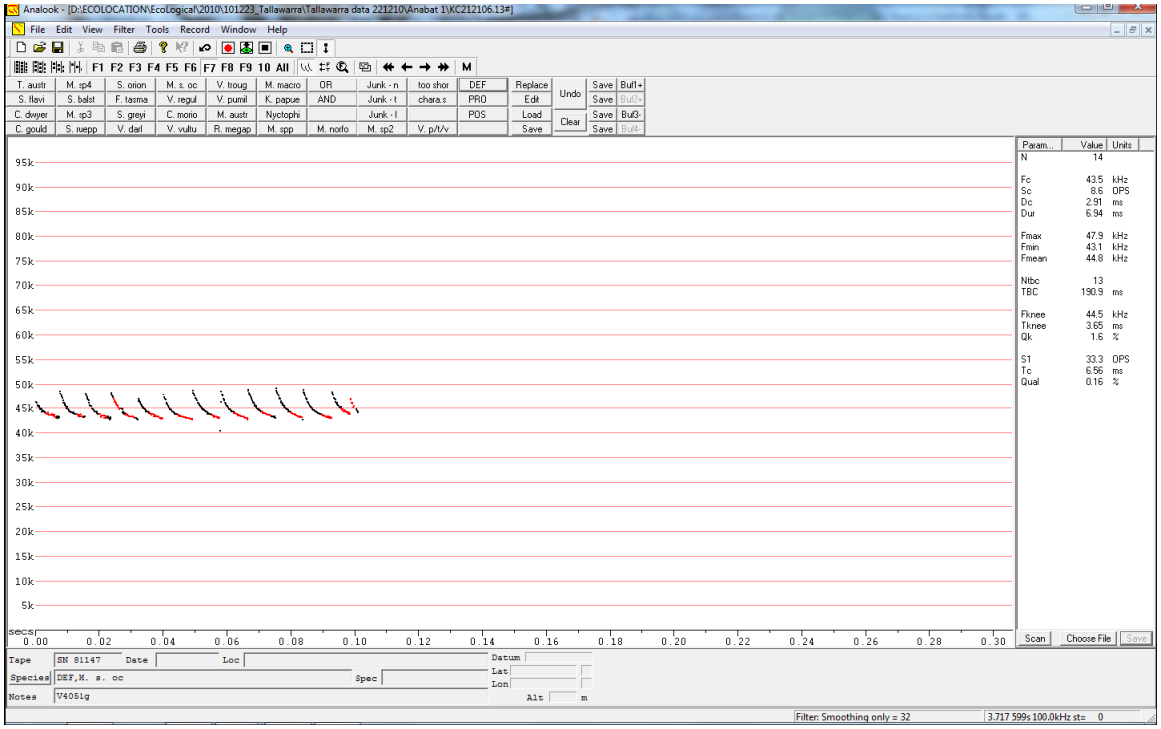

Figure 1: A definite Miniopterus schreibersii oceanensis call recorded during this survey.

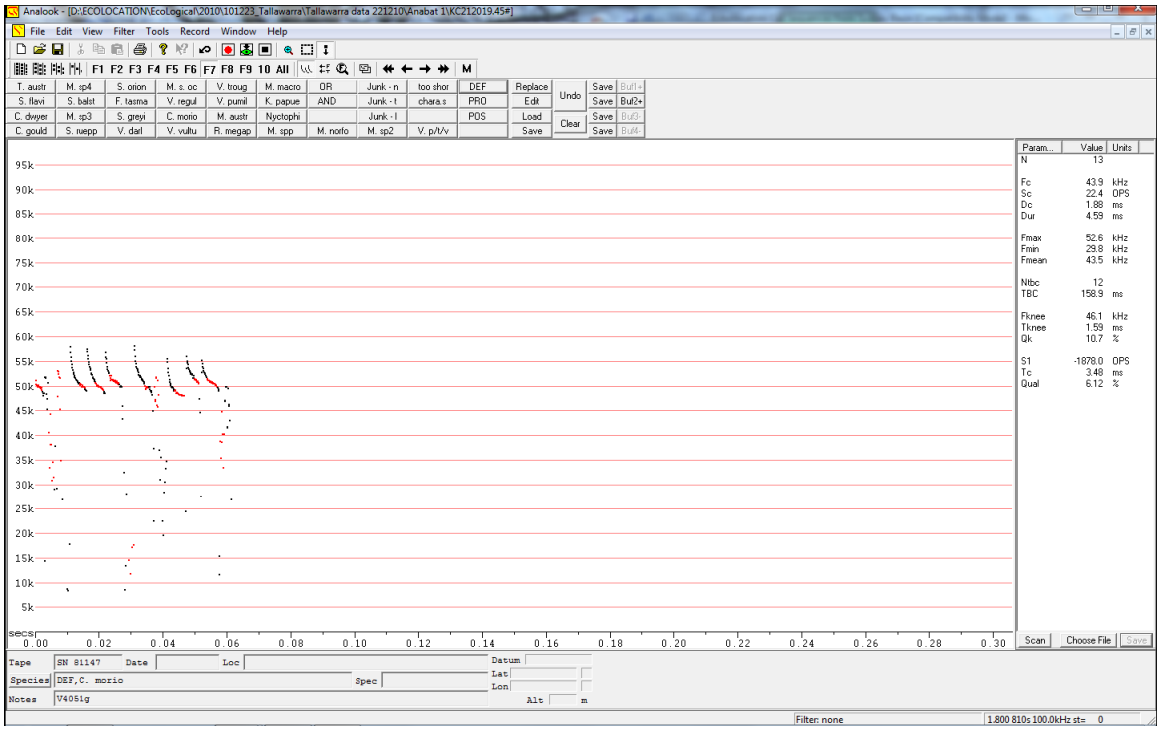

Figure 2: A definite Chalinolobus morio call recorded during this survey.

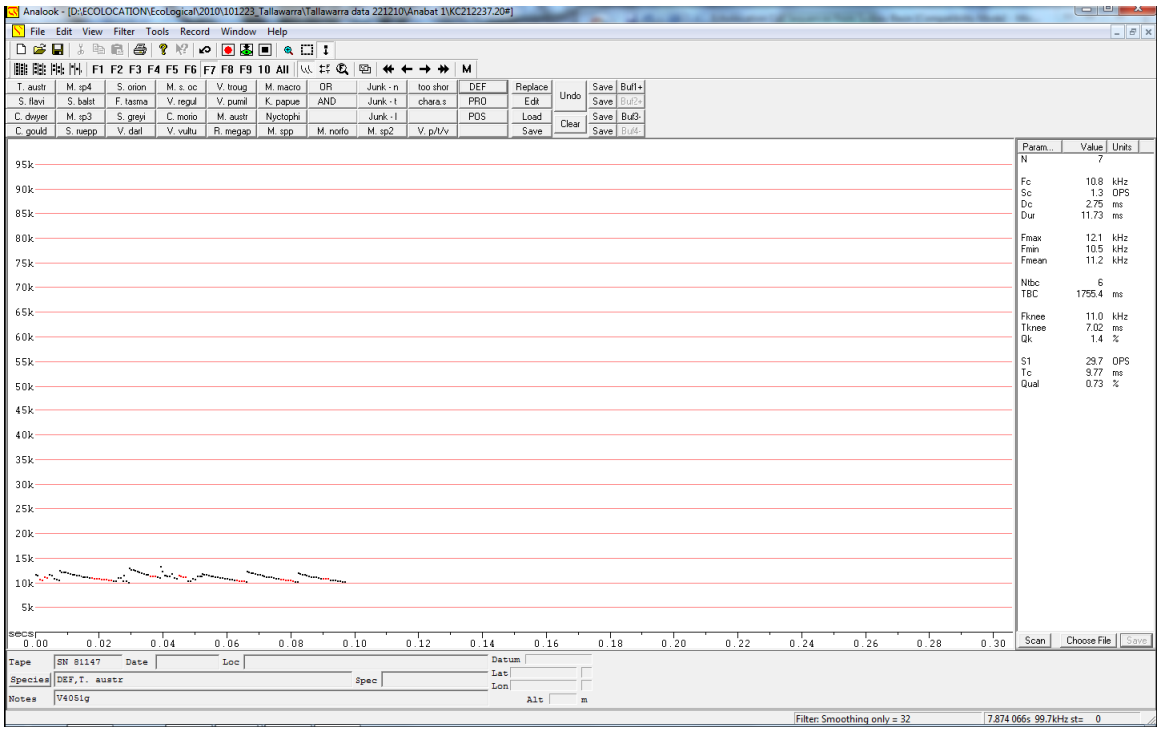

Figure 3: A definite Tadarida australis call recorded during this survey.

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Reinhold, L., Law, B., Ford, G., and Pennay, M. Key to the bat calls of south-east Queensland and north-east New South Wales. 2001. Queensland, DNR.

Appendix E: Part 3A Impact Assessments

NSW Impact Assessment

An assessment of the impacts of the proposal on species, populations and ecological communities listed Schedules 1 and 2 of the TSC Act was undertaken. The proposal will be assessed under Part 3A of the EP&A Act and consequently this impact assessment was undertaken in accordance with the Draft *Guidelines for Threatened Species Assessment* (DECC 2005).

The study area supports extensive areas of native vegetation including a number of EECs and potential and known habitat for a number of threatened flora and fauna species. A full list of species recorded within a 10 km radius of the study area is found in Appendix C, however, not all of these species or their habitat are likely to be impacted by the proposal. Potentially impacted species are listed below. Each flora and fauna species has been assessed separately for potential impacts that may result from the proposal.

Endangered Ecological Communities

- Illawarra Lowlands Grassy Woodland of the Sydney Basin Bioregion (ILGW) - 3.28 ha or 11.07% to be removed
- Swamp Oak Floodplain Forest on the NSW North Coast, Sydney Basin and South East Corner Bioregions (SOFF) – 0.54 ha or 1.68 %
- Coastal Saltmarsh of the Sydney Basin Bioregion (CS) - 0.17 ha or 2.23 %
- Illawarra Subtropical Rainforest in Sydney Basin Bioregion (ISR) – 0.38 ha or 4.51 %

Threatened Flora

- *Caladenia tessellata*
- *Chorizema parviflorum*
- *Cryptostylis hunteriana*
- *Cynanchum elegans*
- *Daphnandra* sp. C Illawarra
- *Haloragis exalata* subsp. *exalata* var. *laevis*
- *Lespedeza juncea* subsp. *juncea*

- *Melaleuca biconvexa*
- *Pterostylis gibbosa*
- *Solanum celatum*
- *Thesium australe*

Threatened Fauna

- Green and Golden Bell Frog
- Australasian Bittern
- Blue-billed Duck
- Sanderling
- Sooty Tern
- Great Knot
- Greater Sand-plover
- Lesser Sand-plover
- Spotted Harrier
- Black-necked Stork
- Sooty Oystercatcher
- Pied Oystercatcher
- Little Eagle
- Black Bittern
- Swift Parrot
- Broad-billed Sandpiper
- Black-tailed Godwit
- Square-tailed Kite
- Turquoise Parrot
- Osprey

- Scarlet Robin
- Pink Robin
- Painted Snipe (Australian subspecies)
- Little Tern
- Sooty Tern
- Freckled Duck
- Hooded Plover
- Regent Honeyeater
- Terek Sandpiper
- Barking Owl
- Powerful Owl
- Masked Owl
- Large-eared Pied Bat
- Eastern False Pipistrelle
- Little Bentwing-bat
- Miniopterus schreibersii oceanensis
- Mormopterus norfolkensis
- Myotis macropus
- Grey-headed Flying-Fox
- Yellow-bellied Sheathtail-bat
- Greater Broad-nosed Bat

8.1 ENDANGERED ECOLOGICAL COMMUNITIES

8.1.1 Swamp Oak Floodplain Forest on Coastal Floodplains on the NSW North Coast, Sydney Basin and South East Corner Bioregions (SSF)

This community is found on the coastal floodplains of NSW. It has a dense to sparse tree layer in which *Casuarina glauca* (swamp oak) is the dominant species northwards from Bermagui.

Other trees including *Acmena smithii* (lilly pilly), *Glochidion* spp. (cheese trees) and *Melaleuca* spp. (paperbarks) may be present as subordinate species, and are found most frequently in stands of the community northwards from Gosford. Tree diversity decreases with latitude, and *Melaleuca ericifolia* is the only abundant tree in this community south of Bermagui.

The understorey is characterised by frequent occurrences of vines, *Parsonsia straminea, Geitonoplesium cymosum* and *Stephania japonica* var. *discolor*, a sparse cover of shrubs, and a continuous groundcover of forbs, sedges, grasses and leaf litter.

The composition of the ground stratum varies depending on levels of salinity in the groundwater. Under less saline conditions prominent ground layer plants include forbs such *Centella asiatica, Commelina cyanea, Persicaria decipiens* and *Viola banksii*; graminoids such as *Carex appressa, Gahnia clarkei, Lomandra longifolia, Oplismenus imbecillis*; and the fern *Hypolepis muelleri*.

On the fringes of coastal estuaries, where soils are more saline, the ground layer may include the threatened grass species, *Alexfloydia repens*, as well as *Baumea juncea, Juncus kraussii, Phragmites australis, Selliera radicans* and other saltmarsh species.

This community occurs on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains generally below 20 m (rarely above 10 m) elevation (DECCW 2010b).

A number of threats to the survival of this community have been identified. Those relevant to this proposal include:

- Clearing for urban and rural development, and the subsequent impacts from fragmentation
- Land filling and earthworks associated with urban and industrial development
- Pollution from urban and agricultural runoff
- Rubbish dumping
- Localised areas, particularly those within urbanised regions, may also be exposed to frequent burning which reduces the diversity of woody plant species (DECCW 2010b).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Not applicable - SOFF is not a threatened species or population.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal includes the removal of approximately 0.54 ha of SOFF. This represents 1.68 % of the SOFF present within the study area. The remaining SOFF (31.58 ha), present primarily along Duck Creek and the south east of the site, will be conserved through incorporation into environmental reserves.

Potential indirect impacts from the proposal on this community include:

- Weed invasion
- Changes to hydrology
- Edge effects
- Fire
- Runoff, sedimentation and erosion

Control measures will be implemented to prevent indirect impacts on SOFF and a VMP has been prepared for the site which will assist in increasing the condition of this community throughout the study area.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Not applicable - SSF is not a threatened species or population.

How is the proposal likely to affect current disturbance regimes?

The greatest potential for accidental fires is likely to be during construction and maintenance works or arson. Therefore a number of preventative measures would need to be implemented to reduce the likelihood of accidental fires. Details of these measures are outlined in the mitigation section of this report and include the preparation of a Bushfire Management Plan.

If mitigation measures are not implemented there is the potential for excess runoff to run downslope and into the reserve supporting SOFF and hence affect current hydrological regimes. However, mitigation measures will be put in place to ensure runoff does not enter the reserve and flooding regimes altered within the conservation areas.

Feral animals can have a detrimental impact on EECs and the species within. Grazing by feral animals such as the European Rabbit can result in the species being precluded from a site. The proposal is considered unlikely to contribute to increasing feral animal activity across the study area and instead is likely to assist with the management of these species through the proposed mitigation measures.

How is the proposal likely to affect habitat connectivity?

The stands of SOFF within the study area are largely connected along the Duck Creek riparian corridor. A small isolated area of SOFF is also present in the very south east of the study area. The proposal will not further isolate this stand of SOFF from the stands to the north and the connectivity along the Duck Creek corridor is likely to be enhanced as a consequence of the proposal as a VMP will be implemented across the site that includes revegetation works within the Duck Creek corridor. The VMP is also likely to reduce the current weed infestations in areas of SOFF and increase the quality of this community within study area.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for EECs.

8.1.2 Illawarra Lowlands Grassy Woodland of the Sydney Basin Bioregion (ILGW)

This community comprises vegetation types that occupy the Illawarra coastal plain and escarpment foothills. Characteristic tree species include Forest Red Gum *Eucalyptus tereticornis*, Thin-leaved Stringybark *Eucalyptus eugenioides*, Woollybutt *Eucalyptus longifolia*, Coast Grey Box *Eucalyptus bosistoana* and White Feather Honey-myrtle *Melaleuca decora*. The understorey is not necessarily grassy as moist forest vegetation types are also included within this broad community. Common shrub species include *Acacia mearnsii* and *Dodonaea viscosa* subsp. *angustifolia*.

This community occurs in near coastal areas below about 200 metres on gently undulating terrain on Berry Siltstone, Budgong Sandstone and Quaternary Alluvium (DECCW 2010b).

A number of threats to the survival of this community have been identified. Those relevant to this proposal include:

- Clearing, degradation and fragmentation of remnants for residential, rural residential, and infrastructure development.
- Invasion of remnants by non-native plant species, including noxious weeds, pasture species and environmental weeds, including garden escapes.
- Dumping of rubbish in remnants
- Physical damage from inappropriate recreational activities (DECCW 2010b).

This community is present in three forms throughout the study area and includes:

- Coastal Grassy Red Gum Forest
- Moist Box – Red Gum Foothills Forest
- Lowland Woollybutt – Melaleuca Forest

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Not applicable - ILGW is not a threatened species or population.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal includes the removal of approximately 3.28 ha of ILGW which is spread across a number of small stands in the west and north east of the study area. This represents 11.07 % of the ILGW present within the study area. The remaining ILGW (26.35 ha) that will be preserved consists of a small stand of LWMF in the south west and a stand of CGRF / MBRGFF in the north east both of which are outside the proposed conservation areas. A larger stand of LWMF will be preserved along Duck Creek and incorporated into an environmental reserve.

Potential indirect impacts from the proposal on this community include:

- Weed invasion
- Changes to hydrology
- Edge effects

- Fire
- Runoff, sedimentation and erosion
- Fragmentation

Control measures will be implemented to prevent indirect impacts on ILGW and a VMP has been prepared for the site which will assist in increasing the condition of this community throughout the study area.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Not applicable - ILGW is not a threatened species or population.

How is the proposal likely to affect current disturbance regimes?

The greatest potential for accidental fires is likely to be during construction and maintenance works or arson. Therefore a number of preventative measures would need to be implemented to reduce the likelihood of accidental fires. Details of these measures are outlined in the mitigation section of this report and include the preparation of a Bushfire Management Plan.

If mitigation measures are not implemented there is the potential for excess runoff to enter the LWMF in the west of the site or increase water levels in Duck Creek and therefore affect current hydrological regimes. It is less likely that runoff from the proposal would impact CGRF / MBRGFF in the north east of the site as this vegetation is upslope of the proposed development area. Mitigation measures will be put in place to ensure runoff does not enter the environmental reserves and flooding regimes altered.

Feral animals can have a detrimental impact on EECs and the species within. Grazing by feral animals such as the European Rabbit can result in the species being precluded from a site. The proposal is considered unlikely to contribute to increasing feral animal activity across the study area and instead is likely to assist with the management of these species through the proposed mitigation measures.

How is the proposal likely to affect habitat connectivity?

The proposal will not alter any current habitat connectivity within the north east of the site. However, it will remove some habitat that is connected as stepping stone habitat in the west. Furthermore, the placement of a road through the lower portion of the most consolidated stand of ILGW along Duck Creek will isolate a small portion of this stand of vegetation.

The connectivity along the Duck Creek corridor is likely to be enhanced as a consequence of the proposal as a VMP will be implemented across the site that includes revegetation works within the Duck Creek corridor. The VMP is also likely to reduce the current weed infestations in and increase the quality of this community within study area.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for EECs.

8.1.3 Coastal Saltmarsh of the Sydney Basin Bioregion (CS)

Coastal Saltmarsh occurs in the intertidal zone on the shores of estuaries and lagoons that are permanently or intermittently open to the sea. It is frequently found as a zone on the landward side of mangrove stands. Characteristic plants include *Baumea juncea*, *Juncus kraussii*, *Sarcocornia quinqueflora*, *Sporobolus virginicus*, *Triglochin striata*, *Isolepis nodosa*, *Samolus repens*, *Selliera radicans*, *Suaeda australis* and *Zoysia macrantha*. Occasionally mangroves are scattered through the saltmarsh. Tall reeds may also occur, as well as salt pans (DECCW 2010b).

A number of threats to the survival of this community have been identified. Those relevant to this proposal include:

- In-filling for development, including roads, residential, industrial, recreational, waste disposal and agricultural purposes.
- Alteration of salinity and increasing nutrient levels resulting from the discharge of stormwater into saltmarshes.
- Weed invasion, particularly by Juncus acutus.
- Physical damage from human disturbance, domestic and feral animals.
- Dumping of rubbish and pollution from oil or chemical spills from shipping or road accidents; catchment runoff of nutrients and agricultural chemicals.
- Inappropriate fire regimes.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Not applicable - CS is not a threatened species or population.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal will not impact any remnant natural areas of CS including two large stands in the south east of the site associated with SEPP14 wetlands, a narrow band of CS present along much of the foreshore of Lake Illawarra and small patches observed near the entrance of Duck Creek.

Some impacts are expected to potential non-natural patches of saltmarsh that have been conservatively classified as CS however are found in highly modified and degraded states resulting from previous site disturbances and land use history (see Section 4.3.1). These patches are found on modified sediments primarily comprised of coal wash that are likely to be disconnected from the tidal influence of the lake. Impacts to these potentially non-natural patches of saltmarsh include the loss of that found at AW2 and the potential loss of a portion of that found within AW 4 totalling 0.17 ha from a total of 7.61 ha in the study area.

These losses are compensated for by the protection of remnant natural patches of CS along with the retention of large areas saltmarsh in other non-natural settings and the rehabilitation of all these areas through the application of the VMP (ELA 2010b). Vegetative management works may indeed allow for the expansion of saltmarsh into suitable environments that are currently degraded or invaded by exotics.

Potential indirect impacts from the proposal on this community include:

- Weed invasion
- Changes to hydrology
- Edge effects
- Fire
- Runoff, sedimentation and erosion

Control measures will be implemented to prevent indirect impacts on the remaining CS.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Not applicable - CS is not a threatened species or population.

How is the proposal likely to affect current disturbance regimes?

The greatest potential for accidental fires is likely to be during construction and maintenance works or arson. Therefore a number of preventative measures would need to be implemented to reduce the likelihood of accidental fires. Details of these measures are outlined in the mitigation section of this report and include the preparation of a Bushfire Management Plan.

There is the potential for the CS on the edge of the artificial wetland (AW4) to be impacted by changes in water levels and water quality due to runoff from the adjacent development or changes to the lake structure. A commitment has been made through the WSUD to maintain current water levels and the pre-development wetting and drying patterns of the wetland and trap runoff from the development and prevent it entering the wetland.

Saltmarsh is present near the proposed employment area in the east of the site. This area is currently highly disturbed and receives discharge from the power station. All run off from the proposed development area will be trapped and prevented from entering this area of saltmarsh. Therefore it is unlikely that the current wetting and drying patterns would be altered as a consequence of the proposal.

The saltmarsh in the south east of the site will be protected within the proposed environmental reserve. Given this habitat is separated from the development area by other vegetation and runoff from the development area will be trapped before it enters the reserve, it is unlikely that the proposal would alter current hydrological regimes.

How is the proposal likely to affect habitat connectivity?

The proposal will not alter any current habitat connectivity for any areas of CS and is not expected to alter current connectivity to watercourses.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for EECs

8.1.4 Freshwater Wetlands on Coastal Floodplains (Freshwater Wetlands)

Associated with coastal areas subject to periodic flooding and in which standing fresh water persists for at least part of the year in most years. Freshwater wetlands typically occur below 20 m elevation on level areas on silts, muds or humic loams in low-lying parts of floodplains, alluvial flats, depressions, drainage lines, backswamps, lagoons and lakes but may also occur in backbarrier landforms where floodplains adjoin coastal sandplains.

Freshwater wetlands are dominated by herbaceous plants and have very few woody species. The structure and composition of the community varies both spatially and temporally depending on the water regime: Those that lack standing water most of the time are usually dominated by dense grassland or sedgeland vegetation, often forming a turf less than 0.5 metre tall and dominated by amphibious plants including *Paspalum distichum* (water couch), *Leersia hexandra* (swamp rice-grass), *Pseudoraphis spinescens* (mud grass) and *Carex appressa* (tussock sedge).

Where they are subject to regular inundation and drying the vegetation may include large emergent sedges over 1 metre tall, such as *Baumea articulata*, *Eleocharis equisetina* and *Lepironia articulata*, as well as emergent or floating herbs such as *Hydrocharis dubia* (frogbit), *Philydrum lanuginosum* (frogsmouth), *Ludwigia peploides* subsp. *montevidensis* (water primrose), *Marsilea mutica* (nardoo) and *Myriophyllum* spp. (milfoils).

As standing water becomes deeper or more permanent, amphibious and emergent plants become less abundant, while floating and submerged aquatic herbs become more abundant. These latter species include *Azolla filiculoides* var. *rubra*, *Ceratophyllum demersum* (hornwort), *Hydrilla verticillata* (water thyme), *Lemna* spp. (duckweeds), *Nymphaea gigantea* (giant waterlily), *Nymphoides indica* (water snowflake), *Ottelia ovalifolia* (swamp lily) and *Potamageton* spp. (pondweeds).

The Freshwater Wetlands on the site are heavily degraded and dominated by exotic grasses. All except one small area (1.32 ha) of FW are present in the south east of the site.

Threats to this community that are relevant to the proposal include:

- Land clearing
- Continuing fragmentation and degradation
- Filling associated with urban and industrial development
- Pollution and eutrophication from urban and agricultural runoff
- Weed invasion
- Dumping of landfill, rubbish and garden refuse
- Native fauna is threatened by predation, particularly by mosquito fish and cane toads

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Not applicable - FW is not a threatened species or population.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

No areas of FW are proposed for direct removal however the small remnant (1.32 ha) which is present in the centre of the site (between Yallah Bay Road and Duck Creek) may be indirectly impacted on through the utilisation of this area for WSUD and open space purposes. This remnant is in a highly degraded state and has been conservatively classified as FW (given its position in the landscape, hydrological connections and perceived potential for compositional changes) despite only containing one native species (*Casuarina glauca*) and being dominated by pasture grasses and other weeds.

The remaining FW (22.91 ha) will be preserved within the proposed conservation areas.

Potential indirect impacts from the proposal on this community include:

- Weed invasion
- Changes to hydrology
- Edge effects
- Fire
- Runoff, sedimentation and erosion

Control measures will be implemented to prevent indirect impacts on the FW and a VMP has been prepared for the site which will assist in increasing the condition of this community throughout the study area.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Not applicable - FW is not a threatened species or population.

How is the proposal likely to affect current disturbance regimes?

The greatest potential for accidental fires is likely to be during construction and maintenance works or arson. Therefore a number of preventative measures would need to be implemented to reduce the likelihood of accidental fires. Details of these measures are outlined in the mitigation section of this report and include the preparation of a Bushfire Management Plan.

If mitigation measures are not implemented there is the potential for excess runoff to enter the FW in the east of the site and therefore affect current hydrological regimes. Mitigation measures will be put in place to ensure runoff does not enter the environmental reserves and flooding regimes altered.

Feral animals can have a detrimental impact on EECs and the species within. Grazing by feral animals such as the European Rabbit can result in the species being precluded from a site. The proposal is considered unlikely to contribute to increasing feral animal activity across the study area and instead is likely to assist with the management of these species through the proposed mitigation measures.

How is the proposal likely to affect habitat connectivity?

The proposal will not alter any current habitat connectivity for this community.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for EECs.

8.1.5 Illawarra Subtropical Rainforest in Sydney Basin Bioregion (ISR)

A rainforest community that occupies high nutrient soils in the Illawarra region, south of Sydney. Characteristic tree species include *Baloghia inophylla* (Brush Bloodwood), *Brachychiton acerifolius* (Flame Tree), *Dendrocnide excelsa* (Giant Stinging Tree), *Diploglottis australis* (Native Tamarind), *Ficus* spp., *Pennantia cunninghamii* (Brown Beech), and *Toona ciliata* (Red Cedar). Species of *Eucalyptus*, *Syncarpia* and *Acacia* may also be present as emergents or incorporated into the dense canopy. While rainforest canopies are generally closed, in highly disturbed stands the canopy of ISR may be irregular and open. The height of the canopy varies considerably, and structurally some stands of ISR are scrub (DECCW 2010b).

Usually found on Permian volcanic rocks, but can occur on a range of rock types. Occupies the Illawarra coastal plain and escarpment foothills, rarely extending onto the upper escarpment slopes.

A number of threats to the survival of this community have been identified. Those relevant to this community include:

- Further loss and fragmentation of habitat, particularly as a consequence of clearing for agriculture, hard rock quarrying, hobby farming, and residential development.
- Habitat degradation as a consequence of weed invasion, altered hydrological conditions, unrestricted access, grazing/trampling by livestock and feral animals, and rubbish dumping.
- Inappropriate fire regimes (DECCW 2010b).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Not applicable - ISR is not a threatened species or population.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal includes the removal of approximately 0.38 ha of ISR which is a small, highly degraded remnant with an understorey dominated by *Lantana camara*. This represents 4.51 % of the ISR present within the study area. The remaining ISR (8.05 ha) is present to the east of the patch to be removed and both are outside the proposed conservation areas. The stand to be preserved is on the boundary of land zoned for residential development and is also heavily degraded. The stands of ISR are disjunct from all other consolidated stands of vegetation across the study area and consequently none of this community is present within the proposed environmental reserves however sensitive management within open space areas will seek to retain remaining remnants (ELA 2010b).

Potential indirect impacts from the proposal on this community include:

- Weed invasion
- Edge effects
- Fire

Control measures will be implemented to prevent indirect impacts on the remaining and a VMP has been prepared for the site which will assist in increasing the condition of this community throughout the study area.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Not applicable - ISR is not a threatened species or population.

How is the proposal likely to affect current disturbance regimes?

The greatest potential for accidental fires is likely to be during construction and maintenance works or arson. Therefore a number of preventative measures would need to be implemented to reduce the likelihood of accidental fires. Details of these measures are outlined in the mitigation section of this report and include the preparation of a Bushfire Management Plan.

If mitigation measures are not implemented there is the potential for excess runoff to enter the ISR immediately adjacent to the proposed development area. Mitigation measures will be put in place to ensure runoff does not enter the environmental reserves and hydrological regimes altered.

Given the proximity of this community to the proposed development area, edge effects are likely. However, a VMP has been prepared for the site which outlines measures that will prevent edge effects and includes management of the current weed infestation within the ISR.

Feral animals can have a detrimental impact on EECs and the species within. Grazing by feral animals such as the European Rabbit can result in the species being precluded from a site. The proposal is considered unlikely to contribute to increasing feral animal activity across the study area and instead is likely to assist with the management of these species through the proposed mitigation measures.

How is the proposal likely to affect habitat connectivity?

The proposal will not alter any current habitat connectivity for this community. Both stands exist as very small, isolated fragments that would act as stepping stone habitat. Whilst some stepping stone habitat will be lost through the removal of the smallest stand, the larger stand is nearby and therefore will continue the function as stepping stone habitat throughout the northern part of the study area.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for EECs.

8.2 FLORA

8.2.1 *Caladenia tessellata* – Thick-lipped Spider Orchid

The Thick-lipped Spider Orchid is from a group of orchids characterised by five long spreading petals and sepals around a broad down-curled labellum ('lip'). It has cream-coloured petals with reddish stripes, and the yellowish labellum is broad with a few darker stripes. The long, sparsely-hairy, narrow leaf is about 6 cm long and 5 mm wide. It has a column base with two prominent yellow glands (DECCW 2010b).

This species is known from the Sydney area (old records), Wyong, Ulladulla and Braidwood in NSW. Populations in Kiama and Queanbeyan are presumed extinct. The species occurs on the coast in Victoria from east of Melbourne to almost the NSW border (DECCW 2010b).

Generally found in grassy sclerophyll woodland on clay loam or sandy soils, though the population near Braidwood is in low woodland with stony soil. The single leaf regrows each year and flowers appear between September and November (but apparently generally late September or early October in extant southern populations) (DECCW 2010b).

Habitat for this species is present in areas of CGRGF and LWMF across the study area. These areas of habitat where specifically surveyed for this species in this study during a suitable season for detection. The species was not observed at the subject site during targeted survey nor has it been observed during previous ecological studies relating to the study area. Regardless, an impact assessment has been completed for this species on the basis of potential habitat that demonstrates a precautionary approach to the proposed development.

Identified threats are relevant to this species with regards to the proposal include:

- At least two known sites have been lost due to clearing associated with urban development. This has probably also caused the destruction of many of the historical populations in the Sydney area.
- Remaining populations could be under threat from intensive use of coastal locations for recreation and other purposes.
- Possibly threatened by long-term absence of fire (DECCW 2010b).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The pollination mechanisms of *Caladenia tessellata* are not well understood. However this species is known to have a 1-1 pollinator relationship and is not thought to self-pollinate. Fire is known to play a role in germination. Little is known of dormancy, the persistence of seedbanks, and germination mechanisms for this species.

Given this species is pollinated by wasps it is unlikely that the proposal would prevent movement of wasps throughout areas of potential habitat for this species. Furthermore, management measures will be implemented to manage indirect impacts on this species and if this species is found on site, the BMP would be altered to allow for prescribed burns to allow this species to germinate. Therefore it is unlikely that the proposal would affect the lifecycle of this species.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal will result in the removal of 3.08 ha of potential habitat for this species (2.54 ha LWMF and 0.54 ha CGRGF). This represents 13.73 % of the habitat within the study area. The remaining 19.35ha will be preserved across the study area with the majority of the LWMF (approximately 14 ha) in the west of the site conserved within an environmental reserve. The CGRGF present in the north east of the site will be preserved (2.10 ha) but will not be incorporated into any proposed conservation areas although it does adjoin the Mt Brown Reserve.

Potential indirect impacts from the proposal on habitat for this species include:

- Weed invasion
- Changes to hydrology
- Edge effects
- Fire

All habitat for this species within the study area is invaded by exotic species. A VMP has been prepared and will be implemented across the study area. Control measures will be implemented to ensure that impacts to habitat for this threatened species are minimised.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Tessellated Spider Orchid is known from the Sydney area (old records), Wyong, Ulladulla and Braidwood in NSW. Populations in Kiama and Queanbeyan are presumed extinct. It also occurs throughout Victoria east of Melbourne and up nearly to the NSW boarder (DECCW 2010b). Therefore this species is not at the limit of its known distribution at Tallawarra.

How is the proposal likely to affect current disturbance regimes?

Long-term absence of fire has been identified as a potential threat to this species. Given that management measures will be implemented to prevent fires within the study area due to the threats to life and property, it is likely that the current disturbance regimes would be altered. Fire is likely to currently be infrequent at the site.

Fires that are too frequent may also impact on the lifecycle of flora. The greatest potential for accidental fires is likely to be during construction and maintenance works or arson. Therefore a number of preventative measures would need to be implemented to reduce the likelihood of accidental fires. Details of these measures are outlined in the mitigation section of this report and include the preparation of a Bushfire Management Plan.

If mitigation measures are not implemented there is the potential for excess runoff to enter the LWMF immediately adjacent to the proposed development area. Mitigation measures will be put in place to ensure runoff does not enter the environmental reserves and hydrological regimes altered. Given the CGRGF is located upslope of the proposed development, issues associated with runoff from the development area are unlikely.

Given the proximity of this community to the proposed development area, edge effects are likely. However, a VMP has been prepared for the site which outlines measures to prevent the spread of weeds across the site and includes management of the current weed infestation within areas of potential habitat.

Feral animals can have a detrimental impact on habitat and the species within. Grazing by feral animals such as the European Rabbit can result in the species being precluded from a site. The proposal is considered unlikely to contribute to increasing feral animal activity across the study area and instead is likely to assist with the management of these species through the proposed mitigation measures.

How is the proposal likely to affect habitat connectivity?

The proposal will not alter any current habitat connectivity within the north east of the site (CGRGF). However, it will remove some habitat that is connected as stepping stone habitat in the west. Given that this species is pollinated by wasps, it is likely that they would still move across the road to the southern areas of LWMF.

The connectivity along the Duck Creek corridor is likely to be enhanced as a consequence of the proposal as a VMP will be implemented across the site that includes revegetation works within the Duck Creek corridor. The VMP is also likely to reduce the current weed infestations in and increase the quality of this community within study area.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for this species.

8.2.2 *Chorizema parviflorum* - population, Wollongong and Shellharbour local government areas

This endangered population has been recorded from between Austinmer and Albion Park in the local government areas of Wollongong and Shellharbour. All known sites (excluding the site at Austinmer) occupy woodland or forest dominated by Forest Red Gum (*Eucalyptus tereticornis*) and/or Woollybutt (*E. longifolia*) (DECCW 2010b). At Austinmer, the species is recorded from a coastal headland.

Chorizema parviflorum is a shrub to 50 cm high, with a stout rootstock. It has narrow leaves (1 to 4 cm long, 1 to 4 mm wide) with a rib down the middle of the leaf. The flowers are pea-like, yellow with a red centre, and are borne in loose clusters at the ends of branches. The flowering period is August to January, with seeds maturing from November.

The species is difficult to locate when not in flower, as it is often tangled amongst (and partially concealed by) a grassy understorey. Habitat for this species is present in areas of LWMF across the study area. Three individuals of this species were observed on the subject site along the western boundary of the site within a less disturbed patch of LWMF. Other areas of LWMF habitat were also searched however no other individuals of this species were observed, possibly due to higher levels of disturbances such as soil or weeds.

The three individuals were observed in an area proposed for an environmental reserve that will be subject to restoration works under the VMP. They are located approximately 150m from the closest works under the proposed development and are upslope from these works. As such, it is expected that direct or indirect impacts to the individuals will be negligible to nothing. Regardless, an impact assessment has been completed for this species on the basis of potential habitat, which demonstrates a precautionary approach to the proposed development.

Threats identified for this species that are relevant to the proposal include:

- Further loss and fragmentation of habitat, particularly as a consequence of clearing for agriculture and residential development.
- Habitat degradation as a result of weed invasion, grazing/trampling by livestock, track/powerline maintenance, and rubbish dumping.
- High frequency fire (DECCW 2010b). The response of the species to fire is reportedly variable. Some plants have been observed to reshoot following fire while others have been killed. A soil seedbank for the species exists although the longevity of this seedbank is not known (DECCW 2010b).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The proposal will result in the removal of 2.54 ha of potential habitat some of which is already comprised of fragmented habitat and therefore the removal of this vegetation is considered unlikely to alter dispersal activities of this species. However, it will reduce the seed bank for this species throughout the study area (in areas of potential habitat) should there be viable seed bank present in these areas. Currently it is understood that a soil seedbank for this species exists where it is present although the longevity of this seedbank is not known (DECCW 2010b).

The proposal includes the minor fragmentation of currently connecting habitat through the construction of an entry road. This is likely to reduce to available seed bank should this species be present, and may also create a barrier to seed dispersal.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal will result in the removal of 2.54 ha of potential habitat for this species. This represents 12.83 % of the habitat within the study area. The remaining 17.25 ha will be preserved across the study area with the majority of the LWMF (approximately 14 ha) in the west of the site conserved within an environmental reserve.

Potential indirect impacts from the proposal on habitat for this species include:

- Weed invasion
- Changes to hydrology
- Edge effects
- Fire

All habitat for this species is invaded by exotic species. A VMP to be implemented at the site will assist in improving the condition of this community. Control measures will also be implemented to ensure that impacts to habitat for the threatened species are minimised.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

This endangered population only occurs within the Wollongong and Shellharbour LGAs (DECCW 2010b) and therefore if present within the study area would be close to the limit of its narrow distribution.

How is the proposal likely to affect current disturbance regimes?

The response of the species to fire is reportedly variable. Some plants have been observed to reshoot following fire while others have been killed. High fire frequency is listed as a threatening process for this species. The greatest potential for accidental fires is likely to be during construction and maintenance works or arson. Therefore a number of preventative measures would need to be implemented to reduce the likelihood of accidental fires. Details of these measures are outlined in the mitigation section of this report and include the preparation of a Bushfire Management Plan.

If mitigation measures are not implemented there is the potential for excess runoff to enter the LWMF immediately adjacent to the proposed development area. Mitigation measures will be put in place to ensure runoff does not enter the environmental reserves and hydrological regimes altered.

Given the proximity of this community to the proposed development area, edge effects are likely. However, a VMP has been prepared for the site which addresses this threat and includes management of the current weed infestation within areas of potential habitat.

Feral animals can have a detrimental impact on habitat and the species within. Grazing by feral animals such as the European Rabbit can result in the species being precluded from a site. The proposal is considered unlikely to contribute to increasing feral animal activity across the study area and instead is likely to assist with the management of these species through the proposed mitigation measures.

How is the proposal likely to affect habitat connectivity?

The proposal will remove some currently fragmented habitat in the west. It is likely that seed dispersal is already somewhat inhibited by this fragmentation.

The connectivity along the Duck Creek corridor is likely to be enhanced as a consequence of the proposal as a VMP will be implemented across the site that includes revegetation works within the Duck Creek corridor. The VMP is also likely to reduce the current weed infestations in and increase the quality of this community within study area.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat has not been for this population.

8.2.3 *Cryptostylis hunteriana* – Leafless Tongue Orchid

The Leafless Tongue Orchid has no leaf and produces an upright flower-stem to 45 cm tall, bearing five to 10 flowers between November and February. It has small narrow green sepals and petals to 22 mm long, but is dominated by an erect narrow very hairy 'tongue' (the labellum). This is up to 33 mm long, maroon along the margins and at the widened tip, and with a black central band. All other tongue orchids have leaves; most have a downward pointing labellum (DECCW 2010b).

This species does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland. The larger populations typically occur in woodland dominated by Scribbly Gum (*Eucalyptus sclerophylla*), Silvertop Ash (*E. sieberi*), Red Bloodwood (*Corymbia gummifera*) and Black Sheoak (*Allocasuarina littoralis*); appears to prefer open areas in the understorey of this community and is often found in association with the Large Tongue Orchid (*C. subulata*) and the Tartan Tongue Orchid (*C. erecta*).

Little is known about the ecology of the species; being leafless it is expected to have limited photosynthetic capability and probably depends upon a fungal associate to meet its nutritional requirements from either living or dead organic material. In addition to reproducing from seed, it is also capable of vegetative reproduction and thus forms colonies which can become more or less permanent at a site (DECCW 2010b).

Habitat for this species is present in areas of CGRGF, LWMF, ASMF and MBRGFF across the study area. These areas of habitat where specifically surveyed for this species in this study during a suitable season for detection. The species was not observed at the subject site during targeted survey nor has it been observed during previous ecological studies relating to the study area. Regardless, an impact assessment has been completed for this species on the basis of potential habitat that demonstrates a precautionary approach to the proposed development.

Identified threats relevant to this species with respect to the proposal include:

- Since the Leafless Tongue Orchid tends to occur in coastal areas the main threat to its continued survival appears to be development pressure on sites where it occurs (DECCW 2010b).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Cryptostylis hunteriana is known to reproduce from seed but is also capable of vegetative reproduction and thus forms colonies which can become more or less permanent at a site (DECCW 2010b).

The proposal will result in the removal of 3.28 ha of potential habitat some of which is already comprised of fragmented habitat and therefore the removal of this vegetation is considered unlikely to alter dispersal activities of this species. However, it will reduce the seed bank for this species throughout the study area should a viable seed bank be present.

Little is known about the ecology of the species; being leafless it is expected to have limited photosynthetic capability and probably depends upon a fungal associate to meet its nutritional requirements from either living or dead organic material (DECCW 2010b). Runoff from the nearby road may also impact on the fungi on which *Cryptostylis hunteriana* is dependant for nutritional requirements. Therefore it is imperative that runoff is trapped around the site and prevented from entering areas of potential habitat.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal will result in the removal of 3.28 ha of potential habitat for this species (2.54 ha LWMF, 0.2 ha MBRGFF and 0.54 ha CGRGF). The remaining 43.69 ha will be preserved across the study area with the majority of the LWMF (approximately 14 ha) in the west of the site conserved within an environmental reserve. The CGRGF and MBRGFF present in the north east of the site will be preserved but will not be incorporated into any proposed conservation areas.

Potential indirect impacts from the proposal on habitat for this species include:

- Weed invasion
- Changes to hydrology
- Edge effects
- Fire
- Runoff, sedimentation and erosion

All habitat for this species is invaded by exotic species. A VMP has been prepared and will be implemented across the study area. Control measures will be implemented to ensure that impacts to habitat for the threatened species are minimised.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Leafless Tongue Orchid has been recorded from as far north as Gibraltar Range National Park south into Victoria around the coast as far as Orbost. It is known historically from a number of localities on the NSW south coast and has been observed in recent years at many sites between Batemans Bay and Nowra (although it is uncommon at all sites). Also recorded at Nelson Bay, Wyee, Washpool National Park, Nowendoc State Forest, Ku-ring-gai Chase National Park, and Ben Boyd National Park. (DECCW 2010b). Therefore this species is not at the limit of its known distribution at Tallawarra.

How is the proposal likely to affect current disturbance regimes?

The greatest potential for accidental fires is likely to be during construction and maintenance works or arson. Therefore a number of preventative measures would need to be implemented to reduce the likelihood of accidental fires. Details of these measures are outlined in the mitigation section of this report and include the preparation of a Bushfire Management Plan.

If mitigation measures are not implemented there is the potential for excess runoff to enter areas of potential habitat for this species. Little is known about the ecology of the species; being leafless it is expected to have limited photosynthetic capability and probably depends upon a fungal associate to meet its nutritional requirements from either living or dead organic material (DECCW 2010b). There is the potential for uncontrolled runoff not only to impact on hydrological regimes in areas of potential habitat but to also impact on the fungi on which this species is thought to be dependant for nutritional requirements. Mitigation measures will be put in place to ensure runoff does not enter the environmental reserves and hydrological regimes altered. Given the CGRGF is located upslope of the proposed development, issues associated with runoff from the development area are unlikely.

Given the proximity of habitat for this species to the proposed development area, edge effects are likely. However, a VMP has been prepared for the site which addresses this threat and includes management of the current weed infestation within areas of potential habitat.

Feral animals can have a detrimental impact on habitat and the species within. Grazing by feral animals such as the European Rabbit can result in the species being precluded from a site. The proposal is considered unlikely to contribute to increasing feral animal activity across the study area and instead is likely to assist with the management of these species through the proposed mitigation measures.

How is the proposal likely to affect habitat connectivity?

The proposal will not alter any current habitat connectivity within the north east of the site (CGRGF, MBRGFF). However, it will remove some habitat currently fragmented habitat in the west (LWMF). Given that this species disperses via seed or vegetative material it is likely that these mechanisms are already somewhat inhibited by this fragmentation

The connectivity along the Duck Creek corridor is likely to be enhanced as a consequence of the proposal as a VMP will be implemented across the site that includes revegetation works within the Duck Creek corridor. The VMP is also likely to reduce the current weed infestations in and increase the quality of this community within study area.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for this species.

8.2.4 *Cynanchum elegans* - White-flowered Wax Plant

A climber or twiner with a highly variable form. Mature stems have a fissured corky bark and can grow to 10 metres long and 3.5 cm thick. The leaves are paired (or rarely in threes), ovate to broadly ovate in shape, 1.5 to 10.5 cm long, and 1.5 to 7.5 cm wide. The flowers are white, tubular, and up to 4 mm long and 12 mm wide. The fruit is a dry pointed pod to 8 cm long, which contains up to 45 seeds with long silky hairs attached to one end (DECCW 2010b).

Restricted to eastern NSW where it is distributed from Brunswick Heads on the north coast to Gerroa in the Illawarra region. The species has been recorded as far west as Merriwa in the upper Hunter River valley (DECCW 2010b).

The White-flowered Wax Plant usually occurs on the edge of dry rainforest vegetation. Other associated vegetation types include littoral rainforest; Coastal Tea-tree *Leptospermum laevigatum* – Coastal Banksia *Banksia integrifolia* subsp. *integrifolia* coastal scrub; Forest Red Gum *Eucalyptus tereticornis* aligned open forest and woodland; Spotted Gum *Eucalyptus maculata* aligned open forest and woodland; and Bracelet Honeymyrtle *Melaleuca armillaris* scrub to open scrub (DECCW 2010b).

Flowering occurs between August and May, with a peak in November. Flower abundance on individual plants varies from sparse to prolific. The fruit can take up to six months to mature.

Seed production is variable and unreliable. Seeds are wind dispersed. It is considered to be unlikely that a soil seed bank for this species exists. Plants are capable of suckering from rootstock in response to occasional slashing or grazing. The fire response of the species is unknown (DECCW 2010b).

Habitat for this species is present in areas of ISR, CGRGF, ASMF and LWMF across the study area.

Surveys were undertaken for this species during the appropriate season. This species was not recorded during the site inspection. However due to the dense Lantana infestation in some areas, all areas could not be fully traversed.

Threats identified to this species that are relevant to this proposal include:

- Further loss and fragmentation of habitat, particularly through clearing for agriculture, quarries and residential development.
- Habitat degradation resulting from weed invasion, grazing, rubbish dumping, landfill, urban run-off, track construction/widening, and inappropriate fire management (DECCW 2010b).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Although potential habitat for this species will be removed from the study area, the current fragmentation of the vegetation types which provide potential habitat is likely to already inhibit seed dispersal. It is unlikely that the proposed ISR and CGRGF clearance would further inhibit seed dispersal should this species be present in these areas.

Cynanchum elegans seeds are dispersed by wind. The current LWMF is fragmented although there is likely to be the potential for some seeds to still move between areas. Based on the current concept plan, the stand of LWMF in the very south west is likely to become further isolated from other areas of LWMF and therefore seed dispersal further inhibited.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal will result in the removal of 3.46 ha of potential habitat for this species (2.54 ha LWMF, ISR 0.38 ha and 0.54 ha CGRGF). The remaining 44.74 ha will be preserved across the study area with the majority of the LWMF (approximately 14 ha) in the west of the site and the ASMF (17 ha) in the south east conserved within environmental reserves. The remaining CGRGF present in the north east of the site and the ISR in the north west will be preserved but will not be incorporated into any proposed conservation areas.

Potential indirect impacts from the proposal on habitat for this species include:

- Weed invasion
- Changes to hydrology
- Edge effects
- Fire
- Runoff, sedimentation and erosion

All habitat for this species is invaded by exotic species. A VMP has been prepared and will be implemented across the study area. Control measures will be implemented to ensure that impacts to habitat for the threatened species are minimised.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Cynanchum elegans is restricted to eastern NSW where it is distributed from Brunswick Heads on the north coast to Gerroa in the Illawarra region. The species has been recorded as far west as Merriwa in the upper Hunter River valley (DECCW 2010b). This species is close to the limit of its distribution at Tallawarra.

How is the proposal likely to affect current disturbance regimes?

The greatest potential for accidental fires is likely to be during construction and maintenance works or arson. Therefore a number of preventative measures would need to be implemented to reduce the likelihood of accidental fires. Details of these measures are outlined in the mitigation section of this report and include the preparation of a Bushfire Management Plan.

If mitigation measures are not implemented there is the potential for excess runoff to enter the LWMF and ISR which are located immediately adjacent to the proposed development areas. Mitigation measures will be put in place to ensure runoff does not enter the environmental reserves and hydrological regimes altered. Given the CGRGF is located upslope of the proposed development, issues associated with runoff from the development area are unlikely. Furthermore, the ASMF is located within a 95.98 ha environmental reserve which will be protected from indirect impacts of the proposal.

Given the proximity of the ISR and LWMF to the proposed development areas, edge effects are likely. However, a VMP has been prepared for the site which addresses this threat and includes management of the current weed infestation within areas of potential habitat.

Feral animals can have a detrimental impact on habitat and the species within. Grazing by feral animals such as the European Rabbit can result in the species being precluded from a site. The proposal is considered unlikely to contribute to increasing feral animal activity across the study area and instead is likely to assist with the management of these species through the proposed mitigation measures.

How is the proposal likely to affect habitat connectivity?

The proposal will not alter any current habitat connectivity within the north east of the site (CGRGF). The proposal will result in a small area of potential habitat being removed and therefore current habitat connectivity in terms of seed dispersal between areas of ISR. Both stands exist as very small, isolated fragments. Whilst some habitat will be lost through the removal of the smallest stand, the larger stand will continue the function as potential habitat throughout the northern part of the study area.

The LWMF in the south west of the site, although fragmented is likely to be connected in terms of seed dispersal. The proposed road south of Duck Creek is unlikely to prevent seed dispersal to areas in the south given the small width. However, the proposal is likely to isolate the smallest stand of LWMF in the south of the site as this vegetation will be further fragmented from the stands to the north.

A large area of potential habitat (17 ha, ASMF) occurs in the south east of the site and will form part of a 95.98 ha environmental reserve. Fragmentation of this habitat will not result as a consequence of the proposal.

The connectivity along the Duck Creek corridor is likely to be enhanced as a consequence of the proposal as a VMP will be implemented across the site that includes revegetation works within the Duck Creek corridor. The VMP is also likely to reduce the current weed infestations in and increase the quality of this community within study area.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for this species.

8.2.5 *Daphnandra* sp. C Illawarra - Illawarra Socketwood

Daphnandra sp. C Illawarra is a rainforest tree to 20 metres tall. Leaves opposite, coarsely toothed, roughly oval in shape, 6 to 12 cm long, 1.5 to 6 cm wide, with a raised mid-vein on the upper surface. Small, pale greenish white flowers (rarely with a pink margin), borne in a many-flowered panicle from the leaf base (DECCW 2010b).

Restricted to the Illawarra region where it has been recorded from the local government areas of Shoalhaven, Kiama, Shellharbour and Wollongong. This species occupies the rocky hillsides and gullies of the Illawarra lowlands, occasionally extending onto the upper escarpment slopes. Associated vegetation includes rainforest and moist eucalypt forest. Associated soils are loams and clay loams derived from volcanic and fertile sedimentary rocks (DECCW 2010b).

Flowers briefly in September and early October with fruits taking 10 to 12 months to mature. Capable of vegetative reproduction from stems (coppicing) and rhizomes (suckering). Low levels of seed production are suspected, with stems at most sites appearing to only produce 'pseudo-fruit' which lack seeds. Possibly killed by fire (DECCW 2010b).

Habitat for this species is present in areas of ISR and CGRGF across the study area. These areas of habitat where specifically surveyed for this species in this study during a suitable season for detection. The species was not observed at the subject site during targeted survey nor has it been observed during previous ecological studies relating to the study area. Regardless, an impact assessment has been completed for this species on the basis of potential habitat that demonstrates a precautionary approach to the proposed development.

Relevant identified threats to this species include:

- Further loss and fragmentation of habitat, particularly as a consequence of clearing for agriculture, hard rock quarrying, hobby farming, and residential development.
- Habitat degradation as a consequence of weed invasion, altered hydrological conditions, grazing and trampling by livestock, and rubbish dumping (DECCW 2010b).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Although potential habitat for this species will be removed from the study area, the current fragmentation of the vegetation types which provide potential habitat is likely to already inhibit seed dispersal. This species is capable of vegetative reproduction from stems (coppicing) and rhizomes (suckering) although it is unlikely that the sharing of genetic material through this mechanism would occur between stands of ISR

The proposal will result in the removal of a small area of habitat on the fringe of the CGRGF and therefore seed dispersal and vegetation reproduction within this community would not be impeded. This community will not become fragmented from adjoining areas of vegetation as a consequence of the proposal.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal will result in the removal of 0.92 ha of potential habitat for this species (ISR 0.38 ha and 0.54 ha CGRGF). The remaining 10.15 ha will be preserved but will not be incorporated into any proposed conservation areas.

Potential indirect impacts from the proposal on habitat for this species include:

- Weed invasion
- Edge effects
- Fire

All habitat for this species is invaded by exotic species. A VMP has been prepared and will be implemented across the study area. Control measures will be implemented to ensure that impacts to habitat for the threatened species are minimised.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Restricted to the Illawarra region where it has been recorded from the local government areas of Shoalhaven, Kiama, Shellharbour and Wollongong (DECCW 2010b). This species is close to the limit of its distribution at Tallawarra.

How is the proposal likely to affect current disturbance regimes?

Daphnandra sp. C Illawarra is thought to be killed by fire (DECCW 2010b). The greatest potential for accidental fires is likely to be during construction and maintenance works or arson. Therefore a number of preventative measures would need to be implemented to reduce the likelihood of accidental fires. Details of these measures are outlined in the mitigation section of this report and include the preparation of a Bushfire Management Plan.

If mitigation measures are not implemented there is the potential for excess runoff to enter the ISR which are located immediately adjacent to the proposed development areas. Mitigation measures will be put in place to ensure runoff does not enter the environmental reserves and hydrological regimes altered. Given the CGRGF is located upslope of the proposed development, issues associated with runoff from the development area are unlikely.

Given the proximity of the ISR to the proposed development areas, edge effects are likely. However, a VMP has been prepared for the site which addresses this threat and includes management of the current weed infestation within areas of potential habitat.

Feral animals can have a detrimental impact on habitat and the species within. Grazing by feral animals such as the European Rabbit can result in the species being precluded from a site. The proposal is considered unlikely to contribute to increasing feral animal activity across the study area and instead is likely to assist with the management of these species through the proposed mitigation measures.

How is the proposal likely to affect habitat connectivity?

The proposal will result in the removal of a small area of habitat on the fringe of the CGRGF and therefore seed dispersal and vegetation reproduction within this community would not be impeded. This community will not become fragmented from adjoining areas of vegetation as a consequence of the proposal.

The proposal will result in a small area of potential habitat being removed and therefore current habitat connectivity in terms of seed dispersal between areas of ISR. Both stands exist as very small, isolated fragments. Whilst some habitat will be lost through the removal of the smallest stand, the larger stand will continue the function as potential habitat throughout the northern part of the study area.

This species is capable of vegetative reproduction from stems (coppicing) and rhizomes (suckering) although it is unlikely that the sharing of genetic material through this mechanism would occur between stands of ISR.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for this species.

8.2.6 *Haloragis exalata* subsp. *exalata* var. *laevis* - Square Raspwort

Square Raspwort is a shrub that reaches 1.5 m tall with square, four-ribbed stems. Its leaves are opposite up to the flower clusters (60 - 100 mm long and 13 - 25 mm wide) with coarsely-toothed margins. Its flowers are insignificant; the petals are only about 3 mm long and yellowish-green to reddish, although the spike-like flower cluster may be prominent at the ends of branches. *Haloragis exalata* subsp. *exalata* has two varieties: variety *exalata* (which is the taxon under consideration here) and variety *laevis*. The former has stems and leaves finely rough to touch, dichasia (in which flower branches appear in regular opposite pairs at the ends of stems) 3-7-flowered. Variety *laevis* is restricted to the central coast region of NSW and has hairless, scaleless stems and leaves and 7-15-flowered dichasia (DECCW 2010b).

Square Raspwort occurs in 4 widely scattered localities in eastern NSW. It is disjunctly distributed in the central coast, south coast and north-western slopes botanical subdivisions of NSW (DECCW 2010b).

Square Raspwort appears to require protected and shaded damp situations in riparian habitats. Flowering specimens in NSW are recorded from November to January (DECCW 2010b).

Habitat for this species is present in areas of SOFF and LWMF across the study area. These areas of habitat where specifically surveyed for this species in this study during a suitable season for detection. The species was not observed at the subject site during targeted survey nor has it been observed during previous ecological studies relating to the study area. Regardless, an impact assessment has been completed for this species on the basis of potential habitat that demonstrates a precautionary approach to the proposed development.

Threats to this species include:

- Square Raspwort grows in damp places near watercourses; habitats which are vulnerable to many threatening processes, including grazing, flooding, clearing, weed invasion, pollution and water regulation (DECCW 2010b).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The current LWMF is fragmented although there is likely to be the potential for some seeds to still move between areas. Based on the current concept plan, the stand of LWMF in the very south west is likely to become further isolated from other areas of LWMF and therefore seed dispersal further inhibited.

A road is also proposed through the most intact stand of LWMF south of Duck Creek. However it is unlikely that this road would prevent this species dispersing seeds to adjacent areas via wind.

The proposal will result in the removal of 0.54 ha mainly from a narrow band of SOFF north of Duck Creek. This vegetation is on the fringe of the SOFF that forms the riparian corridor of Duck Creek. Given that SOFF will remain directly adjacent to the proposed clearance area, it is unlikely that seed dispersal throughout the SOFF would be inhibited. The remaining SOFF will be conserved within environmental reserves throughout the study area.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal will result in the removal of 3.08 ha of potential habitat for this species (2.54 ha LWMF, 0.54 ha SOFF). The remaining 48.83 ha will be preserved across the study area with the majority of the

LWMF (approximately 14 ha) in the west of the site and remaining SOFF conserved within environmental reserves.

Potential indirect impacts from the proposal on habitat for this species include:

- Weed invasion
- Changes to hydrology
- Edge effects
- Fire
- Runoff, sedimentation and erosion

Control measures will be implemented to ensure that impacts to habitat for the threatened species are minimised. A VMP has been prepared and will be implemented across the study area.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Square Raspwort occurs in 4 widely scattered localities in eastern NSW. It is disjunctly distributed in the central coast, south coast and north-western slopes botanical subdivisions of NSW (DECCW 2010b). Given the disjunct nature of populations of this species, it is likely that if this species were present at the site it would be close to the limit of its distribution at Tallawarra.

How is the proposal likely to affect current disturbance regimes?

The greatest potential for accidental fires is likely to be during construction and maintenance works or arson. Therefore a number of preventative measures would need to be implemented to reduce the likelihood of accidental fires. Details of these measures are outlined in the mitigation section of this report and include the preparation of a Bushfire Management Plan.

If mitigation measures are not implemented there is the potential for excess runoff to enter the SOFF along Duck Creek. Mitigation measures will be put in place to ensure runoff does not enter the environmental reserves and hydrological regimes altered.

Given the proximity of SOFF to the proposed development areas, edge effects are likely. However, a VMP has been prepared for the site which addresses this threat and includes management of the current weed infestation within areas of potential habitat.

Feral animals can have a detrimental impact on habitat and the species within. Grazing by feral animals such as the European Rabbit can result in the species being precluded from a site. The proposal is considered unlikely to contribute to increasing feral animal activity across the study area and instead is likely to assist with the management of these species through the proposed mitigation measures.

How is the proposal likely to affect habitat connectivity?

The LWMF in the south west of the site, although fragmented is likely to be connected in terms of seed dispersal. The proposed road south of Duck Creek is unlikely to prevent seed dispersal to areas in the

south given the small width. However, the proposal is likely to isolate the smallest stand of LWMF in the south of the site as this vegetation will be further fragmented from the stands to the north.

The proposal is unlikely to isolate the SOFF throughout the study area. However, the proposed clearance will narrow the band of connectivity between the SOFF to the north of Duck Creek and the SOFF along Duck Creek. A large area of potential habitat (31.58 ha, SOFF) occurs in the south east of the site and will form part of a 95.98 ha environmental reserve. Fragmentation of this habitat will not result as a consequence of the proposal.

The connectivity along the Duck Creek corridor is likely to be enhanced as a consequence of the proposal as a VMP will be implemented across the site that includes revegetation works within the Duck Creek corridor. The VMP is also likely to reduce the current weed infestations in and increase the quality of the potential habitat within study area.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for this species.

8.2.7 *Lespedeza juncea* subsp. *juncea* - Lespedeza juncea subsp. sericea population in Wollongong LGA

An erect or spreading perennial subshrub, 60 to 120 cm high. Leaves alternate, 3-foliate, with narrow leaflets, 7 - 25 mm long. Pink-purple pea flowers borne singularly, or in clusters of up to seven. Fruit a small pod to 3 mm long.

This endangered population occurs south of Dapto in the Wollongong local government area. The population is disjunct from the other (non-endangered) populations of the species in NSW, which occur in western Sydney, the far South Coast and the Southern Tablelands. Known from just one roadside population of approximately 200 plants to the west of the site (DECCW 2010b).

Located in a small strip of open forest dominated by *Eucalyptus tereticornis* (Forest Red Gum), *E. longifolia* (Woollybutt), and *Melaleuca decora* (White Feather Honeymyrtle), on Budgong Sandstone. Also originally recorded in *Pennisetum clandestinum* (Kikuyu) grassland directly across the road from the Tallawarra site. This grassland was subsequently cleared and the species has not regenerated (DECCW 2010b).

This species prefers full sun to light shade and flowers between February and March. The seeds are long-lived and a soil stored seedbank. It is capable of resprouting in response to fire and flowering the following season. Germination is reportedly triggered by fire. It is suspected that frequent fire will lead to a decline in plant numbers, while infrequent fire may lead to local extinctions (DECCW 2010b).

Habitat for this species is present within areas of LWMF and CGRGF. Surveys for this species were undertaken during the flowering period. The known roadside population was visited prior to undertaking the surveys to verify that this species was in flower. This species was not recorded at the site during the surveys.

Threats to this species include:

- Further loss and fragmentation of habitat, particularly as a consequence of clearing for agriculture, road works or residential development.
- Habitat degradation through weed invasion and rubbish dumping.
- Inappropriate fire regimes (DECCW 2010b).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The proposal will result in the removal of potential habitat some of which is already comprised of fragmented habitat and therefore the removal of this vegetation is considered unlikely to alter dispersal activities of this species. However, it will reduce the seed bank for this species throughout the study area should it be present. Currently it is understood that a soil seedbank for this species exists where it is present and is long-lived and germinates in response to fire (DECCW 2010b).

The proposal also includes the fragmentation of currently connecting habitat through the construction of an entry road. This is likely to not only reduce the available seed bank should this species be present, but also create a barrier to seed dispersal and is therefore not recommended.

Although potential habitat for this species will be removed from the study area, the current fragmentation of the CGRGF is likely to already inhibit seed dispersal. It is unlikely that the proposed CGRGF clearance would further inhibit seed dispersal should this species be present in these areas.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal will result in the removal of 3.08 ha of potential habitat for this species (2.54 ha LWMF and 0.54 ha CGRGF). Approximately 14 ha of LWMF will be conserved within an environmental reserve and a small unprotected amount will remain in the south west. The remaining CGRGF present in the north east of the site will be preserved but will not be incorporated into any proposed conservation areas.

Potential indirect impacts from the proposal on habitat for this species include:

- Weed invasion
- Changes to hydrology
- Edge effects
- Fire
- Runoff, sedimentation and erosion

All habitat for this species is invaded by exotic species. A VMP has been prepared and will be implemented across the study area. Control measures will be implemented to ensure that impacts to habitat for the threatened species are minimised.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

This endangered population occurs south of Dapto in the Wollongong local government area. The population is disjunct from the other (non-endangered) populations of the species in NSW, which occur in western Sydney, the far South Coast and the Southern Tablelands. Known from just one roadside population of approximately 200 plants to the west of the site (DECCW 2010b). Therefore if this species was present within the study area it would be at the limits of its known distribution for the population within the Wollongong LGA.

How is the proposal likely to affect current disturbance regimes?

It is suspected that frequent fire will lead to a decline in plant numbers of *Lespedeza juncea* subsp. *sericea*, while infrequent fire may lead to local extinctions (DECCW 2010b). Therefore in appropriate fire regimes have the potential to affect this species.

Long-term absence of fire has been identified as a potential threat to this species. Given that management measures will be implemented to prevent fires within the study area due to the threats to life and property, it is likely that the current disturbance regimes would be altered. Fire is likely to currently be infrequent at the site.

This species was not recorded at the site although there is the potential for it to be present in the seedbank given the long-lived seeds. Given that fire is a natural process and many plants, including *Lespedeza*, it is recommended that all fire is not precluded from the site.

Fires that are too frequent may also impact on this species. The greatest potential for accidental fires is likely to be during construction and maintenance works or arson. Therefore a number of preventative measures would need to be implemented to reduce the likelihood of accidental fires. Details of these measures are outlined in the mitigation section of this report and include the preparation of a Bushfire Management Plan.

If mitigation measures are not implemented there is the potential for excess runoff to enter the LWMF immediately adjacent to the proposed development area. Mitigation measures will be put in place to ensure runoff does not enter the environmental reserves and hydrological regimes altered. Given the CGRGF is located upslope of the proposed development, issues associated with runoff from the development area are unlikely.

Given the proximity of the potential habitat to the proposed development area, edge effects are likely. However, a VMP has been prepared for the site which addresses this threat and includes management of the current weed infestation within areas of potential habitat.

Feral animals can have a detrimental impact on habitat and the species within. Grazing by feral animals such as the European Rabbit can result in the species being precluded from a site. The proposal is considered unlikely to contribute to increasing feral animal activity across the study area and instead is likely to assist with the management of these species through the proposed mitigation measures.

How is the proposal likely to affect habitat connectivity?

The proposal will remove some currently fragmented habitat in the west (LWMF). It is likely that seed dispersal is already somewhat inhibited by fragmentation.

The connectivity along the Duck Creek corridor is likely to be enhanced as a consequence of the proposal as a VMP will be implemented across the site that includes revegetation works within the Duck Creek corridor. The VMP is also likely to reduce the current weed infestations in and increase the quality of this community within study area.

The proposal will result in the removal of a small area of habitat on the fringe of the CGRGF and therefore seed dispersal within this community would not be impeded. This community will not become fragmented from adjoining areas of vegetation as a consequence of the proposal.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat has not been for this population.

8.2.8 *Melaleuca biconvex* - Biconvex Paperbark

Biconvex Paperbark is a shrub or small tree, usually up to 10 m tall, though occasionally as high as 20 m. The bark is that of a typical paperbark. The leaves are small, to 18 mm long and 4 mm wide; each leaf has a centre-vein in a groove and the leaf blade curves upwards on either side of this centre-vein. The placement of the leaves is also distinctive, with each pair of leaves emerging at right angles from the branch. Each pair is offset at right angles to the previous pair so the branch has a squarish appearance when looked at 'end-on'. This species' white flowers are usually clustered in dense heads and the fruit is urn-shaped and 3 - 5 mm in diameter (DECCW 2010b).

Biconvex Paperbark is only found in NSW, with scattered and dispersed populations found in the Jervis Bay area in the south and the Gosford-Wyong area in the north. This species generally grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects. Flowering occurs over just 3-4 weeks in September and October. This species resprouts following fire (DECCW 2010 b).

Habitat for this species is present in areas of LWMF and ASMF across the study area although it is considered marginal that this species would occur at the site as it is only known from two disjunct areas both of which are over 50 km from the study area.

Limited potential habitat (given the proximity of previous records) for this species is present within the study area. These areas of habitat where specifically surveyed for this species in this study during a suitable season for detection. The species was not observed at the subject site during targeted survey nor has it been observed during previous ecological studies relating to the study area. Regardless, an impact assessment has been completed for this species on the basis of potential habitat that demonstrates a precautionary approach to the proposed development.

Identified threats to this species relevant to this proposal include:

- It is likely Biconvex Paperbark has evolved to cope with infrequent fires. Burning for hazard reduction and other unnatural ignitions have increased fire frequency and may threaten the species' survival.
- Clearing for residential development.
- Alterations to the drainage hydrology of low-lying floodplains and swamps including swamp reclamation.
- Increased pollution and nutrients through adjoining developments and rubbish dumping (DECCW 2010b).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The proposal will result in the removal of 2.54 ha of potential habitat some of which is already comprised of fragmented habitat (LWMF) and therefore the removal of this vegetation is considered unlikely to alter dispersal activities of this species. However, it will reduce the seed bank for this species throughout the study area should a viable seed bank be present.

The proposal also includes the fragmentation of currently connecting habitat through the construction of an entry road through the LWMF. This is likely to not only reduce the available seed bank should this species be present, but also create a barrier to seed dispersal.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal will result in the removal of 2.54 ha of potential habitat for this species (LWMF). This represents 6.84 % of the habitat within the study area. The remaining 34.59 ha will be preserved across the study area with the majority of the LWMF (approximately 14 ha) in the west of the site and all of the ASMF conserved within environmental reserves. All habitat for this species is invaded by exotic species but will be managed through the implementation of the VMP.

Potential indirect impacts from the proposal on habitat for this species include:

- Weed invasion
- Changes to hydrology
- Edge effects
- Fire
- Runoff, sedimentation and erosion

Control measures will be implemented to ensure that impacts to habitat for the threatened species are minimised. A VMP has been prepared and will be implemented across the study area.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Biconvex Paperbark is only found in NSW, with scattered and dispersed populations found in the Jervis Bay area in the south and the Gosford-Wyong area in the north (DECCW 2010b). Therefore this species is not at the limit of its known distribution at Tallawarra.

How is the proposal likely to affect current disturbance regimes?

Melaleuca biconvexa is thought to have evolved to cope with infrequent fires. Burning for hazard reduction and other unnatural ignitions have increased fire frequency and may threaten the species' survival (DECCW 2010b). The greatest potential for accidental fires is likely to be during construction and maintenance works or arson. Therefore a number of preventative measures would need to be implemented to reduce the likelihood of accidental fires. Details of these measures are outlined in the mitigation section of this report and include the preparation of a Bushfire Management Plan.

If mitigation measures are not implemented there is the potential for excess runoff to enter areas of potential habitat for this species and alter hydrological regimes. Mitigation measures will be put in place to ensure runoff does not enter the environmental reserves and hydrological regimes altered.

Given the proximity of habitat for this species to the proposed development area, edge effects are likely. However, a VMP has been prepared for the site which addresses this threat and includes management of the current weed infestation within areas of potential habitat. A large area of potential habitat (17 ha of ASMF) occurs in the south east of the site and will form part of a 95.98 ha environmental reserve.

Impacts from the development on this area are less likely. Nevertheless, weed invasion is present in this area and will be managed as part of the measures outlined in the VMP for the site.

Feral animals can have a detrimental impact on habitat and the species within. Grazing by feral animals such as the European Rabbit can result in the species being precluded from a site. The proposal is considered unlikely to contribute to increasing feral animal activity across the study area and instead is likely to assist with the management of these species through the proposed mitigation measures.

Grazing and trampling by stock causing root damage, prevention of seedling establishment and erosion has been identified as a key threat to this species (DECCW 2010b). The study area is currently grazed by cattle. Given the majority of the conserved areas of LWMF will be incorporated into an environmental reserve, this threat is likely to be ameliorated as a consequence of the proposal.

How is the proposal likely to affect habitat connectivity?

The proposal will remove some habitat currently fragmented habitat in the west (LWMF). Given that this species disperses via seed it is likely that this mechanism is already somewhat inhibited by this fragmentation.

The connectivity along the Duck Creek corridor is likely to be enhanced as a consequence of the proposal as a VMP will be implemented across the site that includes revegetation works within the Duck Creek corridor. The VMP is also likely to reduce the current weed infestations in and increase the quality of this community within study area.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for this species.

8.2.9 *Pterostylis gibbosa* - Illawarra Greenhood

Pterostylis - the greenhoods - is a large genus of ground-dwelling orchids with mostly green flowers. The Illawarra Greenhood has a rosette of rounded leaves at the base of the stem, each to 35 mm long. In addition there are up to six leaves that sheath the flower stem, which may be 45 cm high and bear up to seven flowers. The flowers are bright glossy green with transparent patches in the hood. The very broad black labellum ('lip' petal) protrudes from the front of the flower (DECCW 2010b).

Known from a small number of populations in the Hunter region (Milbrodale), the Illawarra region (Albion Park and Yallah) and the Shoalhaven region (near Nowra). It is apparently extinct in western Sydney which is the area where it was first collected (1803). All known populations grow in open forest or woodland, on flat or gently sloping land with poor drainage (DECCW 2010b).

In the Illawarra region, the species grows in woodland dominated by Forest Red Gum *Eucalyptus tereticornis*, Wollybutt *E. longifolia* and White Feather Honey-myrtle *Melaleuca decora*. Near Nowra, the species grows in an open forest of Spotted Gum *Corymbia maculata*, Forest Red Gum and Grey Ironbark *E. paniculata*. In the Hunter region, the species grows in open woodland dominated by Narrow-leaved Ironbark *E. crebra*, Forest Red Gum and Black Cypress Pine *Callitris endlicheri* (DECCW 2010b).

The Illawarra Greenhood is a deciduous orchid that is only visible above the ground between late summer and spring, and only when soil moisture levels can sustain its growth. The leaf rosette grows from an underground tuber in late summer, followed by the flower stem in winter. After a spring flowering, the plant begins to die back and seed capsules form (if pollination has taken place) (DECCW 2010b).

As with many other greenhoods, male fungus gnats are believed to be the pollinator. The Illawarra Greenhood can survive occasional burning and grazing because of its capacity to reshoot from an underground tuber (DECCW 2010b).

Habitat for this species is present in areas of LWMF across the study area. These areas of habitat where specifically surveyed for this species in this study during a suitable season for detection. The species was not observed at the subject site during targeted survey nor has it been observed during previous ecological studies relating to the study area. Regardless, an impact assessment has been completed for this species on the basis of potential habitat that demonstrates a precautionary approach to the proposed development.

Threats to this species include:

- Further loss and fragmentation of habitat, particularly through clearing for agriculture and residential development.
- Habitat degradation resulting from weed invasion particularly, blackberries and aggressive grasses such as Holcus; uncontrolled vehicular/pedestrian access to sites; and inappropriate fire regimes (DECCW 2010b).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Male fungus gnats are believed to be the pollinator for this species (DECCW 2010b). The proposal will result in the removal of 2.54 ha of potential habitat some of which is already comprised of fragmented habitat and therefore the removal of this vegetation is considered unlikely to alter current pollination and seed dispersal of this species. However, it will reduce the amount of potential habitat.

Given the pollinator species of this orchid, it is likely that it can move between fragmented areas provided they are not separated by large distances. There is the potential for the small stand of LWMF in the very south west of the site to become isolated from areas to the north in terms of pollination potential. In the area north of Duck Creek it is likely that pollination activities would not be inhibited.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal will result in the removal of 2.54 ha of potential habitat for this species (LWMF). This represents 12.83 % of the habitat within the study area. The remaining 17.25 ha will be preserved across the study area with the majority of the LWMF (approximately 14 ha) in the west of the site and conserved within environmental reserves.

Potential indirect impacts from the proposal on habitat for this species include:

- Weed invasion
- Changes to hydrology
- Edge effects
- Fire
- Runoff, sedimentation and erosion

All habitat for this species is invaded by exotic species. Control measures will be implemented to ensure that impacts to habitat for the threatened species are minimised. A VMP has been prepared and will be implemented across the study area.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Known from a small number of populations in the Hunter region (Milbrodale), the Illawarra region (Albion Park and Yallah) and the Shoalhaven region (near Nowra). It is apparently extinct in western Sydney which is the area where it was first collected (1803). All known populations grow in open forest or woodland, on flat or gently sloping land with poor drainage (DECCW 2010b). Therefore this species is not at the limit of its known distribution at Tallawarra.

How is the proposal likely to affect current disturbance regimes?

The Illawarra Greenhood can survive occasional burning and grazing because of its capacity to reshoot from an underground tuber (DECCW 2010b). The greatest potential for accidental fires is likely to be during construction and maintenance works or arson. A number of preventative measures will be implemented to reduce the likelihood of accidental fires and hence inappropriate fire regimes. Details of

these measures are outlined in the mitigation section of this report and include the preparation of a Bushfire Management Plan.

If mitigation measures are not implemented there is the potential for excess runoff to enter areas of potential habitat for this species. This species is dependant on fungal gants for pollination. There is the potential for uncontrolled runoff not only to impact on hydrological regimes in areas of potential habitat but to also impact on the fungi on which the gnats rely on which this species. This could affect pollination of the species. However, mitigation measures will be put in place to ensure runoff does not enter the environmental reserves and hydrological regimes altered.

Given the proximity of habitat for this species to the proposed development area, edge effects are likely. However, a VMP has been prepared for the site which addresses this threat and includes management of the current weed infestation within areas of potential habitat. .

Feral animals can have a detrimental impact on habitat and the species within. Although this species has been noted to be tolerant of some grazing, excessive grazing can be detrimental. Grazing by feral animals such as the European Rabbit can result in the species being precluded from a site. The proposal is considered unlikely to contribute to increasing feral animal activity across the study area and instead is likely to assist with the management of these species through the proposed mitigation measures.

How is the proposal likely to affect habitat connectivity?

Male fungus gnats are believed to be the pollinator for this species (DECCW 2010b). The proposal will result in the removal of 2.54 ha of potential habitat some of which is already comprised of fragmented habitat and therefore the removal of this vegetation is considered unlikely to alter current pollination and seed dispersal of this species.

The connectivity along the Duck Creek corridor is likely to be enhanced as a consequence of the proposal as a VMP will be implemented across the site that includes revegetation works within the Duck Creek corridor. The VMP is also likely to reduce the current weed infestations in and increase the quality of this community within study area.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for this species.

8.2.10 Solanum celatum

This recently described shrub is 1 - 2.5 m high, with grey to white branches that are densely covered with hairs and sparsely armed with prickles. Flowers are purple and have contrasting orange stamens. Leaves are elliptical to lanceolate, without lobes, 4.6 - 12.5 cm long, 1.5 - 3.5 cm wide. Upper leaf surface grey-green and lower leaf surface yellowish-white. Fruit is a green smooth globular berry, 13 - 16 mm diameter (DECCW 2010b).

Restricted to an area from Wollongong to just south of Nowra, and west to Bungonia. Majority of records are prior to 1960 and the majority of populations are likely to have been lost to clearing. (DECCW 2010b).

This species grows in rainforest clearings, or in wet sclerophyll forests. Flowers August to October and produces fruit December to January. *Solanum celatum* is a fire sensitive obligate seeder, with adults plants killed by fire and recruitment occurring from a soil stored seed bank (DECCW 2010b).

Habitat for this species is present in areas of ISR across the study area. These areas of habitat where specifically surveyed for this species in this study during a suitable season for detection. The species was not observed at the subject site during targeted survey nor has it been observed during previous ecological studies relating to the study area. Regardless, an impact assessment has been completed for this species on the basis of potential habitat that demonstrates a precautionary approach to the proposed development.

Threats identified for this species and that area relevant to the proposal include:

- Habitat loss due to clearing for agriculture and urban development.
- Habitat degradation, primarily by invasion of *Lantana camara*.
- Inappropriate fire regimes, particularly frequent fire.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The proposal will result in the removal of 0.38 ha of potential habitat for this species. Although potential habitat for this species will be removed from the study area, the current fragmentation of the stands of ISR is likely to already inhibit seed dispersal.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal will result in the removal of 0.38 ha of potential habitat for this species (ISR). This represents 4.51 % of the habitat within the study area. The remaining 8.05 ha will be preserved across within the study area but will not be incorporated into any proposed conservation areas. All habitat for this species is invaded by exotic species.

Potential indirect impacts from the proposal on habitat for this species include:

- Weed invasion
- Edge effects
- Fire

Control measures will be implemented to ensure that impacts to habitat for the threatened species are prevented.

Does the proposal affect any threatened species or populations that are at the limit of its known Restricted to an area from Wollongong to just south of Nowra, and west to Bungonia. Majority of records are prior to 1960 and the majority of populations are likely to have been lost to clearing. (DECCW 2010b). Therefore this species is close to the northern limit of its known distribution if it is present at Tallawarra.

How is the proposal likely to affect current disturbance regimes?

Habitat degradation primarily by invasion of *Lantana camara* is listed as a key threat to *Solanum celatum* (DECCW 2010b). Areas of potential habitat for this species are heavily infested with *Lantana camara*. However, there condition of the ISR at the site is likely to improve as a consequence of the proposal as a VMP has been prepared for the study area that will aim to remove the *Lantana camara* from areas of ISR.

Inappropriate fire regimes and in particular frequent fire has also been identified as a key threat to this species. The greatest potential for accidental fires is likely to be during construction and maintenance works or arson. A number of preventative measures will be implemented to reduce the likelihood of accidental fires and hence inappropriate fire regimes. Details of these measures are outlined in the mitigation section of this report and include the preparation of a Bushfire Management Plan.

If mitigation measures are not implemented there is the potential for excess runoff to enter areas of potential habitat for this species particularly given their proximity to the proposed development area. This may alter hydrological regimes and alter the habitat for this species. However, mitigation measures will be put in place to ensure runoff does not enter adjacent vegetation and hydrological regimes altered.

Given the proximity of habitat for this species to the proposed development area, edge effects are likely. However, a VMP has been prepared for the site which addresses this threat and includes management of the current weed infestation within areas of potential habitat. .

Feral animals can have a detrimental impact on habitat and the species within. Grazing by feral animals such as the European Rabbit can result in the species being precluded from a site. The proposal is considered unlikely to contribute to increasing feral animal activity across the study area and instead is likely to assist with the management of these species through the proposed mitigation measures.

How is the proposal likely to affect habitat connectivity?

The proposal will result in a small area of potential habitat being removed and therefore current habitat connectivity in terms of seed dispersal between areas of ISR. Both stands exist as very small, isolated fragments. Whilst some habitat will be lost through the removal of the smallest stand, the larger stand will continue the function as potential habitat throughout the northern part of the study area.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for this species.

8.2.11 *Thesium australe* – Austral Toadflax

Thesium australe is a small, straggling herb to 40 cm tall. Leaves are pale green to yellow-green, somewhat succulent, 1 - 4 cm long and 0.5 - 1.5 mm wide. Flowers are minute and white, emerging where the leaves meet the stems and appearing in spring. The fruit is small and nut-like, developing in summer. This species is often hidden amongst grasses and herbs (DECCW 2010b).

Austral Toad-flax is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. It is also found in Tasmania and Queensland and in eastern Asia (DECCW 2010b).

Occurs in grassland or grassy woodland. This species is often found in damp sites in association with Kangaroo Grass (*Themeda australis*). This species is a root parasite that takes water and some nutrient from other plants, especially Kangaroo Grass.

Habitat for this species is present in areas of CGRGF and LWMF across the study area. These areas of habitat where specifically surveyed for this species in this study during a suitable season for detection. The species was not observed at the subject site during targeted survey nor has it been observed during previous ecological studies relating to the study area. Regardless, an impact assessment has been completed for this species on the basis of potential habitat that demonstrates a precautionary approach to the proposed development.

Threats to this species that are relevant to the proposal include:

- Loss and degradation of habitat and/or populations for residential, infrastructure and agricultural developments.
- Loss and degradation of habitat and/or populations by invasion of weeds (DECCW 2010b).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The proposal will result in the removal of 3.08 ha of potential habitat for this species. Although potential habitat for this species will be removed from the study area, the current fragmentation of the stands of LWMF means that seed dispersal is likely to already by inhibited.

Given that the proposed CGRGF clearance is to occur on the fringe of a stand of this vegetation and would not isolate it from any other currently connect stands of vegetation, it is unlikely that seed dispersal and key lifecycle stages would be impacted by the proposal.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal will result in the removal of 3.08 ha of potential habitat for this species (2.54 ha LWMF and 0.54 ha CGRGF). The remaining 19.35 ha will be preserved across the study area with the majority of the LWMF (approximately 14 ha) in the west of the site conserved within an environmental reserve. The CGRGF present in the north east of the site will be preserved (2.10 ha) but will not be incorporated into any proposed conservation areas.

Potential indirect impacts from the proposal on habitat for this species include:

- Weed invasion
- Changes to hydrology
- Edge effects
- Fire
- Runoff, sedimentation and erosion

All habitat for this species within the study area is invaded by exotic species. A VMP has been prepared and will be implemented across the study area. Control measures will be implemented to ensure that impacts to habitat for the threatened species are minimised.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Austral Toad-flax is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. It is also found in Tasmania and Queensland and in eastern Asia (DECCW 2010b). Therefore this species is not at the limit of its known distribution at Tallawarra.

How is the proposal likely to affect current disturbance regimes?

Fires that are too frequent may also impact on the lifecycle of flora. The greatest potential for accidental fires is likely to be during construction and maintenance works or arson. Therefore a number of preventative measures would need to be implemented to reduce the likelihood of accidental fires. Details of these measures are outlined in the mitigation section of this report and include the preparation of a Bushfire Management Plan.

If mitigation measures are not implemented there is the potential for excess runoff to enter the LWMF immediately adjacent to the proposed development area. Mitigation measures will be put in place to ensure runoff does not enter the environmental reserves and hydrological regimes altered. Given the CGRGF is located upslope of the proposed development, issues associated with runoff from the development area are unlikely.

Given the proximity of this community to the proposed development area, edge effects are likely. However, a VMP has been prepared for the site which addresses this threat and includes management of the current weed infestation within areas of potential habitat.

Feral animals can have a detrimental impact on habitat and the species within. Grazing by feral animals such as the European Rabbit can result in the species being precluded from a site. The proposal is considered unlikely to contribute to increasing feral animal activity across the study area and instead is likely to assist with the management of these species through the proposed mitigation measures.

How is the proposal likely to affect habitat connectivity?

The proposal will not alter any current habitat connectivity within the north east of the site (CGRGF). The connectivity along the Duck Creek corridor is likely to be enhanced as a consequence of the

proposal as a VMP will be implemented across the site that includes revegetation works within the Duck Creek corridor. The VMP is also likely to reduce the current weed infestations in and increase the quality of this community within study area.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for this species.

8.3 FAUNA

Fauna have been grouped based on the habitat they are likely to utilise within the study area.

8.3.1 Green and Golden Bell Frog – Litoria aurea

The Green and Golden Bell Frog inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typh*a spp.) or spikerushes (*Eleocharis* spp.). Optimum habitat includes water-bodies that are unshaded, free of predatory fish such as Plague Minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available. Some sites, particularly in the Greater Sydney region occur in highly disturbed areas (DECCW 2010a).

Large areas of the site could be considered potential dispersal and foraging habitat given the general open grassed nature of large parts the site. Several large and small water bodies were also identified across various precincts of the site. These structures though constructed and /or heavily modified provide potential breeding habitat for the species. Those with fringing sedges and/or rushes provide better habitat than those without. Similarly some of the water bodies have exotic fish (*Gambusia* sp) present and this would reduce likely breeding success rates if the GGBF were present and breeding. All the large water bodies in the south west precinct (1 to 4, see Figure 13) had Gambusia present. The value of the habitat provided by the onsite water bodies may however be potentially affected by the occurrence of elevated levels of heavy metals and ammonia (Coffey 2010a, 2010b and 2010c) although the impact of these observations is not fully understood.

Concrete overflow structures associated with adjusting water levels between water bodies (3 and 4), the STP polishing ponds within the Special Use Zone and a farm dam within the northern Environmental Management Zone were identified as having some of the best potential GGBF breeding habitat values that were detected, the latter two water bodies did not appear to have exotic fish present.

One water body (2) (Figure 13) is proposed for removal from the south west precinct. Two larger water bodies (2 and 3) also in the south west precinct will be retained in an environmental management zoning and both these ponds are similarly surrounded by large extents of fringing sedges and rushes. The sedges and rushes surrounding the fresh water bodies provide important foraging and shelter habitat for the GGBF where they occur (DEC 2005; DECC 2008).

The long absence of GGBF records from the west of Lake Illawarra does provide an indication of low probability that the species still persists in the locality. In addition, the extensive targeted survey for this species undertaken during this project does provide further evidence that this species does not persist at the study site.

Threats to this species include:

- Loss and degradation of habitat and/or populations for residential, infrastructure and agricultural developments.
- Loss and degradation of habitat and/or populations by intensification of grazing regimes.
- Loss and degradation of habitat and/or populations by invasion of weeds.
- Loss and degradation of habitat and/or populations from road works (particularly widening or re-routing) (DECCW 2010b).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The proposal will result in the removal of potential foraging and dispersal habitat for this species. The proposal will remove one wetland in the west of the site (and modify one other) that may provide breeding habitat for the GGBF and will conserve two others in the south west that provide similar habitat. Furthermore, given that Gambusia was present within most of the waterbodies within the study area, it is unlikely that the GGBF would breed at the site. North-south dispersal is likely to be somewhat inhibited across the study area as a consequence of the proposal although east-west habitat connectivity will remain and will allow north-south movement along the foreshore of Lake Illawarra. Therefore it is unlikely that the proposal would affect the lifecycle of this species.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Given the broad extent of foraging and dispersal habitat across the entire site it is difficult to envisage the proposed development impacting on the species to any major extent provided that some substantial areas of open grassed vegetation is retained. Furthermore, areas of potential breeding habitat will be conserved within the study area. The value of the habitat provided by the onsite water bodies may however be potentially affected by the occurrence of elevated levels of heavy metals and ammonia (Coffey 2010a, 2010b and 2010c) although the impact of these observations is not fully understood.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Formerly distributed from the NSW north coast near Brunswick Heads, southwards along the NSW coast to Victoria where it extends into east Gippsland. Records from west to Bathurst, Tumut and the ACT region. Since 1990 there have been approximately 50 recorded locations in NSW, most of which are small, coastal, or near coastal populations. These locations occur over the species' former range, however they are widely separated and isolated. Large populations in NSW are located around the metropolitan areas of Sydney, Shoalhaven and mid north coast (one an island population). There is only one known population on the NSW Southern Tablelands (DECCW 2010b). Therefore this species is not at the limit of its known distribution at Tallawarra.

How is the proposal likely to affect current disturbance regimes?

If mitigation measures are not implemented there is the potential for excess runoff to enter areas of potential habitat for this species and alter water quality. Mitigation measures will be put in place to ensure untreated runoff is trapped within the development area and prevented from entering waterbodies throughout the study area.

Given the proximity of the potential habitat to the proposed development area, edge effects are likely. Weed invasion has been identified as a key threat to the GGBF (DECCW 2010b). However, a VMP has been prepared for the site which addresses this threat and includes management of the current weed infestation within areas of potential habitat.

Feral animals can have a detrimental impact on habitat and the species within. Grazing is listed as a key threat to foraging areas for the GGBF (DECW 2010b). The proposal is considered unlikely to contribute to increasing feral animal activity across the study area and instead is likely to assist with the management of these species through the proposed mitigation measures.

How is the proposal likely to affect habitat connectivity?

The current concept plan layout does not readily provide for dispersal between the north and south environmental management areas of the site except for highly mobile species. Although interconnection between the north and south of the site with the current concept plan layout would likely restrict dispersal for the GGBF, this species will be able to move from the west of the site, through the environmental reserve in the south east and then north – south along the foreshore of Lake Illawarra. North – south movement throughout the study area will remain as narrow band along the drainage channels incorporated in to the landscaping (eg. Duck Creek – local centre / central residential precinct) and therefore movement will be somewhat inhibited throughout the study area but not entirely prevented.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for this species.

8.3.2 Wetland Birds

Australasian Bittern

This species favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (*Typha* spp.) and spikerushes (*Eleocharis* spp.). They hide during the day amongst dense reeds or rushes and feed mainly at night on frogs, fish, yabbies, spiders, insects and snails. Feeding platforms may be constructed over deeper water from reeds trampled by the bird; platforms are often littered with prey remains. Breeding occurs in summer from October to January; nests are built in secluded places in densely-vegetated wetlands on a platform of reeds; there are usually six olive-brown eggs to a clutch (DECCW 2010b).

Blue-billed Duck

The Blue-billed Duck prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. The species is completely aquatic, swimming low in the water along the edge of dense cover. It will fly if disturbed, but prefers to dive if approached (DECCW 2010b).

Blue-billed Ducks will feed by day far from the shore, particularly if dense cover is available in the central parts of the wetland. They feed on the bottom of swamps eating seeds, buds, stems, leaves, fruit and small aquatic insects such as the larvae of midges, caddisflies and dragonflies (DECCW 2010b).

Blue-billed Ducks are partly migratory, with short-distance movements between breeding swamps and overwintering lakes with some long-distance dispersal to breed during spring and early summer (DECCW 2010b).

Blue-billed Ducks usually nest solitarily in Cumbungi over deep water between September and February. They will also nest in trampled vegetation in Lignum, sedges or Spike-rushes, where a bowl-shaped nest is constructed. The most common clutch size is five or six (DECCW 2010b).

Young birds disperse in April-May from their breeding swamps in inland NSW to non-breeding areas on the Murray River system and coastal lakes (DECCW 2010b).

Painted Snipe

Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds. The nest consists of a scrape in the ground, lined with grasses and leaves. Breeding is often in response to local conditions; generally occurs from September to December. Forages nocturnally on mud-flats and in shallow water (DECCW 2010b).

Freckled Duck

This species prefers permanent freshwater swamps and creeks with heavy growth of Cumbungi, Lignum or Tea-tree. During drier times they move from ephemeral breeding swamps to more permanent waters such as lakes, reservoirs, farm dams and sewage ponds (DECCW 2010b).

Generally rest in dense cover during the day, usually in deep water. Nesting usually occurs between October and December but can take place at other times when conditions are favourable. Nests are usually located in dense vegetation at or near water level (DECCW 2010b).

The Freckled Duck (2 - 10 birds) has been recorded on the site on three occasions by the Tallawarra Bird Observers Club since 1992 and is therefore considered a period visitor to the site. This species was recorded within Ash Pond 3 in the south west of the site (Brandis 2010).

The artificial wetlands throughout the study area provide potential habitat for these species and known habitat for the Freckled Duck. However, the Blue-billed Duck and Freckled Duck breed in inland NSW. Therefore Tallawarra would not provide potential breeding for these species.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The proposal will result in the removal of potential foraging habitat for these species. The Freckled Duck has been recorded on three occasions on the site since 1992 and is known to utilise Ash Pond 3 in the south west of the site (Brandis 2010). This is the largest wetland and will be conserved under the current concept plan. Wetlands identified as having the greatest habitat value for waterbirds will be conserved within the study area and therefore impacts on the lifecycle of these species would be minimal.

Furthermore, the Blue-billed Duck and Freckled Duck breed in inland NSW. The Blue-billed Duck only moves small distances from breeding areas to overwintering lakes. Therefore the habitat at Tallawarra would not be used during key lifecycle stages such breeding by these species.

Potential breeding habitat for the Australasian Bittern and Painted Snipe is limited throughout the study area with the most suitable habitat present within the artificial wetlands proposed for conservation in the south west of the site. This area also includes the most valuable foraging habitat and therefore it is unlikely that the lifecycle of this species would be affected by the proposal. If these species were / are recorded on site it is recommended that construction in this area takes place outside the breeding season (October to January / September to December). However, given the high level of bird survey across the site and that these species have not been recorded this is not considered necessary at this stage.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The two key areas of potential and known habitat for these species will be conserved in the south west of the site. Other areas of artificial wetlands will be removed. However, these are either not considered habitat for these species or are of less value. Other wetland areas will also be conserved in the environmental reserve in south east of the site.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Australasian Bitterns are widespread but uncommon over south-eastern Australia. In NSW they may be found over most of the state except for the far north-west (DECCW 2010b). Therefore this species is not at the limit of its known distribution at Tallawarra.

The Blue-billed Duck is endemic to south-eastern and south-western Australia. It is widespread in NSW, but most common in the southern Murray-Darling Basin area. Birds disperse during the breeding

season to deep swamps up to 300 km away. It is generally only during summer or in drier years that they are seen in coastal areas (DECCW 2010b). Therefore this species is not at the limit of its known distribution at Tallawarra.

In NSW, the Painted Snipe species has been recorded at the Paroo wetlands, Lake Cowell, Macquarie Marshes and Hexham Swamp. Most common in the Murray-Darling Basin (DECCW 2010b). This species is not at the limit of its known distribution at Tallawarra

The Freckled Duck is found primarily in south-eastern and south-western Australia, occurring as a vagrant elsewhere. The species may also occur as far as coastal NSW and Victoria during such times. This species is not at the limit of tis known distribution at Tallawarra.

How is the proposal likely to affect current disturbance regimes?

Predation by domestic animals such as cats and dogs is a key threat to these species particularly the Australasian Bittern. The proximity of the residential area to the wetlands and the proposal to establish a walking trail around the lake increases the potential for predation. However, a number of mitigation measures have been identified to minimise this threat. These include fencing of the proposed trail (or other barrier) so dogs cannot stray, enforcing that dogs must be kept on leases within the residential area, erecting fencing between the wetland and the residential area and enforcing that all cats must have a collar and bell. Predation by feral animals is also a threat. It is likely that the proposed mitigation measures will also assist in the prevention of predation by foxes. Further, it is unlikely that the proposed development would lead to an increase in predation by feral animals.

If mitigation measures are not implemented there is the potential for excess runoff to enter areas of potential habitat for this species and alter water quality and hydrological regimes. Mitigation measures will be put in place to ensure runoff is trapped within the development area and prevented from entering waterbodies throughout the study area.

Given the proximity of the potential habitat to the proposed development area, edge effects are likely. A VMP has been prepared for the site which addresses weed invasion throughout the study area and includes management of the current weed infestation within areas of potential habitat. Where pesticides are to be used near waterways, these will be suitable for use near aquatic environments.

How is the proposal likely to affect habitat connectivity?

Given all of these species are highly mobile and given that current habitat connectivity across the site is fragmented, it is unlikely that the proposed would create further fragmentation.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for these species.

8.3.3 Birds - foreshores, wetland and mudflats

Sanderling

Often found in coastal areas on low beaches of firm sand, near reefs and inlets, along tidal mudflats and bare open coastal lagoons; individuals are rarely recorded in near-coastal wetlands. Generally occurs in small flocks, however may associate freely with other waders. Individuals run behind receding waves, darting after insects, larvae and other small invertebrates in the sand, then dart back up the beach as each wave breaks (DECCW 2010b).

Also feeds on plants, seeds, worms, crustaceans, spiders, jellyfish and fish, foraging around rotting heaps of kelp, at the edges of shallow pools on sandspits and on nearby mudflats. Roosts on bare sand, behind clumps of beach-cast kelp or in coastal dunes. Breeding occurs in the Northern Hemisphere (DECCW 2010b).

Great Knot

Occurs within sheltered, coastal habitats containing large, intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons. Often recorded on sandy beaches with mudflats nearby, sandy spits and islets and sometimes on exposed reefs or rock platforms. Migrates to Australia from late August to early September, although juveniles may not arrive until October-November (DECCW 2010b).

Most birds return north in March and April, however some individuals may stay over winter in Australia. Forages for food by methodically thrusting its bill deep into the mud to search for invertebrates, such as bivalve molluscs, gastropods, polychaete worms and crustaceans (DECCW 2010b).

Greater Sand-plover

Almost entirely restricted to coastal areas in NSW, occurring mainly on sheltered sandy, shelly or muddy beaches or estuaries with large intertidal mudflats or sandbanks. Roosts during high tide on sandy beaches and rocky shores; begin foraging activity on wet ground at low tide, usually away from the edge of the water; individuals may forage and roost with other waders (DECCW 2010b).

Lesser Sand-plover

Almost entirely coastal in NSW, favouring the beaches of sheltered bays, harbours and estuaries with large intertidal sandflats or mudflats; occasionally occurs on sandy beaches, coral reefs and rock platforms. Highly gregarious, frequently seen in flocks exceeding 100 individuals; also often seen foraging and roosting with other wader species. Roosts during high tide on sandy beaches, spits and rocky shores; forages individually or in scattered flocks on wet ground at low tide, usually away from the water's edge (DECCW 2010b).

Broad-billed Sandpiper

Broad-billed Sandpipers favour sheltered parts of the coast such as estuarine sandflats and mudflats, harbours, embayments, lagoons, saltmarshes and reefs as feeding and roosting habitat. Occasionally, individuals may be recorded in sewage farms or within shallow freshwater lagoons. Broad-billed Sandpipers roost on banks on sheltered sand, shell or shingle beaches.

Individuals are strongly migratory and only mildly gregarious when not breeding. Large flocks are seldom recorded and birds are often either encountered alone or feeding with other waders such as Red-necked Stints or Curlew Sandpipers (DECCW 2010b).

Black-tailed Godwit

This is a primarily a coastal species. Usually found in sheltered bays, estuaries and lagoons with large intertidal mudflats and/or sandflats. Further inland, it can also be found on mudflats and in water less than 10 cm deep, around muddy lakes and swamps. Individuals have been recorded in wet fields and sewerage treatment works. This species breeds in Mongolia and Eastern Siberia (Palaearctic) and flies to Australia for the southern summer, arriving in August and leaving in March. It roosts and loafs on low banks of mud, sand and shell bars. Frequently recorded in mixed flocks with Bar-tailed Godwits (DECCW 2010b).

Little Tern

This species migrates from eastern Asia. Almost exclusively coastal, preferring sheltered environments; however may occur several kilometres from the sea in harbours, inlets and rivers (with occasional offshore islands or coral cay records). This species breeds in summer and spring and nests in small, scattered colonies in low dunes or on sandy beaches just above high tide mark near estuary mouths or adjacent to coastal lakes and islands. The nest is a scrape in the sand, which may be lined with shell grit, seaweed or small pebbles (DECCW 2010b).

Hooded Plover

In south-eastern Australia Hooded Plovers prefer sandy ocean beaches, especially those that are broad and flat, with a wide wave-wash zone for feeding, much beachcast seaweed, and backed by sparsely vegetated sand-dunes for shelter and nesting. Occasionally Hooded Plovers are found on tidal bays and estuaries, rock platforms and rocky or sand-covered reefs near sandy beaches, and small beaches in lines of cliffs. They regularly use near-coastal saline and freshwater lakes and lagoons, often with saltmarsh (DECCW 2010b).

At night they favour the upper zones of beaches for roosting. In coastal lagoons they forage in damp or dry substrates and in shallow water, depending on the season and water levels. In eastern Australia, Hooded Plovers usually breed from August to March on sandy ocean beaches strewn with beachcast seaweed, in a narrow strip between the high-water mark and the base of the fore-dunes (DECCW 2010b).

Sooty Tern

The Sooty Tern is found over tropical and sub-tropical seas and on associated islands and cays around Northern Australia. Occasionally seen along coastal NSW, especially after cyclones. Large flocks can be seen soaring, skimming and dipping but seldom plunging in off shore waters. Breeds in large colonies in sand or coral scrapes on offshore islands and cays including Lord Howe and Norfolk Islands (DECCW 2010b).

Pied Oystercatcher

The Pied Oystercatcher favours intertidal flats of inlets and bays, open beaches and sandbanks. It forages on exposed sand, mud and rock at low tide, for molluscs, worms, crabs and small fish. This species nests mostly on coastal or estuarine beaches although occasionally they use saltmarsh or

grassy areas. Nests are shallow scrapes in sand above the high tide mark, often amongst seaweed, shells and small stones. Two to three eggs are laid between August and January (DECCW 2010b).

The Pied Oystercatcher was recorded along the foreshores of Lake Tallawarra during the ELA (2010) survey but has also been recorded a number of times in the ash ponds and attempted to breed at the mouth of Duck Creek in the past (Chafer 1995). A Lake Illawarra resident pair has been observed around the shores, and occasionally sighted on Ash Pond 3 by the Tallawarra Bird Observers Club. A pair attempted to breed adjacent to the coal wash dump besides Hayward's Bay in 2001 but were thought to have been fox predated (Brandis 2010).

Black-necked Stork

Black-necked Storks are mainly found on shallow, permanent, freshwater terrestrial wetlands, and surrounding marginal vegetation, including swamps, floodplains, watercourses and billabongs, freshwater meadows, wet heathland, farm dams and shallow floodwaters, as well as extending into adjacent grasslands, paddocks and open savannah woodlands. They also forage within or around estuaries and along intertidal shorelines, such as saltmarshes, mudflats and sandflats, and mangrove vegetation. They mainly forage in shallow, still water, preferring open wetlands. In NSW, Black-necked Storks breed in late spring and summer (DECCW 2010b).

In NSW, breeding activity has been recorded in most months, with activities from nest construction to fledging of young recorded from May to January. Most activity, however, takes place between June and December, and clutches present May to September. In NSW, Storks usually nest in a tall, live and isolated paddock tree, but also in other trees, including paperbarks, or even lower shrubs within wetlands. The nest is a large platform, 1-2 m in diameter, made in a live or dead tree, in or near a freshwater swamp (DECCW 2010b).

Sooty Oystercatcher

The Sooty Oystercatcher prefers rocky headlands, rocky shelves, exposed reefs with rock pools, beaches and muddy estuaries. This species forages on exposed rock or coral at low tide. Breeding takes place in spring and summer, almost exclusively on offshore islands, and occasionally on isolated promontories. The nest is a shallow scrape on the ground, or small mounds of pebbles, shells or seaweed when nesting among rocks (DECCW 2010b). The Sooty Oystercatcher was recorded along the foreshore of Lake Illawarra during the ELA (2010) survey.

The artificial wetlands, saltmarsh (some species) and Lake Illawarra foreshore provide habitat for these species. The majority of these species breed outside mainland Australia with the exception of the Hooded Plover Little Tern and the Pied Oystercatcher. The Pied Oystercatcher also had the potential to utilise Duck Creek.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The majority of these species breed outside Australia and therefore impacts on breeding habitat will not occur. In addition, Tallawarra represents marginal habitat for a number of species with the north coast and Hunter Valley providing the stronghold areas in terms of habitat.

The Pied Oystercatcher was recorded along the foreshores of Lake Tallawarra during the ELA (2010) survey but has also been recorded a number of times in the ash ponds and attempted to breed at the mouth of Duck Creek in the past (Chafer 1995). All areas of key habitat for this species will be conserved at the site and mitigation measures implemented to prevent indirect impacts. Given that all

of these species forage widely and areas of key foraging habitat throughout the study area will be conserved. It is unlikely that the proposal would affect the lifecycle of any of these species.

The Black-necked Stork has the potential to forage and breed on the site. Although a small number of scattered paddock trees will be removed for the proposal, other areas of potential breeding habitat will be conserved. There is the potential for this species to select other areas as breeding habitat during and following construction due to disturbance. Given this species has not been recorded at the site and is not known to breed on the site, it is unlikely that the proposal would affect the lifecycle of the species.

The Sooty Oystercatcher has been recorded within the study area. However, this species breeds offshore and areas of potential foraging habitat are to be conserved within the study area. Therefore it is unlikely that the proposal would affect the lifecycle of this species.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Areas of key habitat within the study area for these species include the artificial wetlands and the Lake Illawarra foreshore. Areas considered to provide the greatest habitat value due to the presence of mudflats and shallow areas for foraging will be conserved in the south west of the site. Other areas of artificial wetlands will be removed but this is considered unlikely to impact these species.

The study area provides primarily foraging habitat for the Great Knot and Sanderling. The mudflat areas along which these species is likely to forage are located along the foreshore of Lake Illawarra and the large wetland in the south west of the site. Both of these areas will be conserved and mitigation measures implemented to prevent indirect impacts. Neither of these species breed within Australia.

The Greater Sand-plover breeds in central Asia and therefore potential breeding habitat is not present. In NSW, the species has been recorded between the northern rivers and the Illawarra, with most records coming from the Clarence and Richmond estuaries. Therefore the study area would represent marginal habitat for this species. Nevertheless, the areas of potential habitat for this species will be conserved under the current concept plan and protected from indirect impacts.

The Lesser Sand-plover is most commonly recorded in northern NSW with infrequent records in south of the Shoalhaven estuary. Potential foraging habitat for this species is present within the study area with the most valuable areas likely to be present along the foreshore of Lake Illawarra and within the proposed environmental reserve and the large artificial wetland in the south west of the site which will be conserved.

The Broad-billed Sandpiper primarily occurs on the north coast (Hunter River estuary) with only occasional records on the south coast. Therefore Tallawarra represents marginal habitat for this species. Furthermore, this species does not breed in Australia and breeding habitat will not be impacted.

Main sites for the Black-tailed Godwit are on Kooragang (Newcastle) with only occasional records on the south coast. Therefore Tallawarra represents marginal habitat for this species. Furthermore, this species does not breed in Australia and breeding habitat will not be impacted.

Habitat for Little Tern is present along the foreshore and therefore will not be impacted by the proposal.

Occasionally Hooded Plovers are found on tidal bays and estuaries, rock platforms and rocky or sand-covered reefs near sandy beaches, and small beaches in lines of cliffs. They regularly use near-coastal

saline and freshwater lakes and lagoons, often with saltmarsh. However, the site represents marginal habitat for Hooded Plover as this species normally only occurs north to Sussex Inlet. Therefore it is unlikely that the study area provides important habitat for this species.

The study area provides foraging habitat for the Sooty Tern. This species does not breed on Mainland Australia and therefore no potential breeding habitat would be impacted. Key areas of potential foraging habitat will be preserved across the study area and occur in the south west and along the foreshore of Lake Illawarra.

The Pied Oystercatcher was recorded along the foreshores of Lake Tallawarra during the ELA (2010) survey but has also been recorded a number of times in the ash ponds and attempted to breed at the mouth of Duck Creek in the past (Chafer 1995). All areas of key habitat for this species will be conserved at the site and mitigation measures implemented to prevent indirect impacts.

The Black-necked Stork has the potential to forage and breed on the site. Although a small number of scattered paddock trees will be removed for the proposal, other areas of potential breeding habitat will be conserved. There is the potential for this species to select other areas as breeding habitat during and following construction due to disturbance.

No breeding habitat for the Sooty Oystercatcher is present within the study area and all areas of potential foraging habitat will be conserved within the study area.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Sanderling is a regular summer migrant from Siberia and other Arctic breeding grounds to most of the Australian coastline. It is uncommon to locally common, arriving from September and leaving by May (some may overwinter in Australia). Sanderlings occur along the NSW coast, with occasional inland sightings (DECCW 2010b). This species is not at the limit of its distribution at Tallawarra.

In NSW, the Great Knot has been recorded at scattered sites along the coast to about Narooma. It has also been observed inland at Tullakool, Armidale, Gilgandra and Griffith (DECCW 2010b). This species is not at the limit of its distribution at Tallawarra (DECCW 2010b).

The Greater Sand Plover breeds in central Asia from Armenia to Mongolia, moving further south for winter. In Australia the species is commonly recorded in parties of 10-20 on the west coast, with the far northwest being the stronghold of the population. The species is apparently rare on the east coast, being found usually singly. In NSW, the species has been recorded between the northern rivers and the Illawarra, with most records coming from the Clarence and Richmond estuaries (DECCW 2010b). This species would be close to the limit of its distribution if it was present at the site.

The Lesser Sand Plover breeds in central and north eastern Asia, migrating further south for winter. In Australia the species is found around the entire coast but is most common in the Gulf of Carpentaria, and along the east coast of Queensland and northern NSW. Individuals are rarely recorded south of the Shoalhaven estuary, and there are few inland records (DECCW 2010b). This species is close to the limit of its distribution at Tallawarra.

The Broad-billed Sandpiper breeds in northern Siberia before migrating southwards in winter to Australia. In Australia, Broad-billed Sandpipers overwinter on the northern coast, particularly in the north-west, with birds located occasionally on the southern coast. In NSW, the main site for the species

is the Hunter River estuary, with birds occasionally reaching the Shoalhaven estuary. There are few records for inland NSW (DECCW 2010b). This species would be close to the limit of its distribution if it was present at the site although the north coast of NSW is the preferred habitat for this species.

The Black-tailed Godwit is a migratory wading bird that breeds in Mongolia and Eastern Siberia (Palaearctic) and flies to Australia for the southern summer, arriving in August and leaving in March. In NSW, it is most frequently recorded at Kooragang Island (Hunter River estuary), with occasional records elsewhere along the north and south coast, and inland. Records in western NSW indicate that a regular inland passage is used by the species, as it may occur around any of the large lakes in the western areas during summer, when the muddy shores are exposed. The species has been recorded within the Murray-Darling Basin, on the western slopes of the Northern Tablelands and in the far north-western corner of the state. This species would be close to the limit of its distribution if it was present at the site although this species is most frequently recorded on Kooragang Island.

Migrating from eastern Asia, the Little Tern is found on the north, east and south-east Australian coasts, from Shark Bay in Western Australia to the Gulf of St Vincent in South Australia. In NSW, it arrives from September to November, occurring mainly north of Sydney, with smaller numbers found south to Victoria. It breeds in spring and summer along the entire east coast from Tasmania to northern Queensland, and is seen until May, with only occasional birds seen in winter months (DECCW 2010b). This species is not at the limit of its distribution at Tallawarra.

The Hooded Plover is endemic to southern Australia and is nowadays found mainly along the coast from south of Jervis Bay, NSW, south through Victoria and Tasmania to the western side of the Eyre Peninsula in South Australia. Presently the Hooded Plover occurs north to Sussex Inlet. Occasionally, individual birds are sighted slightly further north to the Shoalhaven River and Comerong Beach and one bird was sighted at Lake Illawarra in March 2001 (DECCW 2010b). This species is at the northern limit of its distribution at Tallawarra.

The Pied Oystercatcher is distributed around the entire Australian coastline, although it is most common in coastal Tasmania and parts of Victoria, such as Corner Inlet. In NSW the species is thinly scattered along the entire coast (DECCW 2010b). This species is at the northern limit of its distribution at Tallawarra.

In Australia, Black-necked Storks are widespread in coastal and subcoastal northern and eastern Australia, south to central-eastern NSW and with vagrants recorded at scattered sites well away from the coast (for example, near Moree, north-east of Hay and in Victoria). In NSW, the species rarely occurs south of Sydney. Breeding has been recorded as far south as Bulahdelah in recent years (since 1995), though most breeding in NSW occurs in the north-east (DECCW 2010b). This species is close to the limit of its southern distribution at Tallawarra.

The Sooty Oystercatcher is found around the entire Australian coast, including offshore islands, being most common in Bass Strait. Small numbers of the species are evenly distributed along the NSW coast. The availability of suitable nesting sites may limit populations (DECCW 2010b). This species is not at the limit of its distribution at Tallawarra.

How is the proposal likely to affect current disturbance regimes?

Predation by domestic animals such as cats and dogs is a threat to waterbirds particularly those using the large wetland in the south west of the site. The proximity of the residential area to the wetlands and the proposal to establish a walking trail around the lake increases the potential for predation. However, a number of mitigation measures have been identified to minimise this threat. These include fencing of the proposed trail (or other barrier) so dogs cannot stray, enforcing that dogs must be kept on leases within the residential area, erecting fencing between the wetland and the residential area and enforcing that all cats must have a collar and bell. Predation by feral animals is also a threat. It is likely that the proposed mitigation measures will also assist in the prevention of predation by foxes.

If mitigation measures are not implemented there is the potential for excess runoff to enter areas of potential habitat for this species and alter water quality and hydrological regimes. Mitigation measures will be put in place to ensure runoff is trapped within the development area and prevent for entering waterbodies throughout the study area.

Given the proximity of the artificial wetlands to the proposed development area, edge effects are likely. A VMP has been prepared for the site which addresses weed invasion throughout the study area and includes management of the current weed infestation within areas of potential habitat. Where pesticides are to be used near waterways, these will be suitable for use near aquatic environments.

How is the proposal likely to affect habitat connectivity?

All of these species are highly mobile and given that current habitat connectivity across the site is fragmented, it is unlikely that the proposal would create further fragmentation.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for these species.

8.3.4 Black Bittern

The Black Bittern inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. Where permanent water is present, the species may occur in flooded grassland, forest, woodland, rainforest and mangroves. This species feeds on frogs, reptiles, fish and invertebrates, including snails, dragonflies, shrimps and crayfish, with most feeding done at dusk and at night.

During the day, the Black Bittern roosts in trees or on the ground amongst dense reeds. When disturbed, freezes in a characteristic bittern posture (stretched tall, bill pointing up, so that shape and streaked pattern blend with upright stems of reeds), or will fly up to a branch or flush for cover where it will freeze again. Generally solitary, but occurs in pairs during the breeding season, from December to March.

Like other bitterns, but unlike most herons, nesting is solitary. Nests, built in spring are located on a branch overhanging water and consist of a bed of sticks and reeds on a base of larger sticks (DECCW 2010b).

The Black Bittern has been recorded along Duck Creek in the past (Burcher 1997, DECCW 2010a) and is likely to utilise the densely vegetated margins of the creek such as those present in the east of the study area.

There is one reported breeding record for this species along Duck Creek within an area of SOFF (Brandis 2010). The artificial wetland areas of the site and SEPP 14 wetland in the east of the site are also likely to provide potential habitat for this species.

Threats to this species include:

- Clearing of riparian vegetation.
- Predation by foxes and feral cats on eggs and juveniles (DECCW 2010b).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The study area provides known habitat for this species. Areas of potential foraging and nesting habitat are present within the study area. All of these areas will be conserved for the proposal and management measures implemented to prevent indirect impacts.

Whilst the breeding record for this species is historical, it is recommended that a survey be undertaken during the breeding season for this species to verify if there are any breeding sites in proximity to the development area. If such sites area found, the proximity of the proposed development to this habitat would need to be considered and construction undertaken outside the breeding season (Spring – March) for this species.

Provided the mitigation measures are implemented it is unlikely that the proposal would affect the lifecycle of this species.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal will result in the removal of approximately 0.54 ha of SOFF with the remaining 31.58 ha, present primarily along Duck Creek and the south east of the site, to be conserved through incorporation into environmental reserves.

Although 3.96 ha of artificial wetlands will be removed from the study area. Those that are the most likely to provide habitat for the Black Bittern will be conserved and cover an area of approximately 17.93 ha. The two SEPP 14 wetlands in the south east of the site will also be protected and are incorporated into the approximately 95.98 ha reserve in the south east of the site.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Black Bittern has a wide distribution, from southern NSW north to Cape York and along the north coast to the Kimberley region. The species also occurs in the south-west of Western Australia. In NSW, records of the species are scattered along the east coast, with individuals rarely being recorded south of Sydney or inland (DECCW 2010b). This species is close to the limit of its distribution at the site.

How is the proposal likely to affect current disturbance regimes?

Predation by domestic animals such as cats and dogs is a threat to this species particularly if it is using areas of Duck Creek in close proximity to the residential development or the large wetland in the south west of the site. The proximity of the residential area to the wetlands and the proposal to establish a walking trail around the lake increases the potential for predation. A walking trail is also proposed through the LWMF along Duck Creek in the west of the site. This area is considered less likely to be used by the Black Bittern with areas of SOFF downstream providing more suitable habitat.

A number of mitigation measures have been identified to minimise the threat of predation particularly around the wetland in the south west of the site. Predation from domestic animals is considered less likely in areas in the east of the site as these will be incorporated into a 95.98 ha environmental reserve Proposed mitigation measures for the artificial wetland in the south west include fencing of the proposed trail (or other barrier) so dogs cannot stray, enforcing that dogs must be kept on leases within the residential area, erecting fencing between the wetland and the residential area and enforcing that all cats must have a collar and bell. Predation by feral animals is also a threat. It is likely that the proposed mitigation measures will also assist in the prevention of predation by foxes as the preparation and implementation of a Feral Animal Management plan has been recommended.

Fire has the potential to reduce habitat for this species particularly along Duck Creek. The greatest potential for accidental fires is likely to be during construction and maintenance works or arson. Therefore a number of preventative measures would need to be implemented to reduce the likelihood of accidental fires. Details of these measures are outlined in the mitigation section of this report and include the preparation of a Bushfire Management Plan.

If mitigation measures are not implemented there is the potential for excess runoff to enter areas of potential habitat for this species and alter water quality and hydrological regimes. Mitigation measures will be put in place to ensure runoff is trapped within the development area and prevent for entering waterbodies and riparian areas.

Given the proximity of the artificial wetlands and vegetation along Duck Creek in the west of the site to the proposed development area, edge effects are likely. A VMP has been prepared for the site which addresses weed invasion throughout the study area and includes management of the current weed infestation within areas of potential habitat. Where pesticides are to be used near waterways, these will be suitable for use near aquatic environments.

How is the proposal likely to affect habitat connectivity?

The Black Bittern is highly mobile and given that current artificial wetlands across the site are already fragmented, it is unlikely that the proposal would create further fragmentation. Movement for this species throughout the study area will not be impeded.

The stands of SOFF within the study area are largely connected along the Duck Creek riparian corridor. A small isolated area of SOFF is also present in the very south east of the study area. The proposal will not further isolate this stand of SOFF from the stands to the north and the connectivity along the Duck Creek corridor is likely to be enhanced as a consequence of the proposal as a VMP will be implemented across the site that includes revegetation works within the Duck Creek corridor.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for these species.

8.3.5 Parrots

Swift Parrot

The Swift Parrot breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW this species mostly occurs on the coast and south west slopes.

This species migrates to the Australian south-east mainland between March and October. On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations (DECCW 2010b).

Favoured feed trees include winter flowering species such as Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata*, Red Bloodwood *C. gummifera,* Mugga Ironbark *E. sideroxylon*, and White Box *E. albens*. Commonly used lerp infested trees include Inland Grey Box *E. microcarpa*, Grey Box *E. moluccana* and Blackbutt *E. pilularis*.

Following winter they return to Tasmania where they breed from September to January, nesting in old trees with hollows and feeding in forests dominated by Tasmanian Blue Gum *Eucalyptus globulus* (DECCW 2010b).

Areas of LWMF and ASMF support favoured feed trees for this species although there is the potential for this species to forage more widely across the site on other species in flower during winter.

Turquoise Parrot

The Turquoise Parrot lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. They are usually seen in pairs or small, possibly family, groups and have also been reported in flocks of up to thirty individuals. This species prefers to feed in the shade of a tree and spends most of the day on the ground searching for the seeds or grasses and herbaceous plants, or browsing on vegetable matter.

Forages quietly and may be quite tolerant of disturbance. Turquoise Parrots nest in tree hollows, logs or posts, from August to December (DECCW 2010b).

The LWMF, CGRGF and MBRGFF and adjoining grassy areas provide the most likely habitat for this species within the study area.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The Swift Parrot does not breed in NSW. Only foraging habitat for this species will be impacted by the proposal and despite some clearing, extensive areas of potential foraging habitat remain much of which will be incorporated into environmental reserves. Furthermore, the proposal will not restrict movement of this species to or across the site. Therefore it is unlikely that the proposal would impact on the lifecycle of this species.

The Turquoise Parrot has the potential to breed and forage across the site. One hollow-bearing tree will be removed from the study area and all remaining hollow-bearing trees will be conserved within the CGRGF and MBRGFF in the north west of the site and LWMF in the south. Extensive areas of grassland for foraging will also be conserved in the south east and north east of the site. Therefore it is unlikely that the proposal would affect the lifecycle of this species.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal will result in the removal of 2.54 ha of LWMF, 0.54 ha of CGRGF and 0.2 ha of MBRGFF. This comprises only a very small portion of potential habitat for the Swift Parrot and Turquoise Parrot throughout the study area and an even smaller portion of potential habitat within the locality for these highly mobile species.

One hollow-bearing tree will be removed from the study area and hollow-bearing trees will be conserved within the CGRGF and MBFF in the north west of the site and LWMF in the south. Extensive areas of grassland for foraging by the Turquoise Parrot will also be conserved in the south east and north east of the site.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Swift Parrot breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW mostly occurs on the coast and south west slopes (DECCW 2010b). This species is not at the limit of its distribution at the site.

The Turquoise Parrot's range extends from southern Queensland through to northern Victoria, from the coastal plains to the western slopes of the Great Dividing Range. This species is not near the limit of its known distribution at Tallawarra (DECCW 2010b).

How is the proposal likely to affect current disturbance regimes?

Collisions with cars is listed as a key threat to Swift Parrots (DECCW 2010b). Given this species has not been recorded on site and is known to return to some foraging sites on a cyclic basis depending on food availability, the low speed limits likely to enforced within the developed areas of the study area should minimise the likelihood of collision with cars utilise the site in the future.

Predation by domestic animals such as cats and dogs is a threat to the Turquoise Parrot particularly if it forages in the grassland areas near the proposed residential development. A number of mitigation measures have been identified to minimise the threat of predation throughout the study area. However, these will primarily be implemented within the environmental reserves and around the proposed lake and therefore will not cover all habitat for the Turquoise Parrot. Habitat for this species is extensive across the site and a large area of potential foraging habitat, where the threat of predation will be less, is present in the proposed reserve in the south east.

Fire has the potential to reduce habitat for these species. The greatest potential for accidental fires is likely to be during construction and maintenance works or arson. Therefore a number of preventative measures would need to be implemented to reduce the likelihood of accidental fires. Details of these measures are outlined in the mitigation section of this report and include the preparation of a Bushfire Management Plan.

If mitigation measures are not implemented there is the potential for excess runoff to enter areas of potential habitat for this species and alter hydrological regimes. Mitigation measures will be put in place to ensure runoff is trapped within the development area and prevented from entering waterbodies and riparian areas.

A VMP has been prepared for the site which addresses weed invasion throughout the study area and includes management of the current weed infestation within areas of potential habitat. Where pesticides are to be used near waterways, these will be suitable for use near aquatic environments.

How is the proposal likely to affect habitat connectivity?

The Swift Parrot and Turquoise Parrot are highly mobile species. Habitat for both species is currently fragmented across the study area and it is unlikely that the proposal would increase fragmentation such that it would alter the use of the site or movement of these species across the site should they be present.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for these species.

8.3.6 Woodland Birds

Pink Robin

The Pink Robin inhabits rainforest and tall, open eucalypt forest, particularly in densely vegetated gullies. This species breeds between October and January and can produce two clutches in a season. The nest is a deep, spherical cup made of green moss bound with cobweb and adorned with camouflaging lichen, and is lined with fur and plant down. It is situated in an upright or oblique fork, from 30cm to 6m above the ground, in deep undergrowth (DECCW 2010b).

This species has been recorded just south of the site (DECCW 2010a) and therefore there is the potential for this spices to utilise the site. Areas of suitable habitat for this species include ASMF, ISR, LWMF and CGRGF, MBRGFF.

Scarlet Robin

The Scarlet Robin is primarily a resident in forests and woodlands, but some adults and young birds disperse to more open habitats after breeding. The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs (DECCW 2010b).

This species lives in both mature and regrowth vegetation. It occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps. Scarlet Robin habitat usually contains abundant logs and fallen timber: these are important components of its habitat (DECCW 2010b).

The Scarlet Robin breeds on ridges, hills and foothills of the western slopes, the Great Dividing Range and eastern coastal regions; this species is occasionally found up to 1000 metres in altitude (DECCW 2010b).

In autumn and winter many Scarlet Robins live in open grassy woodlands, and grasslands or grazed paddocks with scattered trees. The Scarlet Robin is a quiet and unobtrusive species which is often quite tame and easily approached (DECCW 2010b).

Scarlet Robin pairs defend a breeding territory and mainly breed between the months of July and January; they may raise two or three broods in each season. This species' nest is an open cup made of plant fibres and cobwebs and is built in the fork of tree usually more than 2 metres above the ground; nests are often found in a dead branch in a live tree, or in a dead tree or shrub (DECCW 2010b).

This species has been recorded within the study area and has the potential to utilise the woodland and forest areas of the site (ASMF, LWMF, CGRGF and MBRGFF). In autumn and winter it may also use the pasture areas.

Regent Honeyeater

The Regent Honeyeater inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. Regent Honeyeaters inhabit woodlands that support a significantly high abundance and species richness of bird species. These woodlands have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes.

Every few years non-breeding flocks are seen foraging in flowering coastal Swamp Mahogany and Spotted Gum forests, particularly on the central coast and occasionally on the upper north coast. Birds are occasionally seen on the south coast.

The Regent Honeyeater is a generalist forager, which mainly feeds on the nectar from a wide range of eucalypts and mistletoes. Key eucalypt species include Mugga Ironbark, Yellow Box, Blakely's Red Gum, White Box and Swamp Mahogany. This species also utilises: E. *microcarpa, E. punctata, E. polyanthemos, E. moluccana, Corymbia robusta, E. crebra, E. caleyi, Corymbia maculata, E. mckieana, E. macrorhyncha, E. laevopinea,* and *Angophora floribunda*. Nectar and fruit from the mistletoes *A. miquelii, A. pendula, A. cambagei* are also eaten during the breeding season. A shrubby understorey is an important source of insects and nesting material (DECCW 2010b)

Colour-banding of Regent Honeyeater has shown that the species can undertake large-scale nomadic movements in the order of hundreds of kilometres. However, the exact nature of these movements is still poorly understood. It is likely that movements are dependent on spatial and temporal flowering and other resource patterns.

There are three known key breeding areas, two of them in NSW - Capertee Valley and Bundarra-Barraba regions. The species breeds between July and January in Box-Ironbark and other temperate woodlands and riparian gallery forest dominated by River Sheoak. Regent Honeyeaters usually nest in horizontal branches or forks in tall mature eucalypts and Sheoaks. Also nest in mistletoe haustoria (DECCW 2010b).

Areas of potential habitat for this species include: ASMF, LWMF, CGRGF and MBRGFF.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Potential foraging and nesting habitat is present for the Pink Robin. Given that only a very small area of potential habitat (3.66 ha) in comparison to the current amount of habitat across the study area (46.97 ha) would be removed for the proposal, it is unlikely that the proposal would affect the lifecycle of this species. There is the potential for the proposal to increase disturbance of areas of habitat for the Pink Robin due to increased pedestrian activity. However, the majority of the potential habitat for this species is present within the conservation areas and a large area of habitat which is less likely to be accessed is present in the south east. Therefore it is unlikely that any disturbance as a consequence of the proposal would affect the lifecycle of this species.

Although the Scarlet Robin has been recorded at the site, only a very small area of potential habitat (3.28 ha) in comparison to the current amount of habitat across the study area (46.97 ha) would be removed for the proposal. Furthermore, extensive areas of grassland which also provide habitat for this species will remain. Therefore, it is unlikely that the proposal would affect the lifecycle of this species.

There are three known key breeding areas, two of them in NSW - Capertee Valley and Bundarra-Barraba regions for the Regent Honeyeater. Therefore it is likely that this species would only use the study area for foraging (46.97 ha) with the most likely areas to be used as foraging (woodland areas) primarily to be conserved. Therefore impacts on the lifecycle of this species are unlikely.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal will result in the removal of 0.38 ha of ISR, 2.54 ha of LWMF, 0.54 ha of CGRGF and 0.2 ha of MBRGFF. No ASMF will be removed. This comprises only a very small portion of the potential habitat (6.61 % for the Pink Robin, 6.98 % for the Scarlet Robin and 6.98 % for Regent Honeyeater) present across the study area. A large proportion of potential habitat will be conserved within environmental reserves with the exception of a very small area of LWMF in the south west of the site

and the CGRGF, MBRGFF and ISR in the north which will be conserved within an environmental management zone.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Pink Robin is found in Tasmania and the uplands of eastern Victoria and far south-eastern NSW, almost as far north as Bombala. On the mainland, the species disperses north and west and into more open habitats in winter, regularly as far north as the ACT area, and sometimes being found as far north as the central coast of NSW (DECCW 2010b). This species is close to the limit of its known distribution at the site.

The Scarlet Robin is found from SE Queensland to SE South Australia and also in Tasmania and SW Western Australia. In NSW, it occurs from the coast to the inland slopes. After breeding, some Scarlet Robins disperse to the lower valleys and plains of the tablelands and slopes. Some birds may appear as far west as the eastern edges of the inland plains in autumn and winter (DECCW 2010b). This species is not at the limit of its known distribution at Tallawarra.

The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands. In some years non-breeding flocks converge on flowering coastal woodlands and forests (DECCW 2010b). This species would not be close to the limit of its known range if it were present at the site.

How is the proposal likely to affect current disturbance regimes?

Fire has the potential to reduce habitat for these species. The greatest potential for accidental fires is likely to be during construction and maintenance works or arson. Therefore a number of preventative measures would need to be implemented to reduce the likelihood of accidental fires. Details of these measures are outlined in the mitigation section of this report and include the preparation of a Bushfire Management Plan.

A VMP has been prepared for the site which addresses weed invasion throughout the study area and includes management of the current weed infestation within areas of potential habitat.

How is the proposal likely to affect habitat connectivity?

The Regent Honeyeater is migratory species and therefore can travel large distances. Therefore it is unlikely that the proposed would affect habitat connectivity in terms of habitat use by this species across the study area.

Habitat for Pink Robin and Scarlet Robin is currently fragmented across the study area and it is unlikely that the proposal would increase fragmentation such that it would alter the use of the site or movement of these mobile species across the site.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for these species.

8.3.7 Birds of Prey

Square-tailed Kite

The Square-tailed Kite is found in a variety of timbered habitats including dry woodlands and open forests. This species shows a particular preference for timbered watercourses. In arid north-western NSW, it has been observed in stony country with a ground cover of chenopods and grasses, open acacia scrub and patches of low open eucalypt woodland (DECCW 2010b).

The species is a specialist hunter of passerines, especially honeyeaters, and most particularly nestlings, and insects in the tree canopy, picking most prey items from the outer foliage. It appears to occupy large hunting ranges of more than 100km^2. Breeding is from July to February, with nest sites generally located along or near watercourses, in a fork or on large horizontal limbs (DECCW 2010b).

Habitat for this species is present throughout woodland areas of the site (LWMF, CGRGF and ASMF and MBRGFF).

Osprey

The Osprey favours coastal areas, especially the mouths of large rivers, lagoons and lakes. This species breeds from July to September in NSW. Nests are made high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea (DECCW 2010b).

The Osprey has been recorded nesting near the power station in the past (1993 – 1994) (Chafer 1995).

Little Eagle

The Little Eagle occupies open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used. This species nests in tall living trees within a remnant patch, where pairs build a large stick nest in winter. This species lays two or three eggs during spring, and young fledge in early summer.

The Little Eagle has been recorded within the study area with several old nesting records just west of Ash Pond 3 in the south of the site with a few sightings over the grasslands of Mt. Brown (Brandis 2010).

The Little Eagle is found throughout the Australian mainland except in the most densely forested parts of the Dividing Range escarpment. It occurs as a single population throughout NSW.

The majority of the study area would provide habitat for this species.

Spotted Harrier

The Spotted Harrier inhabits grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands.

This species builds a stick nest in a tree and lays eggs in spring (or sometimes autumn), with young remaining in the nest for several months (DECCW 2010b).

This species has been recorded hunting over grassland areas and the majority of the site would provide potential habitat.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

A raptor nest was recorded in the south west of the site in a large hollow-bearing tree that is to be removed for a proposed road. Given that the Little Eagle has been recorded nesting in this area in the past (Brandis 2010), it is recommended that surveys be undertaken to verify if this nest is currently being used. Areas of potential breeding habitat are present elsewhere within the study area and extensive areas of foraging habitat are present and will remain. Provided that a currently used nest site for this species is not removed, it is unlikely that the proposal would impact on the lifecycle of this species.

The proposal will result in the removal of potential habitat for these species. The area in which the Osprey has been recorded breeding will not be impacted by the proposal.

Given all of these species are highly mobile, no known breeding habitat would be impacted and extensive areas of potential habitat for these species will be preserved in the north east, central west and south east of the site. It is unlikely that the proposal would affect their lifecycle.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal will result in the removal of 2.54 ha of LWMF, 0.54 ha of CGRGF and 0.2 ha of MBRGFF. No ASMF will be removed. This comprises only a very small portion of potential habitat for these species throughout the study area and an even smaller portion of potential habitat within the locality for these highly mobile species. The Little Eagle and Spotted Harrier also have the potential to utilise the grassland and more disturbed areas of the site. Therefore the proposed habitat removal is unlikely to represent a significant proportion of potential habitat for these species.

The area in which the Osprey has been recorded will be conserved within an environmental reserve. It has been recommended that a survey be undertaken to verify if any birds of prey are utilising the nest recorded in the hollow-bearing tree proposed for removal in the south west of the site.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Square-tailed Kite ranges along coastal and subcoastal areas from south-western to northern Australia, Queensland, NSW and Victoria. In NSW, scattered records of the species throughout the state indicate that the species is a regular resident in the north, north-east and along the major west-flowing river systems. It is a summer breeding migrant to the south-east, including the NSW south coast, arriving in September and leaving by March (DECCW 2010b). This species is close to the limit of its distribution at the site.

Ospreys are found right around the Australian coast line, except for Victoria and Tasmania. They are common around the northern coast, especially on rocky shorelines, islands and reefs. The species is uncommon to rare or absent from closely settled parts of south-eastern Australia. There are a handful of records from inland areas (DECCW 2010b). This species is not at the limit of its known distribution at Tallawarra.

The Little Eagle is found throughout the Australian mainland excepting the most densely forested parts of the Dividing Range escarpment. It occurs as a single population throughout NSW (DECCW 2010b). This species in not at the limit of its known distribution at the site.

The Spotted Harrier occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Individuals disperse widely in NSW and comprise a single population (DECCW 2010b). This species is not at the limit of it distribution at Tallawarra.

How is the proposal likely to affect current disturbance regimes?

Fire has the potential to reduce habitat for these species. The greatest potential for accidental fires is likely to be during construction and maintenance works or arson. Therefore a number of preventative measures would need to be implemented to reduce the likelihood of accidental fires. Details of these measures are outlined in the mitigation section of this report and include the preparation of a Bushfire Management Plan.

If mitigation measures are not implemented there is the potential for excess runoff to enter areas of potential habitat for this species and alter hydrological regimes. Mitigation measures will be put in place to ensure runoff is trapped within the development area and prevent for entering waterbodies and riparian areas.

A VMP has been prepared for the site which addresses weed invasion throughout the study area and includes management of the current weed infestation within areas of potential habitat. Where pesticides are to be used near waterways, these will be suitable for use near aquatic environments.

How is the proposal likely to affect habitat connectivity?

All of these species are highly mobile species. Habitat for these species is currently fragmented across the study area and it is unlikely that the proposal would increase fragmentation such that it would alter the use of the site or movement of these species across the site should they be present. Furthermore, these species will forage over a wide variety of habitat types.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for these species.

8.3.8 Owls

Barking Owl

The Barking Owl inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. This species is flexible in its habitat use and hunting can extend in to closed forest and more open areas. Sometimes able to successfully breed along timbered watercourses in heavily cleared habitats (e.g. western NSW) due to the higher density of prey on these fertile soils (DECCW 2010b).

This species roosts in shaded portions of tree canopies, including tall midstorey trees with dense foliage such as Acacia and Casuarina species. During nesting season, the male perches in a nearby tree overlooking the hollow entrance (DECCW 2010b).

The Barking Owl requires very large permanent territories in most habitats due to sparse prey densities. Monogamous pairs hunt over as much as 6000 hectares, with 2000 hectares being more typical in NSW habitats (DECCW 2010b).

Two or three eggs are laid in hollows of large, old trees. Living eucalypts are preferred though dead trees are also used. Nest sites are used repeatedly over years by a pair, but they may switch sites if disturbed by predators (e.g. goannas). Nesting occurs during mid-winter and spring. Young are dependent for several months (DECCW 2010b)

The Barking Owl (*Ninox connivens*) has been recorded in close proximity to the western boundary of the study area (DECCW 2010a) and is likely to utilise the majority of the study area for foraging.

Powerful Owl

The Powerful Owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. The Powerful Owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats.

It roosts by day in dense vegetation comprising species such as Turpentine *Syncarpia glomulifera*, Black She-oak *Allocasuarina littoralis*, Blackwood *Acacia melanoxylon*, Rough-barked Apple *Angophora floribunda*, Cherry Ballart *Exocarpos cupressiformis* and a number of eucalypt species.

Pairs of Powerful Owls are believed to have high fidelity to a small number of hollow-bearing nest trees and will defend a large home range of 400-1450 ha. Powerful Owls nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old. During the breeding season, the male Powerful Owl roosts in a "grove" of up to 20-30 trees, situated within 100-200 metres of the nest tree where the female shelters.

Powerful Owls are monogamous and mate for life. Nesting occurs from late autumn to mid-winter, but is slightly earlier in north-eastern NSW (late summer - mid autumn) (DECCW 2010b).

All woodland areas across the study area would provide potential habitat for this species (LWMF, ASMF, CGRGF, MBRGFF)

Masked Owl

Pairs of Masked Owls have a large home-range of 500 to 1000 hectares. They live in dry eucalypt forests and woodlands from sea level to 1100 m. This species is primarily a forest owl, but often hunts

along the edges of forests, including roadsides. This species roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting (DECCW 2010b).

All woodland areas across the study area would provide potential habitat for this species (LWMF, ASMF, CGRGF, MBRGFF).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Although a number of hollow-bearing trees have been recorded within the study area that would provide potential habitat for owls, none of these will be cleared for the proposal. Furthermore, all suitable hollow-bearing trees are present within the proposed environmental reserve in the south east of the site. Therefore it is unlikely that any breeding owls would be disturbed by the development and associated increased activity at the site as they are away from proposed development areas.

Extensive areas of potential foraging habitat for all of these owls are present throughout the study area and the majority will be protected within environmental reserves. Given these species forage over hundreds and in some cases thousands of hectares, it is unlikely that the proposal would affect the lifecycle of any of these owl species should they be present at the site.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal will result in the removal of 2.54 ha of LWMF, 0.54 ha of CGRGF and 0.2 ha of MBRGFF. No ASMF will be removed. This comprises only a very small portion of key potential habitat for these species throughout the study area and an even smaller portion of potential habitat within the locality for these highly mobile species. These species also have the potential to utilise the grassland and more disturbed areas of the site. Therefore the proposed habitat removal is unlikely to represent a significant proportion of potential habitat for these species

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Barking Owl is found throughout continental Australia except for the central arid regions. Core populations exist on the western slopes and plains (especially the Pilliga) and in some northeast coastal and escarpment forests. They sometimes extend their home range into urban areas, hunting birds in garden trees and insects attracted to streetlights (DECCW 2010b). This species is not close to the limit of its known distribution at the site.

The Powerful Owl is endemic to eastern and south-eastern Australia, mainly on the coastal side of the Great Dividing Range from Mackay to south-western Victoria. In NSW, it is widely distributed throughout the eastern forests from the coast inland to tablelands, with scattered, mostly historical records on the western slopes and plains. Now uncommon throughout its range where it occurs at low densities (DECCW 2010b). This species is not near the limit of its known distribution at Tallawarra.

The Masked Owl extends from the coast where it is most abundant to the western plains. Overall records for this species fall within approximately 90% of NSW, excluding the most arid north-western corner. There is no seasonal variation in its distribution (DECCW 2010b). This species is not at the limit of its known distribution in the study area.

How is the proposal likely to affect current disturbance regimes?

Fire has the potential to reduce habitat for these species. The greatest potential for accidental fires is likely to be during construction and maintenance works or arson. Therefore a number of preventative measures would need to be implemented to reduce the likelihood of accidental fires. Details of these measures are outlined in the mitigation section of this report and include the preparation of a Bushfire Management Plan.

The loss of hollow-bearing trees has been identified as a key threat for owls. No trees with hollows suitable for these species will be removed.

Predation by domestic animals such as cats and dogs and feral animals such as foxes is a threat to fledglings. A number of mitigation measures have been identified to minimise the threat of predation throughout the study area. However, these will primarily be implemented within the environmental reserves and around the proposed lake and therefore will not cover all habitat for these species. Habitat for this species is extensive across the site and a large area of potential foraging habitat, where the threat of predation will be less, is present in the proposed reserve in the south east.

How is the proposal likely to affect habitat connectivity?

All of these species are highly mobile species. Habitat for these species is currently fragmented across the study area and it is unlikely that the proposal would increase fragmentation such that it would alter the use of the site or movement of these species across the site should they be present. Furthermore, these species will forage over a wide variety of habitat types.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for these species.

8.3.9 Bats

Large-eared Pied Bat

The Large-eared Pied Bat roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (Hirundo ariel), frequenting low to mid-elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves. They remain loyal to the same cave over many years (DECCW 2010b).

This species is found in well-timbered areas containing gullies. This species is thought to forage for small, flying insects below the forest canopy and is likely to hibernate through the coolest months. It is uncertain whether mating occurs early in winter or in spring (DECCW 2010b).

This species was recorded north-east of the current power station during previous surveys (DECCW 2010a). This species roosts predominantly in caves. It is more likely to forage across the study area given the absence of cliffs for roosting and that the power station is unlikely to contain cave-like crevices that contain the moisture required for roost sites for this species.

Areas of potential habitat for this species within the study area include ASMF, LWMF, CGRGF, MBRGFF although this species was not recorded in the microbat surveys conducted across the study area for this assessment.

Eastern False Pipistrelle

The Eastern False Pipistrelle prefers moist habitats, with trees taller than 20 m. It generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings.

This species hunts beetles, moths, weevils and other flying insects above or just below the tree canopy. This species hibernates in winter. Females are pregnant in late spring to early summer (DECCW 2010b).

This species has been recorded at the site and potential habitat is present in areas of ASMF, LWMF, CGRGF, MBRGFF.

Little Bentwing-bat

There are only five nursery sites /maternity colonies known in Australia. Maternity colonies form in spring and males and juveniles disperse in summer. This species inhabits moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub. They are generally found in well-timbered areas (DECCW 2010b).

Little Bentwing-bats roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats.

They often share roosting sites with the Common Bentwing-bat and, in winter, the two species may form mixed clusters. In NSW the largest maternity colony is in close association with a large maternity colony of Common Bentwing-bats (M. *schreibersii*) and appears to depend on the large colony to provide the high temperatures needed to rear its young (DECCW 2010b).

Three definite calls for the Little Bentwing-bat were recorded adjacent to the artificial wetland in the south west of the site in April. Five and thirteen subsequent calls were recorded in November and

December at the Duck Creek Bridge site and Barrons Gully site respectively. This species has not been recorded onsite during any of the previous surveys although has the potential to forage throughout the woodland (ASMF, ISR, CGRGF, MBRGFF and LWMF) and roost within the hollow-bearing trees, culverts and bridges. The one hollow bearing tree located within the development area was surveyed (visually and by anabat recorder) in October to note the utilisation by microbats however this species was not observed or recorded.

Eastern Bentwing-bat

Caves are the primary roosting habitat for the Eastern Bentwing-bat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. This species forms discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young (DECCW 2010b).

At other times of the year, populations disperse within about 300 km range of maternity caves. Cold caves are used for hibernation in southern Australia. Breeding or roosting colonies can number from 100 to 150,000 individuals. This species hunts in forested areas, catching moths and other flying insects above the tree tops (DECCW 2010b).

The Eastern Bentwing-bat has only been recorded at the site during some surveys. Given this species can be seasonal in its occupation of local environments during its regular movement patterns, it is thought that the inconsistent recording of this species may show the seasonality of the distribution at southern latitudes (Richards 1997a). Furthermore, it was noted that the escarpment to the west may provide suitable natural roosts and the wet sclerophyll vegetation adjacent to the escarpment, particularly in the nearby Macquarie Pass National Park, provides foraging habitat that would be more suitable for this species than the patchily distributed vegetation surrounding the Tallawarra Power Station (1997a).

Four calls of the Eastern Bentwing-bat were recorded during the April microbat survey within the Swamp Mahogany Woodland in the south east of the site. Potential foraging and roost habitat is present in this area although impacts from the proposal are not anticipated as the south east of the site will be conserved. Twenty three and forty seven calls of this species where recorded in each of the two anabats set during the November survey at the Yallah Bay Road site and the Duck Creek Bridge site respectively.

Eastern Freetail Bat

The Eastern Freetail Bat occurs in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range. This species roosts mainly in tree hollows but will also roost under bark or in man-made structures. Usually solitary but also recorded roosting communally, probably insectivorous (DECCW 2010b).

One definite call of the Eastern Freetail Bat was recorded in the south west of the study area along with one possible call of this species at the Barrons Gully site. This species is known to roost in hollows as well as under bark and in man-made structures and forages throughout a variety of vegetation types. Therefore the study area provides extensive areas of potential habitat for this species.

Yellow-bellied Sheathtail-bat

The Yellow-bellied Sheathtail-bat 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 lower in more open country (DECCW 2010b).

This species forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory. Breeding has been recorded from December to mid-March, when a single young is born (DECCW 2010b).

Seasonal movements are unknown; there is speculation about a migration to southern Australia in late summer and autumn (DECCW 2010b).

The Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) has been recorded amongst the scrub vegetation on the southern slope of Mt Brown (Richards 1997a). Potential habitat is present in areas of ASMF, LWMF, CGRGF and MBRGFF.

Large-footed Myotis

The Large-footed Myotis generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, stormwater channels, buildings, under bridges and in dense foliage. They forage over streams and pools catching insects and small fish by raking their feet across the water surface. In NSW females have one young each year usually in November or December (DECCW 2010b).

Surveys were conducted by Richards (1997b) in May 1997 to verify if the Large-footed Myotis was roosting on site. Three bats (two female and one male) were radio-tagged. Based on the results of the study, it was concluded that this species was not roosting on the site and was roosting in the nearby escarpment (Richards 1997b). It was also noted that Duck Creek appeared to be a favoured foraging site for this species and that preservation of this watercourse should be a priority (Richards 1997b). The current master plan is consistent with this recommendation.

In the surveys undertaken for this study the Large-footed Myotis was recorded frequently at the Duck Creek survey site (113 calls) as well as the Yallah Bay Road site (8 calls), the Swamp Mahogany Woodland in the south east of the site (2 possible calls) and one definite call recorded at the small artificial wetland in the south west of the site. These results indicate that the Duck Creek area remains heavily utilised by this species along with the various waterbodies and possibly bridges, culverts and hollow bearing trees providing other habitat elements.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Potential breeding habitat is present in the form of hollow-bearing trees, defoliating bark and culverts for the Eastern False Pipistrelle, Little Bentwing-bat, Eastern Bentwing-bat, Eastern Freetail Bat, Large-footed Myotis, Greater Broad-nosed Bat and the Yellow-bellied Sheathtail-bat. Caves are not present within the study area and therefore habitat for species such as the Large-eared Pied Bat which are dependant on caves for breeding is not present. Man-made structures including the Duck Creek Road bridge may however provide roosting sites for some of the threatened bats and although not noted during this study or in previous surveys (Richards 1997b) pre-construction surveys of these features is recommended.

The proposal will result in the removal of one hollow-bearing tree. Survey of this tree for microbats through visual observation and anabat recording was conducted in October however none of the threatened bat species were recorded.

Surveys for the Large-footed Myotis were undertaken across the study area in 1997 and it was concluded that this species was not roosting on site but was roosting in the nearby escarpment with Duck Creek being preferred habitat. Given the Duck Creek corridor will be conserved and mitigation

measures implemented to prevent indirect impacts on water quality and foraging resources, it is unlikely that the proposal would affect the lifecycle of this species.

All these bat species would forage widely across the site and the majority of the potential foraging habitat will be conserved. Therefore it is unlikely that the proposal would affect the lifecycle of any of these species.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal will result in the removal of 2.54 ha of LWMF, 0.54 ha of CGRGF, 0.38 ha of ISR and 0.2 ha of MBRGFF. No areas of ASMF will be removed. This comprises only a very small portion of key potential habitat for these species throughout the study area and an even smaller portion of potential habitat within the locality for these highly mobile species. Therefore the proposed habitat removal is unlikely to represent a significant proportion of potential habitat for these species

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Large-eared Pied Bat is found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW. There are scattered records from the New England Tablelands and North West Slopes (DECCW 2010b). This species is not at the limit of its known distribution at Tallawarra.

The Eastern False Pipistrelle is found on the south-east coast and ranges of Australia, from southern Queensland to Victoria and Tasmania (DECCW 2010b). This species is not at the limit of its known distribution at Tallawarra.

The Little Bentwing-bat occurs on the east coast and ranges of Australia from Cape York in Queensland to Wollongong in NSW (DECCW 2010b). This species is close to the limit of its known distribution at Tallawarra.

Eastern Bent-wing Bats occur along the east and north-west coasts of Australia (DECCW 2010b). This species is not at the limit of its known distribution at Tallawarra.

The Eastern Freetail-bat is found along the east coast from south Queensland to southern NSW (DECCW 2010b). This species is not at the limit of its known distribution at Tallawarra.

The Yellow-bellied Sheathtail-bat is a wide-ranging species found across northern and eastern Australia. In the most southerly part of its range - most of Victoria, south-western NSW and adjacent South Australia - it is a rare visitor in late summer and autumn. There are scattered records of this species across the New England Tablelands and North West Slopes (DECCW 2010b). This species is not at the limit of its known distribution at Tallawarra.

The Large-footed Myotis is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. It is rarely found more than 100 km inland, except along major rivers (DECCW 2010b). This species is not at the limit of its known distribution at Tallawarra.

How is the proposal likely to affect current disturbance regimes?

Fire has the potential to reduce habitat for these species. The greatest potential for accidental fires is likely to be during construction and maintenance works or arson. Therefore a number of preventative measures would need to be implemented to reduce the likelihood of accidental fires. Details of these measures are outlined in the mitigation section of this report and include the preparation of a Bushfire Management Plan.

The loss of hollow-bearing trees has been identified as a key threat many of these hollow-dependant species. One tree with a hollow suitable for use by microbat species will be impacted by the proposal. This tree was surveyed in October and found not to be being utilised by any of the threatened microbats relevant to this study. A number of other hollow-bearing trees are present within the study area, all of which will be conserved and would continue to provide potential habitat for the many bat species recorded across the study area.

Reduction in water quality is a threat to the Large-footed Myotis. If mitigation measures are not implemented there is the potential for excess runoff to enter areas of potential habitat for this species and water quality. Mitigation measures will be put in place to ensure runoff is trapped within the development area and prevented from entering waterbodies and riparian areas.

A VMP has been prepared for the site which addresses weed invasion throughout the study area and includes management of the current weed infestation within areas of potential habitat.

How is the proposal likely to affect habitat connectivity?

All of these species are highly mobile species. Habitat for these species is currently fragmented across the study area and it is unlikely that the proposal would increase fragmentation such that it would alter the use of the site or movement of these species across the site should they be present. Furthermore, these species will forage over a wide variety of habitat types.

Given that the Duck Creek corridor will be maintained and enhanced, habitat connectivity for all of the bats and in particular the Large-footed Myotis is anticipated.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for these species.

8.3.10 Grey-headed Flying-fox

The Grey-headed Flying-fox occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy (DECCW 2010b).

Individual camps may have tens of thousands of animals and are used for mating, birth and the rearing of young. Annual mating commences in January and a single young is born each October or November. Site fidelity to camps is high with some camps being used for over a century. They travel up to 50 km to forage (DECCW 2010b).

This species feeds on the nectar and pollen of native trees, in particular *Eucalyptus, Melaleuca* and *Banksia,* and fruits of rainforest trees and vines. They also forage in cultivated gardens and fruit crops and can inflict severe crop damage (DECCW 2010b).

The Grey-headed Flying-fox has also been recorded at the site and is likely to forage widely across the study area.

Threats to this species include:

- Loss of foraging habitat.
- Disturbance of roosting sites.
- Unregulated shooting.
- Electrocution on powerlines.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Potential foraging habitat for this species is present across most of the study area with the exception of wetlands areas. Given no camp sites for this species are present on site and that extensive areas of foraging habitat are present including winter foraging resources and these will remain on site following the proposed development, it is unlikely that the proposal would affect the lifecycle of this species.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal will result in the removal of 2.54 ha of LWMF, 0.38 ha of ISR, 0.54 ha of CGRGF, 0.2 ha of MBRGFF and 2.43 ha of planted natives and weeds. No ASMF will be removed. This comprises only a very small portion of potential habitat for this species throughout the study area (10.99%) and an even smaller portion of potential habitat within the locality for this highly mobile species. Therefore the proposed habitat removal is unlikely to represent a significant proportion of potential habitat for this species.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Grey-headed Flying-foxes are found within 200 km of the eastern coast of Australia, from Bundaberg in Queensland to Melbourne in Victoria (DECCW 2010b). This species is not at the limit of its known distribution at Tallawarra.

How is the proposal likely to affect current disturbance regimes?

Fire has the potential to reduce habitat for these species. The greatest potential for accidental fires is likely to be during construction and maintenance works or arson. Therefore a number of preventative measures would need to be implemented to reduce the likelihood of accidental fires. Details of these measures are outlined in the mitigation section of this report and include the preparation of a Bushfire Management Plan.

A VMP has been prepared for the site which addresses weed invasion throughout the study area and includes management of the current weed infestation within areas of potential habitat.

How is the proposal likely to affect habitat connectivity?

Habitat for this species is currently fragmented across the study area. However, it is unlikely that the proposal would increase fragmentation such that it would alter the use of the site or movement of this species across the site as it is highly mobile. Furthermore, this species will forage over a wide variety of habitat types.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for these species.

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