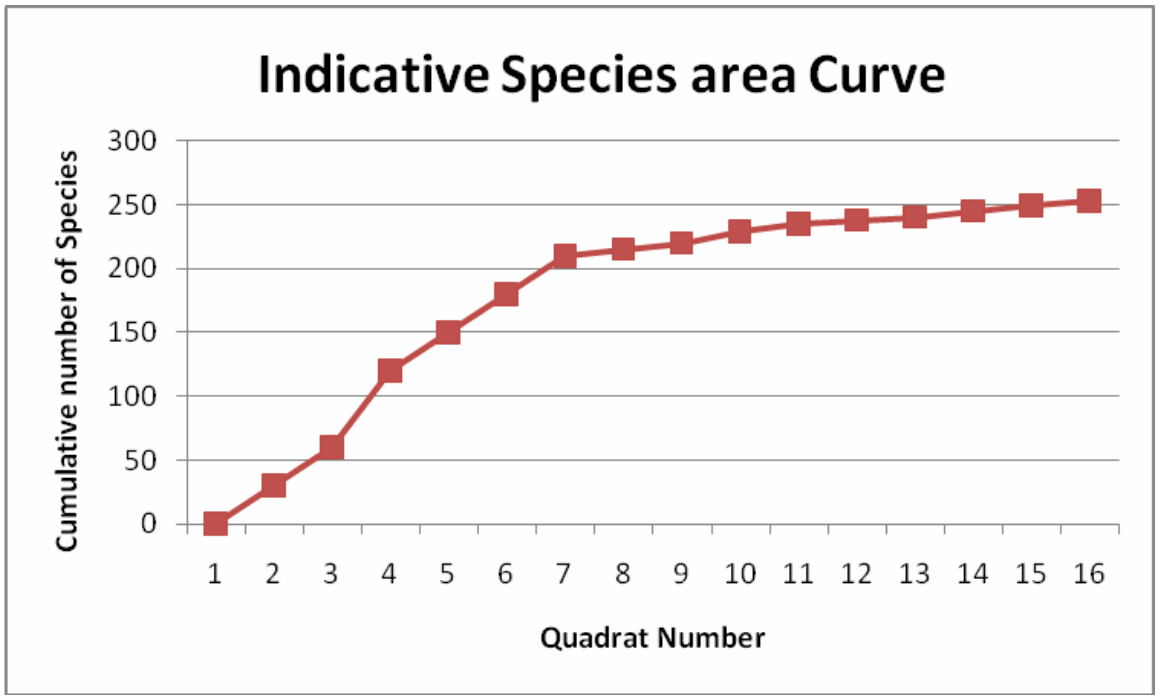


Figure 3-2: Indicative Species Area Curve for Gwandalan

The flowering period for Cryptostylis hunteriana is late November to early December and thus survey for this species was not performed. However, potential habitat for this species occurs in both the Development Estate and the offset lands of the site.

Several of the undescribed orchids (listed in Section 3.2.6) cannot be discounted as occurring within the Development Estate or the offset areas. The Gwandalan site has potential habitat for these undescribed orchid species and several of these orchids have been found within the vicinity of the site (Gunninah 2003) in similar habitats.

Fauna

Fauna survey effort varied according to the standards set within the DEC Biodiversity Survey Guidelines due to the following reasons:

- Seasonal constraints as outlined above.
- Diurnal Birds - Habitat assessment and previous records and reporting were used to determine the probability of site use. Bird census surveys outlined in Section 3.2.8 in combination with opportunistic surveys conducted during other fieldwork were considered as representing a wider and more thorough coverage of the site than short periods over limited transects. Survey coverage was determined by stratification units designed to represent other fauna guilds and flora surveys.
- Nocturnal Birds – Number of nights surveyed for nocturnal birds was less than required, as a consequence, assessment of development impact was based upon the mobility of local species, local records and habitat opportunities.
- Herpetofauna – Given the seasonal constraints, the majority of local frog species were torpid at the time of survey and hence results varied. Note: Surveys were conducted

during the optimal season for the threatened Wallum Froglet. The same seasonal limitations constrained the extent of reptile activity observed during fauna surveys.

Despite the apparent deficiencies, suitable coverage of the site is considered to have been accomplished, particularly as potential occurrences of likely species is assumed (precautionary approach) in light of habitat assessment, previous local records, seasonality deficiencies and the known movements of locally occurring threatened species.

4 Results

4.1 Flora

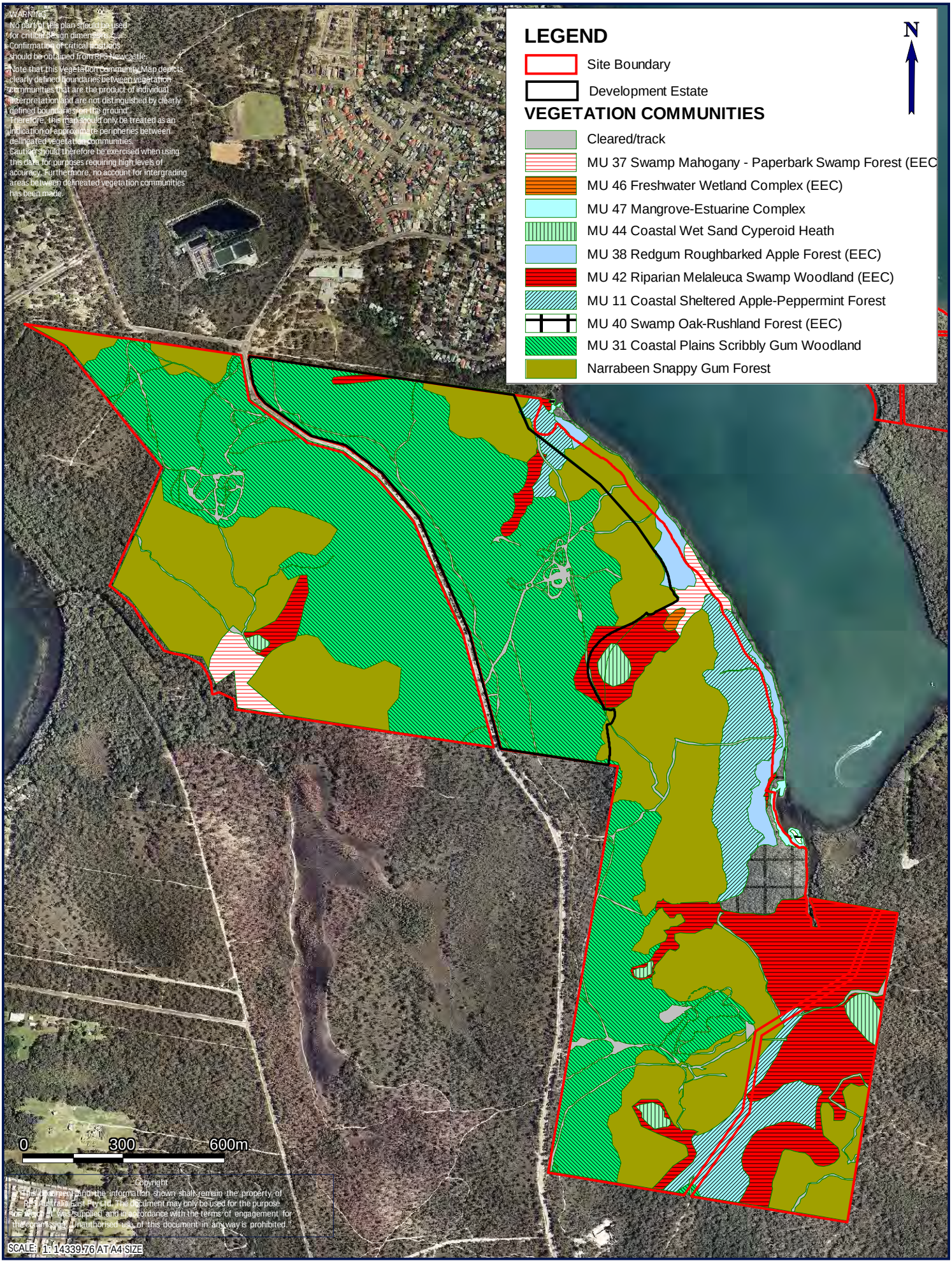
A total of 290 flora species were identified during the survey period over the Gwandalan site within the quadrats, transects and random meander surveys. Additional orchids have also been added which were detected during the targeted *Tetratheca juncea* surveys. A complete list of the flora species identified is provided in Appendix 2 of this report.

4.1.1 Description of Vegetation Communities

A description of each community and classification into both adopted regional vegetation classifications; being Lower Hunter and Central Coast Regional Environmental Management Strategy (LHCCREMS 2000; House 2003) and the Natural Vegetation of the Wyong Local Government Area (Bell 2002), is provided below.

Eleven vegetation communities have been delineated within the Gwandalan site (Figure 4-1) and listed below:-

1. Coastal Sheltered Apple – Peppermint Forest;
2. Coastal Plains Smooth-barked Apple Woodland;
3. Coastal Plains Scribbly Gum Woodland;
4. Narrabeen Snappy Gum Forest;
5. **Redgum Roughbarked Apple Forest (EEC – River Flat Eucalypt Forest on Coastal Floodplains); and**
6. **Swamp Oak Rushland Forest (EEC – Swamp Oak Floodplain Forest);**
7. **Swamp Mahogany - Paperbark Forest (EEC – Swamp Sclerophyll Forest on Coastal Floodplains);**
8. **Riparian Melaleuca Swamp Woodland (EEC - Swamp Sclerophyll Forest on Coastal Floodplains);**
9. Coastal Wet Cyperoid Heath;
10. **Freshwater Wetland Complex (EEC – Freshwater Wetlands on Coastal Floodplains); and**
11. Mangrove Estuarine Complex (Protected under the *Fisheries Management Act 1994*).



TITLE: FIGURE 4-1 VEGETATION MAP

LOCATION: GWANDALAN

DATUM: DATUM
PROJECTION: MGA ZONE 56 (GDA 94)

DATE: 23/3/2010
PURPOSE: EAR

LAYOUT REF: 24530\DRAFT\ECO\SOUTH\ALL 2010\FIG 4-1 VEG MAP 2010
VERSION (PLAN BY): A (A.P-M.D)

CLIENT: COAL & ALLIED INDUSTRIES LTD
JOB REF: 24530-1

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
241 DENISON STREET BROADMEADOW PO BOX 428 HAMILTON NSW 2303
T: 02 4940 4200 F: 02 4961 6794 www.rpsgroup.com.au

RPS

1 Coastal Sheltered Apple – Peppermint Forest

This vegetation community occurs in the eastern and south-eastern portions of the site and encompasses 16.18ha. This vegetation community is commensurate with MU 29 – Narrabeen Coastal Sheltered Peppermint-Apple Forest as described by the Natural Vegetation of the Wyong Local Government Area (Bell, 2002) and MU 11 Coastal Sheltered Apple – Peppermint Forest as described by LHCCREMS (NPWS 2000; House 2003). The threatened flora species *Tetratheca juncea* was identified to occur within this vegetation community.

Upper Stratum – to 20 m with a PFC of 30% to 50%, the dominant species being *Angophora cost*ata (Smooth-barked Apple), *Eucalyptus piperita* (Sydney Peppermint), *Eucalyptus umbra subsp*. *umbra* (Broad-leaved Mahogany), *Eucalyptus resinifera* (Red Mahogany) and occasionally *Eucalyptus tereticornis* (Forest Redgum) and *Angophora floribunda* (Rough-barked Apple).

Mid Stratum – 2 to 8 m with a PFC 10% to 40%, the dominant species being *Allocasuarina torulosa* (Forest She-oak), *Glochidion ferdinandi* (Cheese Tree), *Pultenaea villosa*, *Breynia oblongifolia* (Coffee Bush) and *Acacia longifolia* (Sydney Golden Wattle).

Lower Stratum – to 1.5m with a PFC 70% to 90%, the dominant species being *Gahnia clarkei* (Tall Saw-sedge), *Oplismenus aemulus* (Basket Grass), *Kennedia rubicunda* (Dusky Coral Pea), *Hardenbergia violacea* (Native Sarsaparilla), *Themeda australis* (Kangaroo Grass), *Entolasia stricta* (Wiry Panic), *Imperata cylindrica var*. *major* (Blady Grass) and *Digitaria parviflora* (Small-flowered Finger Grass).

2 Coastal Plains Smooth-barked Apple Woodland

This vegetation community occurs within the conservation lands, adjoining the Riparian Melaleuca Swamp Woodland and as a small section in the south eastern portion of the site. This vegetation community encompasses 10.03ha and is not commensurate with any vegetation communities described by the Natural Vegetation of the Wyong Local Government Area (Bell, 2002) however; this community is commensurate with MU 30 Coastal Plains Smooth-barked Apple Woodland as described by LHCCREMS (NPWS 2000; House 2003). The threatened flora species Tetratheca juncea was identified to occur within this vegetation community

Upper Stratum – 15 to 20 m with a PFC of 20% to 40%, the dominant species being *Angophora costata* (Smooth-barked Apple), *Corymbia gummifera* (Red Bloodwood), *Eucalyptus capitellata* (Brown Stringybark) and occasionally *Eucalyptus signata* (Scribbly Gum).

Mid Stratum 1 – to 5 m with a PFC 10%, the dominant species being *Allocasuarina littoralis* (Black She-oak), juvenile *Eucalyptus capitellata* (Brown Stringybark), and *Corymbia gummifera* (Red Bloodwood).

Mid Stratum 2 – to 2 m with a PFC 10% to 20%, the dominant species being *Dillwynia retorta* (Eggs and Bacon), *Daviesia ulicifolia* (Gorse Bitter Pea), *Persoonia linearis* (Narrow-leaved Geebung) and *Acacia myrtifolia* (Myrtle Wattle).

Lower Stratum – to 1.5m with a PFC 40% to 60%, the dominant species being *Lepidosperma laterale*, *Xanthorrhoea latifolia* (Forest Grass Tree), *Poa labillardieri var*. *labillardieri* (Tussock Grass), *Themeda australis* (Kangaroo Grass), *Entolasia stricta* (Wiry Panic), and *Ptilothrix deusta*.

3 Coastal Plains Scribbly Gum Woodland

This vegetation community dominates the Gwandalan site and covers approximately 199.8 ha. This vegetation community is commensurate with MU 31 – Narrabeen Doyalson Coastal Woodland (including variant b) as described by the Natural Vegetation of the Wyong Local Government Area (Bell, 2002) and MU 31 Coastal Plains Scribbly Gum Woodland as described by LHCCREMS (NPWS 2000; House 2003). The understorey varies within this community from a grassy understorey on the upper slopes to a dense heath in the sheltered areas. The canopy layer also varies from woodland to open forest on the lower slopes. The two threatened species *Angophora inopina* and *Tetratheca juncea* were identified within this community.

Upper Stratum – to 15 m with a Projected Foliage Cover (PFC) of 10% to 20%, the dominant species being *Eucalyptus haemastoma* (Scribbly Gum), *Corymbia gummifera* (Red Bloodwood), *Eucalyptus capitellata* (Brown Stringybark) and occasionally *Angophora costata* (Smooth-barked Apple).

Mid Stratum 1 – 2 to 4 m with a PFC 5%, the dominant species being *Allocasuarina littoralis* (Black She-oak), juvenile *Eucalyptus haemastoma* (Scribbly Gum) and *Corymbia gummifera* (Red Bloodwood).

Mid Stratum 2 – 1 to 2 m with a PFC 30% to 40%, the dominant species being *Banksia spinulosa subsp. collina* (Hair-pin Banksia), *Banksia oblongifolia, Leptospermum polygalifolium* (Lemon-scented Tea-tree), *Hakea dactyloides*, *Persoonia levis* (Broad-leaved Geebung), *Lambertia formosa* (Mountain Devil), *Lomatia silaifolia* (Crinkle Bush) and *Isopogon anemonifolius* (Drumsticks).

Lower Stratum – to 1.5m with a PFC 80% to 90%, the dominant species being *Epacris pulchella* (NSW Coral Heath), *Patersonia sericea* (Purple Flag Flower), *Ptilothrix deusta*, *Lomandra obliqua* (Fishbones), *Xanthorrhoea latifolia subsp*. *latifolia* (Forest Grass Tree), *Cassytha glabella* (Common Devil's Twine), *Themeda australis* (Kangaroo Grass) and *Entolasia stricta* (Wiry Panic),

4 Narrabeen Snappy Gum Forest

This community occurs patchily across the mid-slopes and ridges of the site where it covers an area of approximately 87.13ha. This vegetation community is commensurate with MU 32 'Narrabeen Snappy Gum Forest' as described in 'The natural vegetation of the

Wyong Local Government Area, Central Coast, NSW' (Bell 2002). The most consistently dominant components of the canopy layer are *Eucalyptus ramosa* (Snappy Gum), *Angophora costata* (Smooth-barked Apple) and *Corymbia gummifera* (Red Bloodwood), but there are areas where *E. resinifera* (Red Mahogany) and / or *E. piperita* occur as co-dominant species. The community contains an upper mid-storey of juvenile *eucalypts* and *Allocasuarina littoralis* (Black She Oak), which often forms relatively dense stands. The lower mid storey is characterised by a moderate diversity of shrubs, including, *Dillwynia retorta* (Heathy Parrot Pea), *Persoonia levis* (Smooth Geebung), *Acacia myrtifolia* (Myrtle Wattle), *Oxylobium scandens* with *Banksia spinulosa* and conspicuous understorey species. Ground cover layers are composed of native grass species with *Themeda australis* (Kangaroo Grass) most abundant. *Xanthorrhoea latifolia* (Grass Tree) occurs widely within the ground cover layer. Where it abuts other bordering vegetation communities the community shows influences in the understorey and canopy layers with a mixing of *E. haemastoma* and *Banksia oblongifolia* from up slope influences and *E. piperita* at the confluences with lower slope communities.

Upper Stratum –15 to 20 m with a PFC varying between 25% to 50%, the dominant species being *Eucalyptus ramosa* (Snappy Gum), *Angophora costata* (Smooth-barked Apple) and *Corymbia gummifera* (Red Bloodwood), with *E. resinifera* (Red Mahogany), *E. capitellata* (Brown Stringybark) and / or *E. piperita* occurring spasmodically as co-dominant species.

Mid Stratum 1 –4 to 6 m with a PFC of 10% to 30%, the dominant species being *Allocasuarina littoralis* (Black She Oak) and juvenile *Eucalyptus* species.

Mid Stratum 2 – to 2 m with a PFC to 10 to 20%, the dominant species being *Banksia spinulosa* (Hairpin Banksia), *Dillwynia retorta* (Heathy Parrot Pea), *Acacia myrtifolia* (Myrtle Wattle), *Persoonia levis* (Smooth Geebung), *Mirabella rubicunda*, and *Oxylobium scandens*.

Lower Stratum – to 1 m with a PFC of 70% to 80%, the dominant species being *Xanthorrhoea latifolia* (Grass Tree), *Themeda australis* (Kangaroo Grass), *Entolasia stricta* (Wiry Panic) and *Lomandra obliqua* (Fish Bones).

5 Redgum Roughbarked Apple Forest (EEC – River Flat Eucalypt Forest)

This community occurs on foreshore flats within the Gwandalan site and covers an area of approximately 3.96ha. This vegetation community is commensurate with LHCCREMS MU 38 'Redgum Rough-barked Apple Swamp Forest' and with the alluvial variant of Narrabeen Foreshore Redgum-Ironbark Forest as described in 'The natural vegetation of the Wyong Local Government Area, Central Coast, NSW' (Bell, 2002). The community is characterised by *Eucalyptus tereticornis* and *Angophora floribunda* in the canopy stratum. This community does not occur within inundated lowland areas, but upon narrow linear lakeside benches perched above the direct influence of estuarine and freshwater communities. The immediate edges of the lake are colonised by a narrow band of *Casuarina glauca*, with *E. tereticornis* occurring immediately behind this band, often within a couple of metres of the lake's edge. The inland edge of the community abuts Coastal

Sheltered Apple – Peppermint Forest with Angophora floribunda mixing with this community to form an ecotonal edge between the respective canopies. Understorey strata in the majority of cases within the site are degraded by the presence of weed species, unformed tracks, rubbish dumping and in some cases evidence of unauthorised camping.

Upper Stratum –15 to 20 m with a PFC of 30% to 40%, the dominant species being *Eucalyptus tereticornis*(Forest Red Gum) and *Angophora floribunda* (Rough-barked Apple).

Mid Stratum 1 – 3 to 5 m with a PFC of 10% to 15%, the dominant species *Glochidion ferdinandi* (Cheese Tree).

Mid Stratum 2 – 1 to 3 m with a PFC to 40 – 60%, the dominant species being, *Acacia longifolia var*. *sophorae* (Sydney Golden Wattle), *Chrysanthemoides monilifera ssp*. *rotunda* (Bitou Bush), *Dodonaea triquetra* (Common Hop Bush), *Lantana camara* (Lantana), *Gahnia Clarkei* (Tall Saw Sedge) and *Breynia oblongifolia* (Coffee Bush.

Lower Stratum – to 1 m with a PFC of 70% to 90%, the dominant species being *Stenotaphrum secundatum* (Buffalo Grass), *Pteridium esculentum* (Bracken Fern), *Imperata cylindrica var*. *major* (Blady Grass), *Oplismenus aemulus* (Basket Grass), *Dichondra repens* (Kidney Weed), *Goodenia ovata* (Hop Goodenia), *Dianella caerulea ssp*. *producta* (Blue Flax Lily), *Echinopogan caespitosus* (Hedgehog Grass), *Eragrostis tenuifolia* (Elastic Grass), *Rubus parviflorus* (Native Raspberry), *Digitaria parviflora* (Smallflower Fingergrass), *Cassytha glabella* (Devil's Twine), *Stephania japonica* (Snake Vine), *Parsonsia straminea* (Monkey Rope), *Kennedia rubicunda* (Dusky Coral Pea) and *Cayratia clematidea* (Slender Grape).

6 Swamp Oak Rushland Forest (EEC – Swamp Oak Floodplain Forest)

This vegetation community occurs along the foreshore of Lake Macquarie and within the estuarine inlet of Mangrove Gully in the south-eastern portion of the site. Within Mangrove Gully this community has a mixture of a diverse canopy layer with *Melaleuca quinquenervia* (Broad-leafed Paperbark) and *Eucalyptus robusta* (Swamp Mahogany) present in small numbers. This vegetation community covers approximately 6.17ha and is commensurate with MU 3 – Estuarine Swamp Oak Forest as described by the Natural Vegetation of the Wyong Local Government Area (Bell, 2002) and MU 40 Swamp Oak Sedge Forest as described by LHCCREMS (NPWS 2000; House 2003).

Upper Stratum – to 10 m with a PFC of 20% to 40%, the dominant species being *Casuarina glauca* (Swamp Oak), *Eucalyptus tereticornis* (Forest Redgum) and *Avicenna marina* (Grey Mangrove).

Mid Stratum – to 6m with a PFC 20% to 50%, the dominant species being *Chrysanthemoides monilifera subsp*. *rotundata* (Bitou Bush), *Suaeda australis* (Austral Seabite) and *Acacia longifolia var*. *sophorae* (Coastal Wattle).

Lower Stratum – to 1m with a PFC 50% to 80%, the dominant species being *Juncus kraussii subsp*. *australiensis* (Sea Rush), *Isolepis nodosa*, *Baumea juncea* and *Sporobolus virginicus* (Sand Couch).

7 Swamp Mahogany - Paperbark Forest (EEC Swamp Sclerophyll Forest on Coastal Floodplains)

This vegetation community occurs in the more estuarine drainage lines, adjoining the Riparian Melaleuca Swamp Woodland vegetation community. These drainage lines include the tributary of Tiembula Creek in the south-western portion of the site, Strangers Gully which flows in a north easterly direction into Lake Macquarie and the lower reaches of Mangrove Gully in the site's southeast. This vegetation community encompasses 4.14ha and is commensurate with MU 10 – Coastal Sand Mahogany – Paperbark Forest as described by the Natural Vegetation of the Wyong Local Government Area (Bell, 2002) and MU 37 Swamp Mahogany – Paperbark Forest as described by LHCCREMS (NPWS 2000; House 2003).

Upper Stratum – 18 m to 20 m with a Projected Foliage Cover (PFC) of 40% to 50%, the dominant species being *Eucalyptus robusta* (Swamp Mahogany), *Melaleuca quinquinervia* (Broad-leafed Paperbark) and occasionally *Eucalyptus resinifera* (Red Mahogany).

Mid Stratum – 6 m to 8m with a PFC of 10% to 20%, the dominant species being *Melaleuca linearifolia* (Snow-in Summer), *Melaleuca sieberi* (Sieber's Paperbark), *Melaleuca nodosa* (Ball Honeymyrtle), *Acacia longifolia* (Sydney Golden Wattle), *Livistonia australis* (Cabbage Tree Palm) and *Glochidion ferdinandi* (Cheese Tree).

Lower Stratum – to 1.5m with a PFC of 80% to 90%, the dominant species being *Gahnia clarkei* (Tall Saw Sedge), *Centella asiatica* (Pennywort), *Blechnum nudum*, *Oplismenus aemulus* (Basket Grass), *Calochlaena dubia* (False Bracken) and *Hemarthria uncinata* (Matt Grass).

8 Riparian Melaleuca Swamp Woodland (EEC - Swamp Sclerophyll Forest on Coastal Floodplains)

This vegetation community occurs in drainage lines, often surrounding the Coastal Wet Sand Cyperoid Heath vegetation community. These drainage lines include the tributary of Tiembula Creek in the south-western portion of the site and the three drainage lines, which flow in a north easterly direction into Lake Macquarie. This vegetation community covers approximately 32.36 ha and is not commensurate with any vegetation community described by the Natural Vegetation of the Wyong Local Government Area (Bell, 2002). However this community is commensurate with MU 42 and 42a Riparian Melaleuca Swamp Woodland as described by LHCCREMS (NPWS 2000; House 2003). This vegetation community is variable due to the estuarine influences, which are proportional to the degree of inundation from Lake Macquarie. The threatened frog species *Crinia tinnula* (Wallum Froglet) was heard calling from this vegetation community.

Upper Stratum – 15 m to 18 m with a Projected Foliage Cover (PFC) of 30% to 40%, the dominant species being *Melaleuca sieberi* (Sieber's Paperbark), *Eucalyptus resinifera* (Red Mahogany), *Eucalyptus robusta* (Swamp Mahogany) and occasionally *Angophora costata* (Smooth-barked Apple).

Mid Stratum – 4m to 8m with a PFC to 10%, the dominant species being *Melaleuca linearifolia* (Snow-in Summer), *Melaleuca thymifolia* (Thyme Honey-myrtle) *Melaleuca nodosa* (Ball Honeymyrtle), *Callistemon citrinus* (Crimson Bottlebrush), *Banksia robur* (Swamp Banksia) and *Glochidion ferdinandi* (Cheese Tree).

Lower Stratum – to 1.5m with a PFC of 70% to 90%, the dominant species being *Gahnia clarkei* (Tall Saw Sedge), *Gonocarpus micranthus ssp*. *ramosissimus*, *Empodisma minus* (Spreading Rope Rush), *Blechnum nudum*, *Oplismenus aemulus* (Basket Grass), *Calochlaena dubia* (False Bracken) and *Hemarthria uncinata* (Matt Grass).

9 Coastal Wet Sand Cyperoid Heath

This vegetation community occurs within alluvial soils of the Wyong group on Narrabeen Sandstone within the drainage depressions in the lower elevations of the site and encompasses 2.75ha. This vegetation community is commensurate with MU 22 – Narrabeen Coastal Alluvial Sedgeland as described by the Natural Vegetation of the Wyong Local Government Area (Bell, 2002) and MU 44 Coastal Wet Cyperoid Heath as described by LHCCREMS (NPWS 2000; House 2003).

Mid Stratum – 2 to 5m with a PFC to 10%, the dominant species being *Eucalyptus robusta* (Swamp Mahogany) and *Melaleuca sieberi* (Sieber's Paperbark).

Lower Stratum – to 2m with a PFC of 80% to 100%, the dominant species being *Jacksonia scoparia* (Dogwood), *Leptospermum juniperinum*, *Melaleuca thymifolia*, *Hakea teretifolia* (Dagger Hakea), *Gonocarpus micranthus ssp*. *ramosissimus*, *Sphaerolobium vimineum*, *Lepyrodia scariosa*, *Leptocarpus tenax* and *Xanthorrhoea minor subsp*. *minor*.

10 Freshwater Wetland Complex (EEC – Freshwater Wetlands on Coastal Floodplains)

This vegetation community occurs within the lower lying area of Strangers Gully in the centre of the site. This community was floristically diverse with native flora and provides habitat for a range of native flora and fauna. This vegetation community covers approximately 0.27ha and is commensurate with MU 14 Freshwater Wetlands as described by the Natural Vegetation of the Wyong Local Government Area (Bell, 2002). This community is also commensurate with MU 46 Freshwater Wetland Complex as described by LHCCREMS (NPWS 2000; House 2003). The threatened frog species *Crinia tinnula* (Wallum Froglet) was heard calling from this vegetation community.

Upper Stratum – to 15 m with a Projected Foliage Cover (PFC) of 5%, the dominant species being *Eucalyptus robusta* (Swamp Mahogany), *Melaleuca linearifolia* (Snow in Summer), *Melaleuca styphelioides* (Prickly-leaved Melaleuca) and *Melaleuca sieberi* (Sieber's Paperbark).

Mid Stratum – to 2 m with a PFC 30% to 40%, the dominant species being *Acacia elongata* (Swamp Acacia), *Banksia robur* (Swamp Banksia), *Callistemon citrinus* (Crimson Bottlebrush), *Leptospermum juniperinum* (Prickly Tea-tree) and *Gahnia clarkei* (Tall Saw Sedge).

Lower Stratum – to 1.5m with a PFC 20% to 30%, the dominant species being *Baloskion tetraphyllus ssp*. *meiostachyum* (Tassel Cord Rush), *Hemarthria uncinata* (Mat Grass), *Blechnum indicum*, *Entolasia marginata* (Bordered Panic), *Gonocarpus micranthus subsp*. *ramosissimus*, *Lepyrodia scariosa*, *Baumea rubiginosa* and *Leptocarpus tenax*.

Emergents – to 1.0 m with a PFC to 40%, the dominant species being *Baumea articulata* (Jointed Twig-rush).

11 Mangrove Estuarine Complex

This vegetation community occurs along the foreshore of Lake Macquarie within the site. This vegetation community covers approximately 0.48ha and is commensurate with MU 2 – Estuarine Mangrove-Saltmarsh Complex as described by the Natural Vegetation of the Wyong Local Government Area (Bell, 2002) and MU 47 Mangrove Estuarine Complex as described by LHCCREMS (NPWS 2000; House 2003).

Upper stratum – 4m to 5 m. with a PFC to 80%, with no mid-storey. The dominant species was *Avicennia marina* (Grey Mangrove) and occasionally *Casuarina glauca* (Swamp Oak).

Lower Stratum – to 1m with a PFC to 50% to 80%, the dominant species being *Juncus kraussii subsp*. *australiensis* and *Baumea juncea*.

4.1.2 Conservation Status of Vegetation Communities

SEPP 14 Wetland No. 890 is present within the estuarine area of Mangrove Gully, and encompasses part of the Mangrove Estuarine Complex and Swamp Oak Rushland Forest vegetation communities within the Gwandalan site.

Three EEC's that are listed under the TSC Act 1995 occur within four delineated vegetation communities extent on the Gwandalan site. These three communities are listed below:

- Freshwater Wetland Complex is commensurate with 'Freshwater Wetlands on Coastal Floodplains in the NSW North Coast, Sydney Basin and South East corner Bioregions';

- The vegetation community delineated as Swamp Oak Rushland Forest is commensurate with 'Swamp Oak Floodplain Forest in the NSW North Coast, Sydney Basin and South East Corner Bio-regions'; and
- The vegetation communities delineated as Swamp Mahogany - Paperbark Forest and Riparian Melaleuca Swamp Woodland are both commensurate with 'Swamp Sclerophyll Forest on Coastal Floodplains in the NSW North Coast, Sydney Basin and South East Corner Bio-regions'.

The Mangrove Estuarine Complex vegetation community present on site is protected under the Fisheries Management Act 1994.

4.1.3 Regionally Significant Vegetation Communities within Wyong LGA

The following vegetation communities, which occur within the site, are considered to be regionally significant by Bell (2002) within the Wyong LGA:

- Narrabeen Coastal Alluvial Sedgeland (Wet Cyperoid Heath)
- Narrabeen Coastal Sheltered Peppermint – Apple Forest (Coastal Plains Peppermint Apple Forest)
- Coastal Sheltered Apple – Peppermint Forest;
- Narrabeen Snappy Gum Forest; and
- Coastal Plains Scribbly Gum Woodland.

4.1.4 Regionally Significant Flora Species

No ROTAP listed species (Briggs and Leigh, 1996) were identified within the Gwandalan site. However, Bell (2002) contains a list of regionally significant flora species and 21 of these were identified within the site, and are listed as follows:

- ***Angophora inopina*** **(listed under TSC Act)**
- *Asplenium aethiopicum*
- *Astroloma humifusum*
- *Avicenna marina* subsp. *australasica*
- *Bossiaea rhombifolia*
- *Chloanthes stoechadis*
- *Cyathea australis*
- *Cyathea cooperi*
- *Cyperus difformis*
- *Geranium solanderi* var. *solanderi*
- *Grevillea speciosa*
- *Lissanthe strigosa*
- *Melaleuca hypericifolia*

- *Oxalis perennans*
- *Pterostylis nutans*
- *Pultenaea daphnoides*
- *Schizaea dichotoma*
- *Senecio linearifolius*
- *Sporobolus creber*
- ***Tetratheca juncea*** **(listed on TSC Act)**
- *Xanthorrhoea minor* subsp. *minor*.

Melaleuca hypericifolia was located within a drainage line within the Coastal Plains Scribbly Gum Woodland vegetation community and could represent a northerly extent of its range, as this species is generally restricted to the Sydney area and to the south (Harden, 2002). However, this species was in low numbers and could possibly represent a garden escapee.

The Wyong Shire Council Survey Guidelines have a list of keystone species that are functionally important links in the wildlife food chain. These guidelines also list flora species of local conservation significance within the Wyong LGA. The following Table 4-1 lists these species and the vegetation communities in which they occur within the Gwandalan Site.

Table 4-1: Local Significant and Keystone Species recorded within the site

Species	Locally Significant	Keystone Species	Vegetation Community
Allocasuarina torulosa (Forest Oak)	No	Yes	2, 5 & 6
Angophora costata (Smooth-barked Apple)	No	Yes	2, 3, 5, 6 & 9
Banksia sp.	No	Yes	2, 3, 5, 6, 7 & 8
Casuarina glauca (Swamp Oak)	No	Yes	4, 5 & 6
Corymbia gummifera (Red Bloodwood)	No	Yes	1, 2 & 3
Eucalyptus haemastoma (Scribbly Gum)	No	Yes	3
Eucalyptus piperita (Sydney Peppermint)	No	Yes	2, 3 & 6
Eucalyptus resinifera (Red Mahogany)	No	Yes	1, 2, 5 & 6
Eucalyptus robusta (Swamp Mahogany)	Yes	Yes	2, 4, 5, 6 & 7
Eucalyptus tereticornis (Forest Redgum)	No	Yes	2 & 4
Hakea bakerana	Yes	No	3
Melaleuca quinquenervia (Broad-leaved Paperbark)	No	Yes	4, 5, 6 & 8

4.1.5 Desktop Assessment – Threatened Flora Search Results

The results of this search indicated numerous threatened flora species have been previously recorded within the locality and/ or have potential habitat within the site. The following have been recorded within 10km (DECCW Wildlife Atlas 2010) of the site:

- *Acacia bynoeana*
- *Angophora inopina* (Charmhaven Apple)

- *Caladenia tessellata* (Thick Lip Spider Orchid)
- *Callistemon linearifolius* (Netted Bottle Brush)
- *Chamaesyse psammogeton* (Sand Spurge)
- *Corybas dowlingii* (Red Helmet Orchid)
- *Cynanchum elegans* (White-flowered Cynanchum)
- *Cryptostylis hunteriana* (Leafless Tongue Orchid)
- *Dendrobium melaleucaphilum* (Spider Orchid)
- *Diuris praecox* (Rough Double Tail)
- *Eucalyptus camfieldii* (Camfield's Stringybark)
- *Eucalyptus parramattensis subsp. decadens* (Drooping Red Gum)
- *Genoplesium insignis* (Variable Midge Orchid)
- *Grevillea parviflora ssp parviflora* (Little-flower Grevillea)
- *Melaleuca biconvexa*
- *Pultenaea maritima* (Coastal Headland Pea)
- *Rutidosis heterogama* (Heath Wrinklewort)
- *Syzygium paniculatum* (Magenta Lilly Pilly)
- *Tetratheca glandulosa*
- *Tetratheca juncea* (Black-eyed Susan)

Eucalyptus parramattensis subsp*. decadens* (Drooping Red Gum) and *Rutidosis heterogama* (Heath Wrinklewort) do not have potential habitat within the Gwandalan site and therefore have not been assessed further within this report.

In addition, to the above threatened flora species recorded on the DECCW Wildlife Atlas, it was considered the following species had potential habitat within the site and should be considered within this assessment:

- *Caladenia porphyrea*
- *Microtis angusii* (Angus's Onion Orchid)

Threatened Flora Species with potential to occur

In summary 15 threatened flora species have potential to occur on the Gwandalan Development Estate as listed below:

- *Acacia bynoeana* – Potential habitat within Coastal Plains Scribbly Gum Woodland within the site. Identified within the Lake Macquarie State Conservation Area to the south of the site;
- *Angophora inopina* – Potential habitat within Coastal Plains Scribbly Gum Woodland within the site. Identified within the Lake Macquarie SRA to the south of the site;

- *Caladenia tessellata* – Potential habitat within the Coastal Plains Scribbly Gum Woodland within the site. Recorded within Munmorah State Conservation Area to the south of the site;
- *Caladenia porphyrea* - potential habitat within the Coastal Plains Scribbly Gum Woodland, Narrabeen Snappy Gum Forest and Coastal Sheltered Apple-Peppermint Forest vegetation communities;
- *Callistemon linearifolius* – Potential habitat within the Melaleuca Riparian Swamp Woodland within the site. Recorded within the region to the north of Catherine Hill Bay;
- *Cryptostylis hunteriana* – Highly cryptic orchid found in flat plains in coastal areas, good potential habitat is present within the Coastal Plains Scribbly Gum Woodland;
- *Diuris praecox* – cryptic orchid with potential habitat within the Coastal Sheltered Apple – Peppermint Forest and Coastal Plains Smooth-barked Apple Woodland vegetation communities;
- *Dendrobium melaleucaphilum* – Epiphytic Orchid most often found in *Melaleuca styphelioides* (this Melaleuca was not common within the site) in Coastal Swamps and Rainforests, potential habitat in swampy areas of the site particularly the Riparian Melaleuca Swamp Woodland;
- *Eucalyptus camfieldii* – Potential habitat within Coastal Plains Scribbly Gum Woodland. Identified to the south west of the site on NPWS database Atlas records;
- *Genoplesium insignis* – High probability of this species occurring within the Coastal Plains Scribbly Gum Woodland. This species has been located within Lake Macquarie SRA adjoining the south of the site;
- *Melaleuca biconvexa* – Potential habitat within the Swamp Forests of the site. However, closest record is approximately 16 km to the south of the site;
- *Microtis angusii* – A tentative identification of this species within Lake Macquarie SRA however, potential habitat exists within the Coastal Plains Scribbly Gum Woodland;
- *Syzygium paniculatum* – Recorded to the north of Cams Wharf by DECCW database. Potential habitat in the riparian zones within the site;
- *Tetratheca glandulosa* - this species has habitat within the Coastal Plains Smooth-barked Apple Woodland, Coastal Sheltered Apple – Peppermint Forest, Coastal Plains Scribbly Gum Woodland and Narrabeen Snappy Gum Forest.; and
- *Tetratheca juncea* – Shrub mostly found on south facing slopes, this species has habitat within the Coastal Plains Smooth-barked Apple Woodland and Coastal Plains Scribbly Gum Woodland.

4.1.6 Threatened Cryptic Orchid Species

Following the precautionary approach, areas of vegetation communities that have been known to support these cryptic orchids have been included in calculations of potential habitat within the Gwandalan site.

Caladenia tessellate

Potential habitat for this species occurs within Coastal Plains Scribbly Gum Woodland, Coastal Sheltered Apple-Peppermint Forest and Narrabeen Snappy Gum Forest. Approximately 57.23 ha (26%) of potential habitat for this species will be removed within the Development Estate at Gwandalan. However, over 163.52 ha (74%) of habitat will be retained as part of the conservation lands at Gwandalan. Thus, whilst it cannot be determined if this species is present within the Development Estate without numerous return surveys over many years, as there are large tracks of habitat to be retained within the conservation lands it is unlikely that the proposal will have a significant impact upon this species.

Caladenia porphyrea

Potential habitat for this species occurs within the coastal habitats of Coastal Plains Scribbly Gum Woodland, Narrabeen Snappy Gum Forest and Coastal Sheltered Apple-Peppermint Forest. Approximately 57.23 ha (26%) of potential habitat for this species will be removed as part of the development proposal. However, over 163.52 ha (74%) of habitat for this species is being retained within the conservation lands. Therefore, it is considered unlikely that the proposal will have a significant impact upon this species.

Cryptostylis hunteriana

Potential habitat for this species occurs within the Gwandalan site. Potential habitat for this species occurs within Coastal Plains Scribbly Gum Woodland, Narrabeen Snappy Gum Forest and Coastal Sheltered Apple – Peppermint Forest. Approximately 57.23 ha (26%) of potential habitat for this species will be removed for proposal at Gwandalan. However, over 163.52 ha (74%) of potential habitat for this species will be retained within the conservation lands at Gwandalan. Therefore, it is considered unlikely that the proposal will have a significant impact upon this species.

Genoplesium insignis

Potential habitat for this species occurs within Coastal Plains Scribbly Gum Woodland and Narrabeen Snappy Gum Forest within the Gwandalan site. It is proposed to remove 56.37 ha (28%) of potential habitat for this species as part of the proposal at Gwandalan. However, over 144.87 ha (72%) of potential habitat for this species will be retained within the conservation lands at Gwandalan. Therefore, it is considered unlikely that the proposal will have a significant impact upon this species.

Microtis angusii

Potential habitat for this species occurs within Coastal Plains Scribbly Gum Woodland and Narrabeen Snappy Gum Forest within the Gwandalan site. It is proposed to remove 56.37 ha (28%) of potential habitat for this species as part of the proposal. However, over 144.87 ha (72%) of this potential habitat for this species will be retained within the conservation lands at Gwandalan. Therefore, it is considered unlikely that the proposal will have a significant impact upon this species.

4.1.7 Targeted Threatened Flora Species Survey Results

This section lists the results of the threatened flora surveys, a total of two threatened flora species were located within the site, being *Tetratheca juncea* and *Angophora inopina*. No other species were detected within the site.

Acacia bynoeana

Whilst this species was not located during any of the targeted surveys, it must be noted that high quality potential habitat was identified within the Coastal Plains Scribbly Gum Woodland within the Development Estate and the offset lands. Whilst targeted surveys were undertaken within the development lands, complete survey of the offset lands has not been completed and therefore, its presence or absence within the Gwandalan site cannot be discounted. Good quality habitat is also present within the offset lands to the west of Kanangra Drive and this area will be conserved as part of the proposed development.

Angophora inopina

A total of 3109 individual *Angophora inopina* trees were identified within the northern portion of the Gwandalan site. Of these, 2411 were within the offset lands and the remaining 698 were within the Development Estate. Of the 698, which are located within the development, estate 54 (0.02%) of the total population will be impacted upon by the development proposal. The remaining will be retained within the landscape buffer adjoining Kanangra Drive. This population has already been fragmented by Kanangra Drive and Figure 4-2 shows the point and area data of all the individuals located within the Gwandalan site.

Caladenia porphyrea

Targeted surveys were undertaken within the Development Estate during the September flowering season for this species, with no individuals being located. During surveys, the similar species *Caladenia carnea* was checked when it was encountered to ensure it was not *C. porphyrea*.

Cryptostylis hunteriana

This species was surveyed for within the 2007 flowering period using parallel searches in the Development Estate and no specimens were located. RPS found a small population of this species on the edge of Narrabeen Doyalson Coastal Woodland (Coastal Plains Scribbly Gum Woodland) on adjacent lands to the south of the Coal & Allied lands within the Catherine Hill Bay locality in November 2007. Thus, this species was known to be flowering in 2007 and targeted surveys were undertaken within the Gwandalan Development Estate in late November 2007, with no specimens located.

Diuris praecox

Targeted searches for *Diuris praecox* were conducted throughout the open forest areas of the Development Estate during the flowering period for this species. No individuals of this species were located during any of the targeted searches. However due to the cryptic nature of this species (i.e. does not flower every year) it cannot be discounted as occurring within the Gwandalan Site.

Genoplesium insignis

Targeted searches were undertaken within the Development Estate during the flowering period for this species with no individuals located.

Microtis angusii

Targeted searches were undertaken within the Development Estate during the flowering period for this species with no individuals located.

Tetratheca juncea

A total of 10,089 *Tetratheca juncea* plants were located during the targeted surveys within the Gwandalan site (Table 4-3 shows the distribution). Of these 6,591 will be retained within the conservation lands to the south and west of the Development Estate. Whilst, 3,498 (34%) are located within the Development Estate, it is likely that a further 226 individuals could be retained within the landscape areas of the Development Estate. Thus, it is considered that this population is significant due to the large size of the population and likely high content of genetic diversity. Other similar sized populations of 25,000 have been located within the Wallarah Peninsula by Conacher Travers (2007). Of these, over 9,900 have been conserved within Wallarah National Park, with more individuals to be retained within the bush parks within the Development Estate.

The work of Payne (2000) states that all sub-populations of 100 plants or more are of very high conservation significance within the Gwandalan area. However, at the time the whole population of *Tetratheca juncea* was estimated to be only 10,000. This figure is an underestimation of the entire population throughout its range, but due to the cryptic nature of this species and the lack of extensive surveys a conservative approach was taken. Further surveys since that time have increased the known numbers of this species and this is supported by the large numbers located on the Wallarah Peninsula alone.

The Wyong LGA constitutes the southern limit for this species; however the site is not at the southern most point of the distribution with records in the Wyong, Toukley, Doyalson and Wyee districts (DECCW database records, 2010). However it must be pointed out that this population is one of the largest on record within the Wyong LGA.

Some of the elements of the life-cycle of *Tetratheca juncea* have recently been discovered although much of the ecology is still unknown. However, as this species is an outcrosser (i.e. cannot self pollinate) and utilises buzz pollination (Gross et al., 2003; Driscoll 2003) this type of reproduction leads to low fruit set. Buzz pollinators are highly specialized and require specific habitat requirements and this has been hypothesised as one of the reasons for the species decline and fragmentation (Gross et al., 2003). As the population at Gwandalan is large and contains other species, which utilise buzz pollination (e.g.

Hibbertia sp. and *Dianella sp*.) it is considered that the habitat within the both the Development Estate and offset lands provides good quality habitat for the buzz pollinator of *Tetratheca juncea*. Thus, it is vital that conservation of good quality habitat for the pollinator is conserved to ensure sufficient seed is set to ensure the survival of this species. The populations located within the offset lands are densely spaced and may be more successful in attracting a pollinator than the population within the Development Estate.

In conclusion, it is estimated that the population within the Wallarah Peninsula is at least 49,000 to date (RPSHSO (2010a, 2010b) and Conacher Travers (2007) data combined).

Table 4-2 is a breakdown of the numbers of *Tetratheca juncea* currently within conservation lands that has been surveyed to date. This number is expected to be an underestimation as less than half of the habitat for this species has been surveyed at Catherine Hill Bay, and there are still some areas to be surveyed in the conservation lands at Gwandalan and Nords Wharf. In addition to these populations, Wildthing (2003) located further populations of *Tetratheca juncea* within Catherine Hill Bay and the land to the south of Nords Wharf. Thus whilst the population within the Development Estate is large, over 76% of the population within the Gwandalan site will be conserved within the conservation lands. Within the Wallarah Peninsula this will increase the current known conservation of *Tetratheca juncea* numbers from 10,225 (Conacher Travers 2007, Payne (2000)) to over 29,000. Thus the removal of 7% of the population from the Gwandalan site is unlikely to have a significant effect upon the population within the Wallarah peninsula. Such a large number of known plants protected in several disjunct but proximate conservation areas bodes well for the long term security of the species in this locality.

Table 4-2: Known Distribution of *Tetratheca juncea* within the Wallarah Peninsula within Conservation Reserves

Site at Wallarah Peninsula	Numbers of *Tetratheca juncea*
Wallarah National Park and Habitat Corridor at Murrays Beach*	9900
Munmorah State Conservation Area**	296
Lake Macquarie State Conservation Area**	29
Catherine Hill Bay Proposed Conservation Lands	7,596
Gwandalan Proposed Conservation Lands	8,222
Nords Wharf Proposed Conservation Lands	5,933
Total in Conservation Reserves at Wallarah Peninsula	**31,976**

* Data from Conacher Travers (2007)
** Data from Payne (2000)

Other Cryptic orchids

No other cryptic orchids were located during the targeted surveys. However habitat is present for a number of the undescribed and threatened orchids, which have been listed previously and are discussed below. Therefore, these species cannot be discounted as not occurring within the Development Estate; however approx 124 ha of habitat is present within the offset lands, which will be set aside for conservation.

WARNING
No part of this plan should be used for critical design dimensions. Confirmation of critical positions should be obtained from RPS Newcastle.

N

LEGEND

- Site Boundary
- Development Estate
- *Angophora inopina*
- *Area of Angophora inopina*

0 100 200m

SCALE: 1: 2300 AT A3 SIZE

TITLE: FIGURE 4-2 DISTRIBUTION OF *Angophora inopina*

LOCATION: GWANDALAN

DATUM: DATUM
PROJECTION: MGA ZONE 56 (GDA 94)

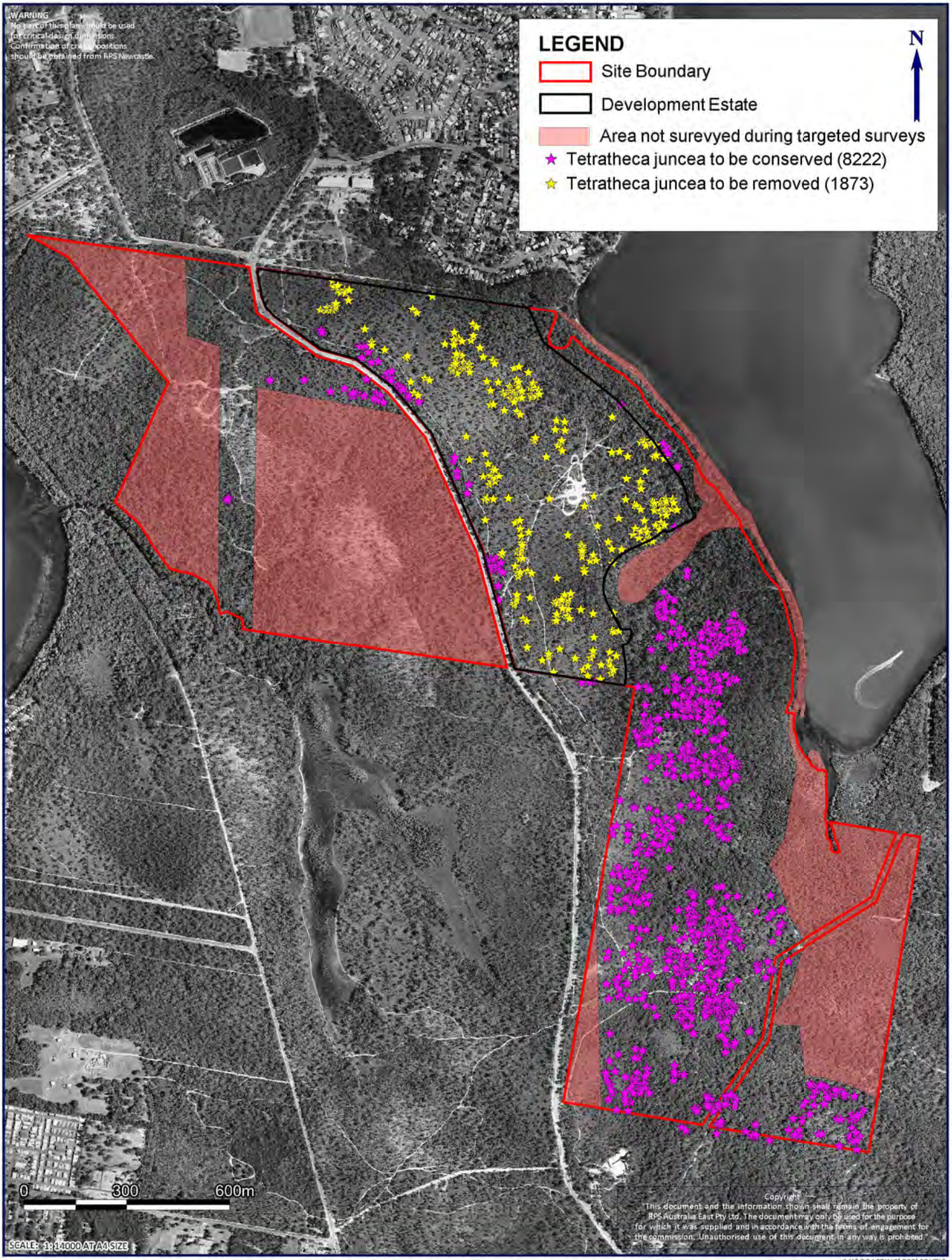
DATE: 23/3/2010
PURPOSE: EAR

24K\\DRAFTING\ECOLOGY\SOUTH\ALL\2010WORKSPACES
LAYOUT REF: \GWANDALAN\FIGURE 4-3 DISTRIB OF ANGOPHORA 2010 A3
VERSION (PLAN BY): A (A.P-M.D)

CLIENT: COAL & ALLIED INDUSTRIES LTD
JOB REF: 24530-1

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
241 DENISON STREET BROADMEADOW PO BOX 428 HAMILTON NSW 2303
T: 02 4940 4200 F: 02 4961 6794 www.rpsgroup.com.au

RPS



TITLE: FIGURE 4-3 DISTRIBUTION OF *Tetratheca juncea*

LOCATION: GWANDALAN

DATUM: DATUM
PROJECTION: MGA ZONE 56 (GDA 94)

DATE: 23/3/2010
PURPOSE: EAR

24K\DRAFTING\ECO\SOUTH\ALL\2010\GWANDALAN
LAYOUT REF: FIG4-4 DISTRIB TJ 2010 A4
VERSION (PLAN BY): A (A.P-M.D)

CLIENT: COAL & ALLIED INDUSTRIES LTD
JOB REF: 24530-1

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
241 DENISON STREET BROADMEADOW PO BOX 428 HAMILTON NSW 2303
T: 02 4940 4200 F: 02 4961 6794 www.rpsgroup.com.au

RPS

4.1.8 Regionally Significant Orchid Species

The following orchids which are listed in this section have not been listed under either state (TSC Act) or federal (EPBC Act) legislation as threatened. However, these species have been addressed here further to clarify their significance within the Gwandalan site.

Acianthus exertus

Jones (2006) describes this orchid as occurring in QLD, NSW, ACT and Victoria. It is widespread and locally common occurring in coastal areas in forest and woodlands on well drained soils. Jones (2006) also notes that this species rarely occurs with *Acianthus fornicatus*, which was found to be common in the forest and woodland communities within Gwandalan. Bell (2008) notes that there is a lack of records for this species along the coastal strip between Newcastle and the Hawkesbury River; however, Gunninah (2003) notes a record for this species at the Colongra Wetland, near Doyalson. A submission to list an endangered population of this species has been submitted to the Scientific Committee (Bell 2008), but at the time of writing, this endangered population has not yet been listed as either a preliminary or a final determination on the DECCW website. The location of this endangered population in the locality is also unknown in relation to published or informal literature at the time of writing. Whether this species occurs within the Development Estate is unknown, however, the proposed development will remove 57.23 ha (26%) of potential habitat, being Coastal Plains Scribbly Gum Woodland, Narrabeen Snappy Gum Forest and Coastal Sheltered Apple – Peppermint Forest in the Gwandalan site. However, over 163.52 ha (74%) of potential habitat for this species will be retained within the conservation lands at Gwandalan. Therefore, it is considered unlikely that the proposal will have a significant impact upon this species.

Genoplesium ruppii

One public submission reports that this species has been located within the Wallarah Peninsula, however, no location information was provided with this submission. This species has been recorded at Wyee Road in Wyong and several other records exist from Paterson in the lower Hunter Valley. No targeted surveys for this species in particular have been undertaken within the Development Estate. The habitat within which the species has been previously recorded varies from open grassland, heathlands (Gunninah 2003) to moist swampy forests (Jones 2006). Potential habitats within the Gwandalan site include, Narrabeen Snappy Gum Forest, Coastal Plains Scribbly Gum Woodland and Coastal Sheltered Apple - Peppermint Forest. Approximately 57.23 ha (26%) of potential habitat will be removed within the Gwandalan Development Estate. However, over 163.52 ha (74%) will be retained within the conservation lands. Therefore, it is considered unlikely that the proposal will have a significant impact upon this species.

Pterostylis alveata syn. Diplodium alveata

There may be potential for this species to occur within the Development Estate at Gwandalan. It is generally found within Teatree heathland on sand dunes (Bishop 2000). Bell (2008) suggests that an endangered population nomination has been submitted for this species. At the time of writing this report no preliminary or final determination for this species or population has been listed on either the TSC Act or the EPBC Act. Sub-

optimal habitat occurs within the Coastal Plains Scribbly Gum Woodland and Narrabeen Snappy Gum Forest as these communities occur on sandy soils. However, it appears unlikely as this species is generally found on sand dunes. Whilst the proposal will remove 56.37 ha (28%) of sub-optimal habitat, over 144.87 ha (72%) of sub-optimal habitat will be retained within the conservation lands at Gwandalan. Whilst it is a possibility that this species could occur within the Development Estate, it is unlikely due to lack of optimal habitat. Therefore, it is considered unlikely that the proposal will have a significant impact upon this species.

Pterostylis daintreana syn. Pharochilum daintreanum

This species has been found along the edges of sandstone outcrops growing under heathy vegetation or in moss and lichen fringing this vegetation (Bishop 2000). Habitats such as these are common within the Hawkesbury sandstone vegetation communities in the vicinity of the Hawkesbury River. The Gwandalan site may contain some habitat for this species on the edges of vegetation that adjoins the conglomerate shelving adjacent to Lake Macquarie. The majority of this type of habitat occurs where the Narrabeen Snappy Gum Forest adjoins the Swamp Oak Rushland Forest on the foreshore of Lake Macquarie. These habitats do not occur within the Development Estate at Gwandalan and therefore this species will not be impacted upon by the development and all potential habitat will be retained within the Gwandalan conservation lands.

4.1.9 Regionally Significant Undescribed Cryptic Orchids

Bell (2008) identified several undescribed orchids which may have habitat within the Gwandalan site. These orchids have been discussed below.

Caladenia sp. aff. fuscata

This species has been reported from three locations on the Central Coast with records also from the Wallarah Peninsula (Bell 2008). This species has wider petals than the common species, *Caladenia fuscata*. *Caladenia fuscata* was not detected by RPS during the vegetation surveys, however, as it is similar to *Caladenia carnea* it is possible that it occurs within the habitats within the Wallarah Peninsula and may have been overlooked during surveys due to similarities. Limited information is available on the habitat of this species to enable a full assessment of the suitable habitats for this species. Further taxonomic investigations are required to determine if this is indeed a new species. Thus a precautionary approach has been taken in this instance to assume that *Caladenia sp. aff fuscata* occurs within similar habitats to *Caladenia fuscata*. Potential habitats for this species within the Gwandalan area are considered most likely to be Coastal Plains Scribbly Gum Woodland, Narrabeen Snappy Gum Forest and Coastal Sheltered Apple – Peppermint Forest. Approximately 57.23 ha (26%) of potential habitat will be removed within the Gwandalan Development Estate with over 163.52 ha (74%) to be retained within the conservation lands. Therefore, it is considered unlikely that the proposal will have a significant impact upon this species.

Caladenia catenata var. 'warnervalensis'

Records for this species occur on the Central Coast and have been reported from the Wallarah Peninsula (Bell, 2008). A nomination has been made for this species to be listed

as endangered; however, at the time of writing, a preliminary or final determination for this species had not yet been listed on either the TSC Act or the EPBC Act. Further taxonomic investigations are required to determine if this is indeed a new species. Thus a precautionary approach will be taken in this instance to assume that *Caladenia catenata var. 'warnervalensis'* occurs within similar habitats to *Caladenia catenata*. Potential habitats within the Gwandalan site are most likely to be Coastal Plains Scribbly Gum Woodland, Narrabeen Snappy Gum Forest and Coastal Sheltered Apple – Peppermint Forest. Approximately 57.23 ha (26%) of habitat will be removed within the Gwandalan Development Estate with over 163.52 ha (74%) to be retained within the conservation lands. Therefore, it is considered unlikely that the proposal will have a significant impact upon this species.

Calochilus sp. aff. paludosus

This species has been identified as occurring on the Wallarah Peninsula, however, no information on the exact location is known (Bell 2008). The similar species *Calochilus paludosus* is common and occurs in open forest, woodland and heathland (Bishop 2001). *Calochilus paludosus* has not been recorded within the Gwandalan site and surveys were conducted during the flowering period for this species. Thus a precautionary approach has been taken in this instance to assume that *Calochilus sp. aff. paludosus* occurs within similar habitats to *Calochilus paludosus*. Potential habitats within the Gwandalan site are most likely to be Coastal Plains Scribbly Gum Woodland, Narrabeen Snappy Gum Forest and Coastal Sheltered Apple – Peppermint Forest. Approximately 57.23 ha (26%) of habitat will be removed within the Gwandalan Development Estate with over 163.52 ha (74%) to be retained within the conservation lands. Therefore, it is considered unlikely that the proposal will have a significant impact upon this species.

Diuris sp. aff. alba

Bell (2008) reports that this species has been recorded at several locations on the Central Coast and at Chain Valley Bay and Gwandalan. Little information is available on the description of this taxon and thus it is difficult to determine if this species is present. Thus, a precautionary approach has been taken in this instance to assume that *Diuris sp. aff alba* occurs within similar habitats to *Diuris alba*. Potential habitats within the Gwandalan site are most likely to be Coastal Plains Scribbly Gum Woodland, Narrabeen Snappy Gum Forest and Coastal Sheltered Apple – Peppermint Forest. Approximately 57.23 ha (26%) of habitat will be removed within the Gwandalan Development Estate with over 163.52 ha (74%) to be retained within the conservation lands. Therefore, it is considered unlikely that the proposal will have a significant impact upon this species.

Diuris sp. aff. aurea/Diuris sp. aff. chrysantha

The taxonomy of this species is currently under investigation as it is unknown if the affinities of this species is closer to *Diuris aurea* or *Diuris chrysantha* (Bell 2008). This species has been recorded in the local area including Gwandalan, Chain Valley Bay, Charmhaven, Warnervale, Munmorah and Norah Head (Gunninah 2003). As taxonomy of this species has not yet been determined for this species habitat has been assumed to be as for *Diuris aurea*. Potential habitats within the Gwandalan site are most likely to be Coastal Plains Scribbly Gum Woodland, Narrabeen Snappy Gum Forest and Coastal Sheltered Apple – Peppermint Forest. Approximately 57.23 ha (26%) of habitat will be

removed within the Gwandalan Development Estate with over 163.52 ha (74%) to be retained within the conservation lands. Therefore, it is considered unlikely that the proposal will have a significant impact upon this species.

Thelymitra sp. aff. purpurata

This species shows affinities to both *Thelymitra purpurata* and *Thelymitra ixioides*. *Thelymitra ixioides* was identified within the Coastal Plains Scribbly Gum Woodland within the Gwandalan site. As the taxonomy of this species has not been completed it is assumed that this species occurs within similar habitats to those in which *Thelymitra ixioides* occurs within the Gwandalan site. Potential habitats within the Gwandalan site include the Coastal Plains Scribbly Gum Woodland. Approximately 45.71 ha (40%) of habitat will be removed within the Gwandalan Development Estate with over 68.40 ha (60%) to be retained within the conservation lands at Gwandalan. Therefore, it is considered unlikely that the proposal will have a significant impact upon this species.

4.1.10 Groundwater Dependent Ecosystems

The potential presence of Groundwater Dependent Ecosystems (GDE's) within the Southern Lands was raised by DEWHA during the consultation stage of the project and is addressed in the following discussion.

GDE is a broad definition covering all ecosystems which are dependent upon groundwater either permanently or occasionally to survive (DLWC, 2002). Several of the vegetation communities on the Gwandalan site have been identified as GDE's. Identification GDE's depends upon the location of the vegetation communities in relation to groundwater. GDE's are typically the communities which are located in drainage depression, swamps and creeklines, where groundwater comes up to the surface.

Douglas Partners (2008) have undertaken groundwater and soil studies within the Gwandalan Development Estate (Douglas Partners 2008). This report indicates that the Swamp Oak Rushland Forest and the majority of the Redgum Roughbarked Apple Forest (excluding the portion adjoining Strangers Gully) is situated on areas in which the groundwater is controlled by the water level within Lake Macquarie and not by recharge from rainfall within the vicinity of the Development Estate. Therefore, these two GDE's will not be affected by the development. The alluvial soils which have been mapped by Douglas Partners (2008) within Strangers Gully are expected to contain unconfined aquifers perched above the less permeable underling residual soils and rock. This low-lying area's source of recharge to the aquifers is from surface runoff and direct rainfall. The upslope area which contributes to the recharge of these aquifers includes the Development Estate. The vegetation communities located within Strangers Gully include Swamp Mahogany Paperbark Forest, Freshwater Wetland Complex, Riparian Melaleuca Swamp Woodland, Redgum Rough-barked Apple Forest and Coastal Wet Sand Cyperoid Heath would be dependent upon this aquifer for a water source. Thus, the maintenance of water flow to these communities would be important for their survival.

The two portions of Riparian Melaleuca Swamp Woodland mapped within the Development Estate to the north of Strangers Gully are located in a shallow gully over residual soils and the presence of this community is most likely to be a result of surface runoff rather than groundwater dependence. The remaining GDE vegetation community of Mangrove – Estuarine Complex can occasionally be dependent upon groundwater; however, due to the close proximity to Lake Macquarie in this case it is most likely to be dependent on water levels within Lake Macquarie rather than groundwater.

GDE's have been classified into several different types according to DLWC (2006). These classes take into consideration aquifer, ecological and geomorphic types. The GDE's that have been identified on this site include Freshwater Wetland Complex, Coastal Wet Sand Cyperoid Heath, Swamp Mahogany- Paperbark Forest, Riparian Melaleuca Swamp Woodland, Swamp Oak- Rushland Forest, Redgum Roughbarked Apple Forest and Mangrove – Estuarine Complex (as shown in Figure 4-4).

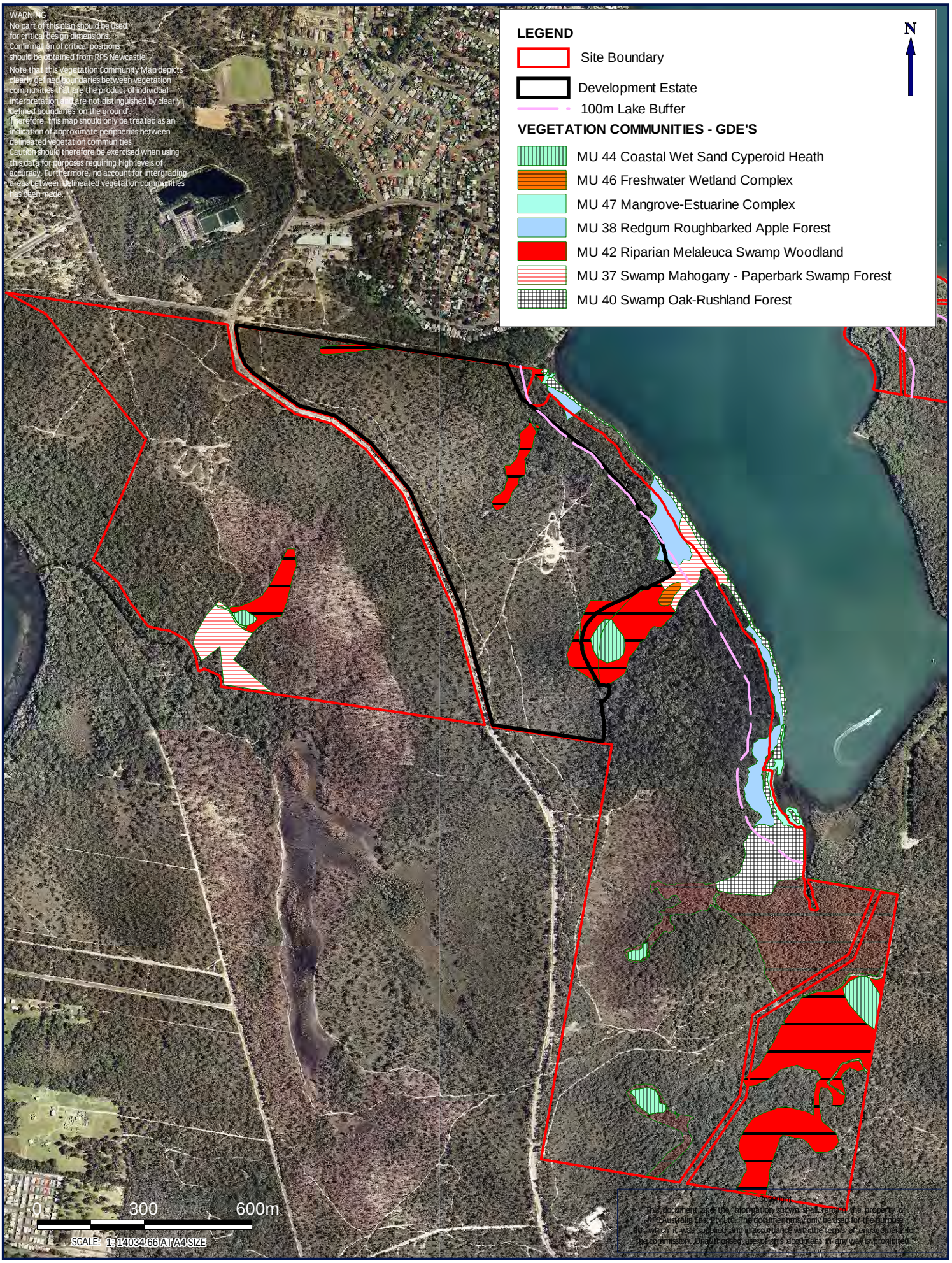
Table 4-3 below outlines the GDE types, classes and sub-classes as per DLWC (2006) which occur within the Gwandalan Development Estate.

Table 4-3: GDE types, classes and sub-classes as per DLWC (2006) which occur within the Gwandalan Development Estate.

Vegetation Community at CHB	GDE TYPE	Class	Description of Class	Habitat
Freshwater Wetland Complex	Wetlands (W)	W6	Permanent Freshwater Pond	Epigean
Coastal Wet Sand Cyperoid Heath	Wetlands (W)	W10	Wet Heath	Epigean
Swamp Mahogany – Paperbark Forest	Riparian & Terrestrial Vegetation (T)	T1	Riparian Vegetation Community	Terrestrial
Redgum Roughbarked Apple Forest	Riparian & Terrestrial Vegetation (T)	T1	Riparian Vegetation Community	Terrestrial
Riparian Melaleuca Swamp Woodland	Riparian & Terrestrial Vegetation (T)	T1	Riparian Vegetation Community	Terrestrial
Mangrove – Estuarine Complex	Marine Estuarine Habitats (M)	T4	Mangrove Swamp	Epigean
Swamp Oak Rushland Forest	Marine Estuarine Habitats (M)	M4	Tidal Freshwater swamp forests	Epigean

If existing surface water flow rates are maintained there will be minimal impact upon the GDE's present within the Gwandalan. As recommended by Douglas Partners (2008) this can be achieved by appropriate water sensitive design via the provision of surface water detention basins or swales to limit peak flows.

In conclusion, several of the vegetation communities within the Gwandalan Development Estate have been classed as GDE's. However, it must be noted that whilst some communities are generally reliant on surface water runoff, when groundwater is available these communities would utilise this water source for their water requirements.



TITLE: FIGURE 4-4 GDE DISTRIBUTION | LOCATION: GWANDALAN | DATUM: DATUM | PROJECTION: MGA ZONE 56 (GDA 94) | DATE: 8/10/2010 | PURPOSE: EAR | LAYOUT REF: 24530\DRAFT\ECO\SOUTHERN\2010TEMPLATES\FIGURE 4-5 GDE MAP 2010 A 3 | VERSION (PLAN BY): A(A.P-M.D)

CLIENT: COAL & ALLIED INDUSTRIES LTD
JOB REF: 24530-1

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4.2 Fauna

The results of fauna survey work carried out on the site are as follows (Refer to Figure 4-5). A comprehensive list of species expected and recorded during the survey period is presented in Appendix 3.

4.2.1 NPWS Threatened Species Database Search Results

The results of the above search indicated that 36 threatened fauna species have been previously recorded within 10km (DECCW Wildlife Atlas 2010) of the site. Of these species, seven were recorded during the fauna survey (indicated by an asterisk '*'). For a number of these species no suitable habitat occurs within the site, but discussion is added below with regard to the potential for these species to occur as a precautionary approach to the assessment process.

Calyptorhynchus lathami	Glossy Black-Cockatoo
Callocephalon fimbriatum	Gang-gang Cockatoo
Lathamus discolor	Swift Parrot
Glossopsitta pusilla	Little Lorikeet
Crinia tinnula	Wallum Froglet*
Litoria aurea	Green and Golden Bell Frog
Ixobrychus flavicollis	Black Bittern
Ephippiorhynchus asiaticus	Black-necked Stork
Pandion haliaetus	Osprey
Haematopus fuliginosus	Sooty Oystercatcher
Haematopus longirostris	Pied Oystercatcher
Charadrius mongolus	Lesser Sand Plover
Sterna albifrons	Little Tern
Ptilinopus regina	Rose-crowned Fruit-Dove
Ninox connivens	Barking Owl
Ninox strenua	Powerful Owl
Tyto novaehollandiae	Masked Owl
Tyto tenebricosa	Sooty Owl
Xanthomyza phrygia	Regent Honeyeater
Pomatostomus temporalis temporalis	Grey-crowned Babbler
Climacteris picumnus	Brown Treecreeper
Pyrrholaemus saggitatus	Speckled Warbler
Stagonopleura guttata	Diamond Firetail
Dasyurus maculatus	Spotted-tailed Quoll
Phascolarctos cinereus	Koala
Cercartetus nanus	Eastern Pygmy-possum
Petaurus norfolcensis	Squirrel Glider*
Pteropus poliocephalus	Grey-headed Flying-fox*
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat
Mormopterus norfolkensis	Eastern Freetail-bat
Falsistrellus tasmaniensis	Eastern False Pipistrelle*

Miniopterus australis	Little Bentwing-bat*
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat*
Myotis macropus	Large-footed Myotis
Scoteanax rueppellii	Greater Broad-nosed Bat*

In addition to the above threatened species a number of threatened oceanic fauna species, including oceanic bird species and whale species, occurred within a 10km perimeter buffer of the site, as a consequence of the site's proximity to oceanic habitats. These species have not been included within the above 10km threatened species list as potential impacts within the site will not include the habitats of these oceanic species.

Nevertheless, a small number of species for which records do not occur within 10km of the site (due in part, to a measure of difficulty in their surveying and limits on previous and current survey works) are considered as having a moderate or greater opportunity of occurring within the site on at least an intermittent basis. For this reason those species are included below.

Hoplocephalus bitorquatus	Pale-headed Snake
Hoplocephalus stephensii	Stephen's Banded Snake
Lophoictinia isura	Square-tailed Kite

The above species were considered for their potential to occur within the site. In considering the potential occurrence of these species those broad vegetation community types found to exist within the site are discussed below with regard to their containing potential habitat attributes for those fauna species listed above.

The higher slopes, to the east and west of Kanangra Drive, are characterised by open woodland habitat offering opportunities for local fauna species including a number of threatened species as listed above. The woodland trees contain hollows, which may be used by hollow-dwelling Microchiropteran bats for roosting purposes, and the canopy would provide foraging habitat for these insectivorous species listed above during the warmer months.

Hollows within woodland habitats are not of sufficient size to represent potential nesting sites for Glossy Black-Cockatoos, but there are areas containing *Allocasuarina littoralis*, which is a feed tree for this species.

Woodland hollows are of insufficient size to represent nesting and roosting sites for forest owl species, although woodland habitats are likely to represent foraging habitat for forest owls occurring in the area, particularly the Masked Owl. Those woodlands to the west of Kanangra Drive offer higher understorey diversity and are likely to be more suited to this species for foraging purposes.

Records for Barking Owls are relatively uncommon from near coastal areas, and the local record from the vicinity of Sunshine on the Morisset peninsula is considered somewhat unusual. As such, it is considered unlikely that the site represents important habitat for this species.

For the most part the woodland habitats are of an open structure, which reduces their habitat potential for Squirrel Gliders due to a lack of canopy continuity, but where they are characterised by a higher diversity and density in their upper and lower vegetation strata, particularly when associated with drainage lines, there are foraging opportunities for this species.

Within those areas of woodland with high quality understorey vegetation there is some potential for Pygmy Possums, but those areas of greatest potential occur west of Kanangra Drive and to the south of the Development Estate.

Despite the widespread occurrence of the Koala feed tree *Eucalyptus haemastoma* within woodland habitats, records for Koalas are limited to the south of Mangrove Gully, within riparian areas, where woodland habitats are more continuous. It is unlikely that the Development Estate lands represent highly suitable habitat for this species.

Although a woodland and open forest species within its range, the local record of a Grey-crowned Babbler from the coastal heath of Wybung Head is considered very unusual. As such, it is considered unlikely that the site represents important habitat for this species.

Tall open forest habitats occur on the lower slopes of the site where vegetation communities approach the lake. Within these forests there are hollow-bearing trees of sufficient size to represent nesting sites for Glossy Black-Cockatoos and forest owls and roosting sites for hollow-dwelling Microchiropteran bat species.

The canopy provides foraging habitat for Microchiropteran bats, but there is little blossom foraging for Flying-foxes, Swift Parrots and Regent Honeyeaters apart from *E. tereticornis* that occur within and adjacent to Swamp Oak Rushland Forest and preferred foraging habitat within stands of Swamp Mahogany - Paperbark forest.

Squirrel Gliders appear to favour woodland habitats over tall forest habitats within the site and the locality.

There are trees of sufficient size within these forests to represent nesting trees for the Osprey and conveniently located foraging habitat in the adjacent lake.

A local Gwandalan peninsula record of the Spotted-tailed Quoll is considered unusual, due to this species' preference for remote and high quality habitat. As such, the site's habitats are not considered to possess an adequate combination of sufficient remoteness, quality or extent for this species.

Rose-crowned Pigeons may move through the site on odd occasions, but most forest habitat within the site provides little foraging potential for this species apart from Cabbage Tree Palm stands in the lower reaches of Mangrove Gully.

Swamp Sclerophyll and Swamp Oak vegetation assemblages and associated wetland habitats on the lower reaches of the site's drainage lines provide habitat for Wallum

Froglets; potential canopy foraging resources for Flying-foxes, Swift Parrots and Regent Honeyeaters and foraging habitat for Microchiropteran bats.

There is potential habitat within the open forest habitats of the site for both the Pale-headed and Stephen's Banded Snakes and these lands fall wholly within lands to be protected as conservation lands.

There is foraging habitat within the site for both the Square-tailed Kite and Yellow-bellied Sheath-tailed-bat, but those vegetation communities containing the greatest structural diversity are likely to be preferred foraging habitats for these species.

There are no wetland habitats within the site of sufficient extent or of the open nature that is suited to Black-necked Storks.

The interface of Mangrove Gully's drainage line and the estuarine habitats of Lake Macquarie may represent foraging and nesting habitat for the Black Bittern, but there is no suitable habitat within the site for a range of other estuarine bird species, including, Pied and Sooty Oystercatchers, Little Tern and Lesser Sand Plover despite their occurrence in the wider locality.

4.2.2 Regionally Significant Fauna Species

Lake Macquarie Flora and Fauna Guidelines (2001) contain a list of regionally significant fauna species, of which nine were identified within the site, and are listed as follows:

Amphibolurus muricatus	Jacky Lizard
Calyptorhynchus funereus	Yellow-tailed Black-Cockatoo
Crinia tinnula	Wallum Froglet (listed under TSC Act)
Demansia psammophis	Yellow-faced Whip Snake
Haliaeetus leucogaster	White-bellied Sea-Eagle
Petaurus breviceps	Sugar Glider
Stipiturus malachurus	Southern Emu-wren
Tachyglossus aculeatus	Short-beaked Echidna
Vespadelus pumilus	Eastern Forest Bat

4.2.3 Terrestrial Mammals

Mammals recorded within the site encompassed species from terrestrial, arboreal and aerial guilds. Terrestrial fauna survey captures were dominated by *Antechinus stuartii* (Brown Antechinus), particularly where understorey vegetation densities were higher within open forest habitats. There was a noted absence of *Rattus fuscipes* (Bush Rat) within terrestrial fauna surveys, which may be displaced within the area by the introduced *Rattus rattus* (Black Rat), as this species was recorded somewhat regularly in Casuarina forest in the southeast of the site. *Rattus lutreolus* (Swamp Rat) was recorded in relatively good numbers within and adjacent to wet habitats exhibiting dense understorey vegetation. In addition to these small terrestrial mammals, foxes or secondary fox indications, such as scent marking, were encountered throughout the site, but generally along track lines which are numerous to the east of Kanangra Drive. *Wallabia bicolour*

(Swamp Wallaby) was observed across the site during diurnal and nocturnal surveys. Grazing opportunities occur across the site for this species.
Hair Tubes

Results from the targeted hair tube and cage trap survey for *D. maculatus* are presented in Table 4-4 and the following text.

Table 4-4: Results from Hair Tube Traps and Cage Traps

Hair Tube Traps Results			
Site	**Hair Trap ID**	**Species Identified**	**Comment**
3	H22	Possum (*Trichosurus sp*)	I.D. confirmed
3	H23	Possum (*Trichosurus sp*)	I.D. confirmed
3	H25	Mouse (*Mus musculus*)	I.D. probable
4	H11	Insect material	I.D. confirmed
4	H13	Fox (*Vulpes vulp*es)	I.D. probable
4	H15	Possum (*Trichosurus sp*)	Facial setae, I.D. probable
6	H3	Bandicoot (*Isoodon macrourus*)	I.D. confirmed
6	H4	Rat (*Rattus fuscipes*)	I.D. probable
7	H6	Insect material	I.D. confirmed
Cage Traps Results			
Site	**Cage trap ID**	**Species Identified**	**Comment**
2	CT 14	Black Rat (*Rattus rattus*)	
2	CT 15	Black Rat (*Rattus rattus*)	

Hair Tube Traps

Six mammal hair samples were collected and identified from hair traps set within the site. Mammals identified from the Development Estate lands were *Vulpes vulpes* (Red Fox) from survey site 4 and *Rattus sp.* (*R. fuscipes* probable) and *Isoodon macrourus* (Northern Brown Bandicoot) at survey site 2. Mammals identified from lands to be retained for conservation purposes lands within the site were *Trichosurus vulpecula* (Common Brush-tailed Possum) and *Mus musculus* (House Mouse) from survey site 5. No other animals were identified within hair traps apart from invertebrates. No hair samples indicated the presence of *D. maculatus.*

Scat Searches

No Quoll scats were observed during the survey period.

Cage Traps

A single mammal species was recorded in cage traps during fauna surveys, being two separate individuals of the introduced species *Rattus rattus* (Black Rat) at survey site 4. No Quolls were trapped during this survey.

4.2.4 Arboreal Mammals

Petaurus breviceps (Sugar Glider) and *Petaurus norfolcensis* (Squirrel Glider) were identified during arboreal fauna surveys within Swamp Oak forest in the southeast of the site. Both these species were also recorded during nocturnal spotlight surveys feeding on sap from *Corymbia gummifera* (Bloodwood) on separate nights in separate locations. The *P. norfolcensis* observation was recorded within Strangers Gully within the northeastern area of the site. Gliders feed scars were observed across the site predominantly on *C. gummifera* associated with open forest and closed understoreys.

Pseudocheirus peregrinus (Ring-tail Possum) and *Trichosurus vulpecula* (Common Brush-tail Possum) were observed during nocturnal surveys on several occasions within open forest habitat with moderate understorey.

Note: Petaurus norfolcensis (Squirrel Glider) is listed as Vulnerable under the TSC Act 1995.

A total of 18 SAT points (Table 4-5) were assessed for the presence of Koala activity based on the occurrence of Potential Koala Habitat occurring in those areas considered most likely to represent Koala habitat opportunities. For these sites, Koala feed tree species varied in density between 20% and 80%. Koala feed tree species recorded included *Eucalyptus haemastoma* (Scribbly Gum), *E. signata* (Scribbly Gum), *E. robusta* (Swamp Mahogany), and *E. tereticornis* (Forest Red Gum).

Scats and claw scratches were noted and identified for several species of arboreal marsupials including *Trichosurus vulpecula* (Brush-tailed Possum), *Pseudocheirus peregrinus* (Ring-tailed Possum) and *Petaurus spp*. (Gliders). None of the SAT points were found to have koala scats or koala claw scratches, and no individual Koalas were recorded within the site.

Table 4-5: Results of Spot Assessment Technique (SAT)

SAT Point	Koala Feed Tree species	Feed Tree Density (% Cover)	Evidence of Koalas (scats or claw scratches)
1	*Eucalyptus haemastoma*	60	*No evidence*
2	*E. signata*	70	*No evidence*
3	*E. haemastoma*	25	*No evidence*
4	*E. haemastoma*	50	*No evidence*
5	*E. robusta*	50	*No evidence*
6	*E. robusta*	65	*No evidence*
7	*E. signata*	60	*No evidence*
8	*E. signata*	60	*No evidence*
9	*E. haemastoma*	60	*No evidence*
10	*E. haemastoma*	80	*No evidence*
11	*E. haemastoma*	80	*No evidence*
12	*E. tereticornis*	70	*No evidence*
13	*E. signata*	30	*No evidence*
14	*E. signata*	85	*No evidence*
15	*E. signata*	75	*No evidence*
16	*E. signata*	60	*No evidence*
17	*E. robusta*	80	*No evidence*
18	*E. signata*	50	*No evidence*

4.2.5 Bats

A number of Microchiropteran bat species were detected within the site during nocturnal surveys with a definite – probable confidence, including, *Miniopterus australis* (Little Bentwing-bat), *Tadarida australis* (White-striped Freetail Bat), *Chalinolobus gouldii* (Gould's Wattled Bat), *Chalinolobus morio* (Chocolate Wattled Bat) and calls possibly belonging to *Scoteanax rueppellii* (Greater Broad-nosed Bat), *Scotorepens orion* (Eastern Broad-nosed Bat), *Falsistrellus tasmaniensis* (Eastern Falsistrellus) and *Vespadelus sp* (Forest Bat species). Note: *Miniopterus australis*, *Scoteanax rueppellii* and *Falsistrellus tasmaniensis* are listed as Vulnerable under the *TSC Act 1995*.

Pteropus poliocephalus (Grey-headed Flying Fox) was observed foraging and heard calling within the site during nocturnal survey work. Habitat occurs across the site in the form of flowering Eucalypt species with winter flowering species *Eucalyptus robusta* (Swamp Mahogany) and *Corymbia maculata* (Spotted Gum) being of note during the survey period.

4.2.6 Avifauna

Habitat opportunities for avifauna within the Gwandalan lands are largely limited to forest and woodland habitats, with small areas of wetland, heath and riparian vegetation communities. Forest bird species generally dominate these habitats and encompass a number of guilds with those species recorded including, Whistlers and Thrushes, Robins, Flycatchers, Fairy-wrens, Scrub-wrens, Thornbills, Whipbirds, Cuckoos, Finches, Butcherbirds and birds of prey amongst others. The presence of nectar producing Eucalyptus and Proteaceous plant species throughout the understorey and canopy strata attract a wide range of nectivorous bird species such as Honeyeaters and Lorikeets. The lower drainage lines of the site contain *Eucalyptus robusta* (Swamp Mahogany) within swamp sclerophyll vegetation assemblages and this species is an important source of winter nectar for nectivorous species. Due to the presence of Swamp Mahogany it is possible that the site might be visited by *Lathamus discolor* (Swift Parrot) and *Xanthomyza phrygia* (Regent Honeyeater) during the winter months when these species seasonally move into the Central Coast and Lower Hunter Valley regions. The Swift Parrot and Regent Honeyeater are both listed as Endangered under the *TSC Act 1995* and the *EPBC Act 1999*. No Swift Parrots were observed during the targeted surveys. Surveys conducted in June 2008 found that *E. robusta* blossom was in short supply, although these forests are likely to represent local resources for Swift Parrots and other nectivorous birds during seasons when *E. robusta* is blossoming strongly. Observation of nectivorous bird species during the June 2008 survey were limited to sedentary honeyeater species.

Throughout the sites open forest habitats there is a widespread presence of *Allocasuarina sp*. (She Oaks), which are the source of the dominant food resource for *Calyptorhynchus lathami* (Glossy Black-Cockatoo). There are records of this species (DECC Atlas of NSW Wildlife data) elsewhere on the Gwandalan peninsula and the local area, so it is likely that this species uses the site on at least an intermittent basis. Glossy Black-Cockatoos are listed as Vulnerable under the *TSC Act 1995*.

Extensive wooded habitats within the site, containing moderate to high levels of understorey structural diversity and numerous hollow-bearing trees, support populations of terrestrial and arboreal mammal species. These habitat attributes are important features for forest owl species, particularly, in relation to the Gwandalan Site, *Ninox strenua* (Powerful Owl) and *Tyto novaehollandiae* (Masked Owl). There is a Powerful Owl record from within the vicinity of the site and a Masked Owl record from within the site (DECCW Atlas of NSW Wildlife). No evidence of Masked or Powerful Owls could be detected within the site despite targeted surveys and the presence of healthy terrestrial and arboreal mammal populations, which are the respective favoured prey guilds of these forest owl species. Masked and Powerful Owls are listed as Vulnerable under the *TSC Act 1995*.

Forested habitats abut Lake Macquarie in the east of the site and here there are roosting and foraging opportunities for estuarine bird species, such as Cormorants, Pelicans, Herons, Egrets, Ducks and those birds of prey species, which frequent adjacent estuarine habitats.

The site contains a moderate number of large and prominent Eucalypt trees that are the favoured nesting sites for those birds of prey, which frequent estuarine habitats. A large stick nest was noted in a very prominent *Angophora costata*, and although the builder of the nest was not observed during a number of visits to the site, it is likely that the nest belongs to White-bellied Sea Eagles, which were noted in the vicinity of the site on a number of occasions, including early morning territorial calling from the direction of the nest. The nest occurs to the south of the Development Estate and as such, is unlikely to be impacted upon by the proposal. It is considered unlikely that the nest belongs to Ospreys, which are a fishing specialist that is listed as Vulnerable under the *TSC Act 1995*, due to the prevalence of White-bellied Sea Eagle sightings during fauna surveys.

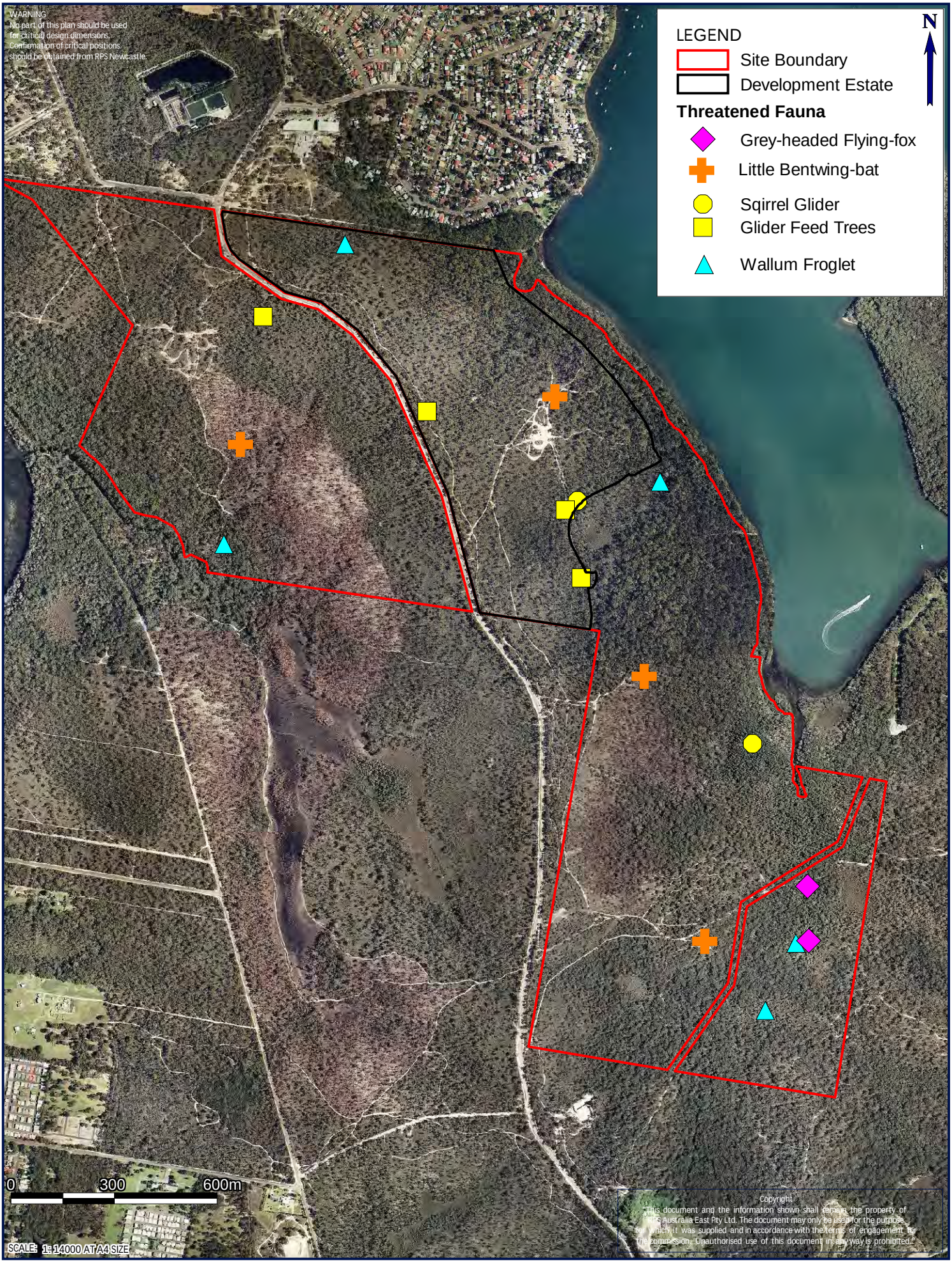
4.2.7 Amphibians

Crinia signifera (Common Froglet) was heard to call across the site within wetland environs and ephemeral ponds and creeks, and was also observed active nocturnally in winter puddles on a clay bush track. *Uperoleia fusca* (Dusky Toadlet) were heard calling in permanent swamp sclerophyll wetlands within the lower catchments of Mangrove Gully and Strangers Gully in the east and Tiembula Creek in the west.

Crinia tinnula (Wallum Froglet) were recorded calling in three areas within the site, being permanent swamp sclerophyll wetlands within the lower catchments of Mangrove Gully and Strangers Gully in the east and Tiembula Creek in the west. This species has a limited habitat preferring acid paperbark swamps and sedge swamps of coastal 'wallum' areas. The Wallum Froglet is listed as Vulnerable under the *TSC Act 1995*, and any change to the natural flow regime within these areas is likely to impact on the habitat currently being utilised by this species.

4.2.8 Reptiles

Common skink species were found within ground debris active during the day and included *Lampropholis delicata* (Grass Skink). Several *Ctenotus robustus* (Striped Skink) were found sheltering beneath debris to the northeast of Kanangra Drive.



TITLE: FIGURE 4-5 FAUNA RESULTS

LOCATION: GWANDALAN

DATUM: DATUM
PROJECTION: MGA ZONE 56 (GDA 94)

DATE: 23/3/2010
PURPOSE: EAR

LAYOUT REF: 24\DRAFT\ECO\SOUTH\ALL\2010\GWANDALAN\FIG 4-7 FAUNA RESULTS2010
VERSION (PLAN BY): A (A.P-M.D)

CLIENT: COAL & ALLIED INDUSTIRES LTD
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4.3 Habitat Survey

4.3.1 Flora Habitat

The vegetation communities present throughout the site offer a number of suitable habitat types for an array of native flora species. A number of geomorphological factors contribute to the diversity of vegetation communities present within the Gwandalan site. These factors include the geology, soils, elevation, proximity to Lake Macquarie and rainfall patterns. This range of geomorphological influences has produced nine vegetation communities. Freshwater Wetland Complex, Swamp Mahogany Paperbark Forest, Riparian Melaleuca Swamp Forest and Swamp Oak Floodplain Forest vegetation communities, which occur within the site, are of significance. These vegetation communities are listed as an EEC under the *TSC Act 1995*.

The condition of the vegetation communities varies across the site and corresponds to proximity to urban development, tracks and changes to fire regimes. The main disturbances within areas, which are not adjoining urban development, are unformed tracks and associated erosion across the site. These tracks are regularly used by unauthorised motorbike riders and to a lesser extent 4WDs. The Coastal Plains Smooth-barked Apple vegetation community has been disturbed by tracks made by motorbikes and these tracks have destroyed some *Tetratheca juncea* populations within this area. Soil erosion is present along and within close proximity to the majority of the tracks along with pasture weed incursions and rubbish dumping. In addition to the aforementioned disturbances the tracks also fragment the vegetation communities across the site.

The most disturbed area is to the west of Kanangra Drive within the Coastal Plains Scribbly Gum Woodland in which numerous tracks are present and numerous rubbish dumping sites are present. Away from the tracks the vegetation is in good condition with a wide variety of native flora species. The area to the east of Kanangra Drive has been subject to a more frequent fire regime evidenced by the grassy understorey present in this area. A large population of *Angophora inopina* (Vulnerable species) is present within this community. The majority of the population occurs on the western side of the road within the conservation lands. The vegetation community provides a habitat for a wide diversity of species from the families of Proteaceae, Poaceae, Myrtaceae and a wide variety of graminoid species. Potential habitat for a wide variety of threatened orchids, Eucalypts, and graminoids exists within this woodland habitat.

The wetland and estuarine habitats provide habitat for the threatened species *Callistemon linearifolius*, and common occurring species such as Melaleucas, sedges, ferns and grasses.

The remaining areas of open forest have been delineated into three vegetation assemblages and the understorey varies from open grassy areas to dense shrubby understorey. These three communities provide optimum habitat for *Tetratheca juncea*,

cryptic orchids and a wide variety of commonly occurring Myrtaceous, Fabaceae, herbs and grass species.

4.3.2 Fauna Habitat

Fauna recorded within the site varies with respect to vegetation quality, density and community form. The site encompasses vegetation communities ranging from Cyperoid Heath and Sedgeland habitats through Swamp Sclerophyll Forests to Tall Open Forest communities and Open Woodlands with both sparse and dense shrubby understoreys. The variation in vegetation within the site provides habitat for a diversity of common fauna species and opportunities for a moderate number of threatened fauna species.

Eucalypt and other dominant trees flowering times have potential to supply nectar and foraging opportunities for a diversity of species throughout the majority of the year. Dominant tree species and flowering period is presented below in Table 4-6.

Table 4-6: Dominant Tree Species and Flowering Period

Threatened Flora Species	TSC listed	EPBC listed	Habitats (But not confined to) Map units REMS	Potential Threatened Fauna Species that May be attracted by Blossom	Flowering Period (Best time to Survey) in Months of the Year											
					J	F	M	A	M	J	J	A	S	C	N	D
Angophora costata	NA	NA	15, 30, 31, 34 39, 51	Micro bats (insects)												
Eucalyptus punctata	NA	NA	Narrabeen Sheltered & 15	Micro bats (insects), Flying Foxes, Gliders												
Eucalyptus resinifera	NA	NA	15, 30, 31, 34 37, 39, 42, 51	Micro bats (insects), Flying Foxes, Gliders												
Eucalyptus haemastoma	NA	NA	31	Micro bats (insects)												
Eucalyptus robusta	NA	NA	37, 42	Micro bats (insects), Flying Foxes, Gliders, Regent Honeyeater, Swift Parrot												
Eucalyptus piperita	NA	NA	Narrabeen Sheltered & 30	Micro bats (insects)												
Corymbia gummifera	NA	NA	Narrabeen Sheltered & 30, 31	Micro bats (insects), Flying Foxes, Gliders												
Eucalyptus tereticornis	NA	NA	38	Micro bats (insects), Flying Foxes, Gliders, Regent Honeyeater, Swift Parrot												

Note: The cleared areas occurring within the site are considered to be insignificant in terms of providing habitat for native fauna species aside from providing foraging habitat along the edge of the forested areas (such as for hunting bats).

Terrestrial Mammals

The Open Forest communities provide suitable habitat for a number of terrestrial mammals. Habitat quality is dependent upon the amount of available groundcover,

density and floristic diversity of shrubs and grasses and land use history (e.g. selective logging, clearing, grazing and understorey management practices).

Limited open foraging habitat occurs within the site for macropods, but swamp Wallabies were noted in habitats adjacent to riparian areas. Foxes were observed during nocturnal fauna surveys.

Trends observed from the trapping surveys indicate that small mammals such as *Antechinus* and Native Rats are generally abundant throughout any dry woodland/ forest areas across the site regardless of habitat quality.

Arboreal Mammals

The site's woodland Land and open forest communities contain spasmodic foraging resources such as foliage, pollen, nectar and invertebrates for Possums and Gliders. A range of *Eucalyptus spp.* are likely to provide seasonal foraging resources for arboreal mammals and there are Hollow-bearing trees occurring across the site. Much of the woodland habitat is of an open nature, which reduces connectivity and provides minimal resources for gliders, although where woodland habitats are associated with riparian areas an increase in structural and floristic diversity provides habitat for these possums.

Bats

Wooded areas within the site provide extensive foraging habitat for insectivorous Microchiropteran bats. Potential roosting sites for those species that utilise tree hollows for roosting purposes are available in varying densities across the site. Although there are widespread foraging resources for cave-dwelling Microchiropteran bats within the site, there are no known roosting opportunities for these species occurring within the vicinity of the site.

Blossom of *Eucalyptus spp*. provides foraging opportunities for Grey-headed Flying-foxes. *E. robusta* on the site, within Swamp Mahogany – Paperbark Forest and *E. tereticornis* within Swamp Oak Rushland Forest are likely to be the most important foraging resources for flying-foxes within the site. The Grey-headed Flying Fox is listed as Vulnerable under both the *TSC Act 1995* and the *EPBC Act 1999*.

Frogs

Permanent wetland habitats and creeklines with ephemeral pools that persist after significant rain events provide significant habitat opportunities for a variety of common frog species. Adjacent wooded habitats are likely to provide foraging and shelter opportunities for a variety of tree dwelling frog species. *Crinia tinnula* was recorded within permanent water along drainage lines in the north of the site, Strangers Gully and Mangrove Gully. *C. tinnula* is listed as Vulnerable under the *TSC Act 1995*.

Reptiles

Habitat within the site has potential for representing significant shelter and foraging opportunities for a diversity of reptile species. This can be attributed to the diversity of onsite habitats that includes open forest / woodland habitats with associated wet

areas/wetlands and moderate to high floristic diversity and forest debris within understorey strata.

Semi to permanent wetlands are likely to provide year round habitat and those creeklines and drainage lines exhibiting ephemeral ponds provide intermittent foraging opportunities for common snake and turtle species. Wooded areas are likely to represent habitat for common lizard and snake species.

Avifauna

The wooded areas provide suitable foraging resources (e.g. Invertebrate habitat and blossom) and nesting and roosting opportunities for a variety of sedentary and migratory birds. Hollow bearing trees may provide nesting habitat for hollow dependant birds such as Forest Owls, Tree creepers, Parrots, Kingfishers and Woodswallows.

Areas with heathy understorey plants provide a variety of foraging opportunities within woodland and open forest habitats that include invertebrate resources and nectar providing Proteaceae species. Species likely to be regularly using these habitats includes a variety of Honeyeaters, Wren and Finch species.

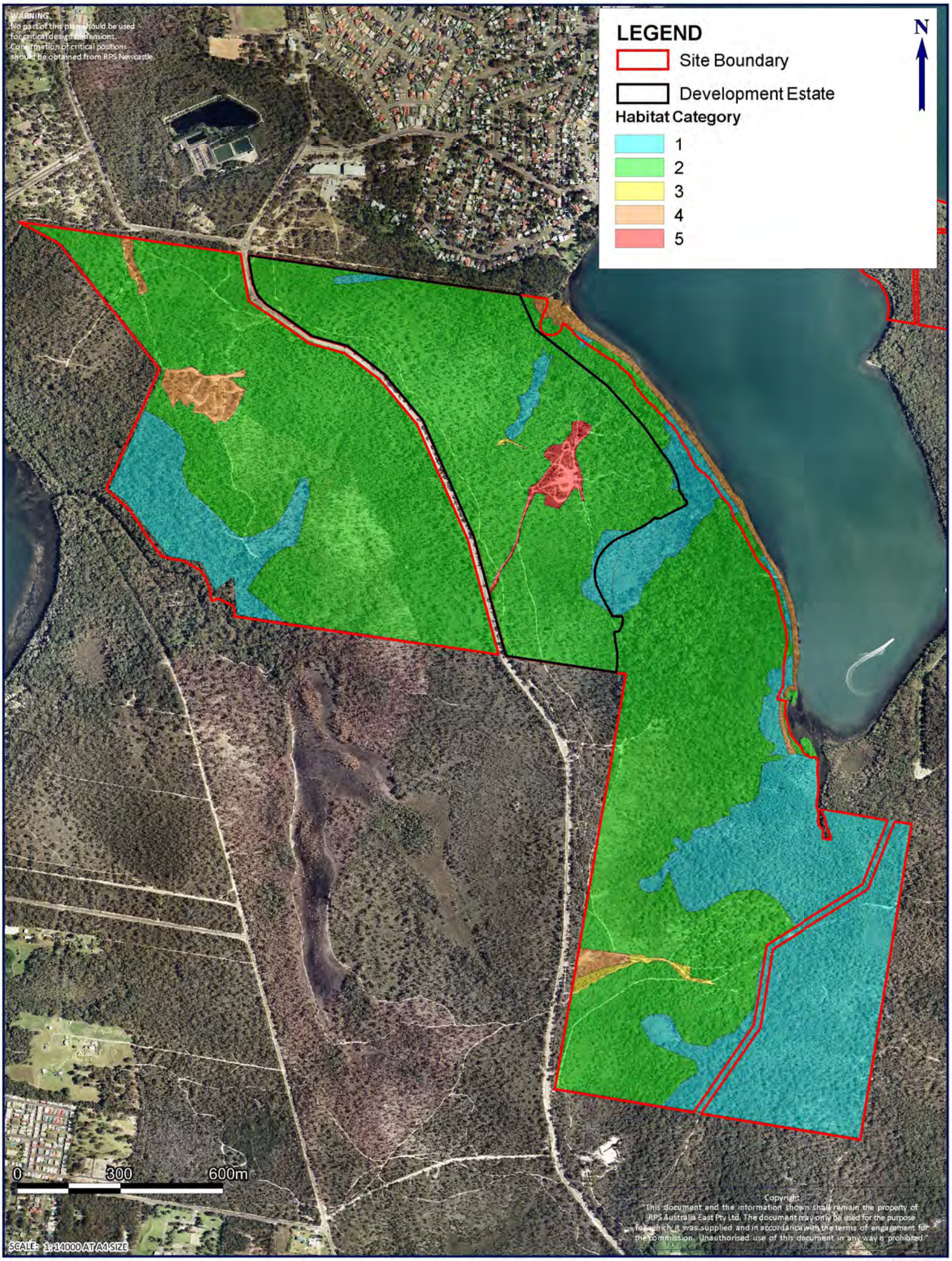
Habitat for nocturnal bird species and Forest Owl species occurs within open forest and woodland areas, particularly where main prey species, which includes arboreal and terrestrial mammals, reptiles and invertebrates are found to occur. Roost sites for these species preferably occur within dense forest areas particularly within areas of *Allocasuarina littoralis* and Eucalypt species.

4.3.3 Habitat Mapping

Habitat mapping (Figure 4-6) has been undertaken based on the results of field assessment coupled with the results of floristic investigations and RPS Ecology staff combined observations and experience. To optimise the habitat mapping for display and analysis, habitat quality has been divided into the five categories outlined below, based on the habitat assessment elements discussed previously in Table 3-2. The habitat assessment elements are; hollow bearing tree density, Eucalypt diversity, Allocasuarina species density, Proteaceae species density, structural diversity and fallen timber density.

1. **High –** Quality habitat with native flora showing no significant disturbance with old growth elements, intact understorey and year round foraging opportunities preferable to significant and threatened fauna species that includes forest owls, arboreal mammals, avifauna (includes EEC with no weed incursion and areas perceived to have regionally unique floristic representations or fauna habitat).
2. **Above average –** Quality habitat with native flora showing little to no disturbance with moderate level of key elements. These areas are likely to be utilised by native fauna species, including threatened species, as part of a larger home range (includes EEC with minor weed incursion).
3. **Average quality –** Habitat with dominant native community with low – moderate level within elements, and includes areas of recent fire disturbance where understorey

4. diversity is low with long term natural regeneration likely (also includes EEC with moderate weed incursion).
5. **Below average –** Habitat representing a native vegetation community with high weed incursion and other disturbances and low level of foraging opportunities (includes EEC with severe weed incursion, and disused tracks with signs of native regeneration).
6. **Low –** Cleared land dominated by exotic flora species and representing preferred habitat for exotic fauna species (includes highly disturbed and frequently used tracks).



TITLE: FIGURE 4-6 HABITAT CONDITION MAP	LOCATION: GWANDALAN	DATUM: DATUM PROJECTION: MGA ZONE 56 (GDA 94)	DATE: 23/3/2010 PURPOSE: EAR	24\DRAFT\ECO\SOUTH\ALL 2010\GWANDALAN\24530 LAYOUT REF: FIGURE 4-8 HABITAT 2010 A4 VERSION (PLAN BY): A (A.P-M.D)	

CLIENT: COAL & ALLIED INDUSTRIES LTD
JOB REF: 24530-1

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
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RPS

5 Threatened Species and Communities Assessment

5.1 Identification of Subject Species and Communities

Those threatened flora and fauna species (listed under the *TSC Act 1995* and the *EPBC Act 1999*) that have been gazetted / recorded from within the vicinity of the site have been considered within this assessment. EEC's and Endangered Populations known from the broader area have also been addressed. Each species / community / population is considered for its potential to occur within the study area and the likely level of impact as a result of the overall proposal. This assessment deals with each species / community / population separately and identifies the ecological parameters of significance associated with the overall proposal.

Those species / communities that have been identified as having either a moderate level of impact (or greater) as a result of the proposed Development Estate or that have been recorded within the site during field investigations have been subject to further assessment within Section 5.2 of this report.

'Species' or **'EEC / Population'** – Lists each threatened species / EEC / population known from the vicinity of the site. The status of each threatened species under the *TSC Act 1995* and *EPBC Act 1999* is also provided.

'Habitat Description and Known Populations' or **'Habitat Description and Known Stands / Populations'** – Provides a brief account of the species / community / population and the preferred habitat attributes required for the existence / survival of each species / community / population.

'Chance of Occurrence within Site' – Assesses the likelihood of each species / community / population to occur within the site in terms of the aforementioned habitat description and taking into account local habitat preferences, results of recent field investigations, data gained from various sources and previously gained knowledge via fieldwork undertaken within other ecological assessments in the locality.

'Likely Level of Impact within Development Estate' – Assesses the likely level / significance of impacts to each species / community / population that would result from the proposed Development Estate, taking into account both short and long-term impacts. This assessment is largely based on the chance of occurrence of each species / community with due recognition to other parameters such as home range, habitat use, connectivity etc. It also considers the scope of the proposal, including the likely 'ecological footprint', duration of construction works, proposed remediation works etc. All impact assessment is undertaken with due consideration of the Conservation Lands forming part of the proposal.

Table 5-1: Threatened Species Assessment

Species	Habitat Description and Known Populations	Chance of Occurrence within Site	Likely Level of Impact within Development Estate
Plants			
Acacia bynoeana Bynoe's Wattle (E)	Small, prostrate shrub found in low heath and open woodland, generally on loamy clays and sand. Occurs from the Lower Hunter south to the Southern Highlands. Within the Hunter Sub-bioregion it has been found in several locations within the Cessnock LGA where it has been found growing in Kurri Sand Swamp Woodland (KSSW). Has also been recently recorded as isolated populations within Yellow Bloodwood Woodland and Blue-leaved Stringybark Woodland near Ellalong. Locally, it is known to occur with Coastal Plains Scribbly Gum Woodland and a record exists to the south of the site within the Lake Macquarie State Recreation Area.	**Moderate** Targeted surveys were unable to record this species within the site, despite an abundance of potential habitat to the east and west of Kanangra Drive. However, this cryptic species is relatively difficult to locate in the field and as such its presence within the site cannot be discounted.	**Low - Moderate** The Coastal Plains Scribbly Gum Woodland is considered to be good potential habitat for this species. However, it is considered unlikely to be significantly affected by the proposal due to the conservation of large areas of potential habitat for this species, both to the south of the Development Estate and to the west of Kanangra Drive.
Angophora inopina Charmhaven Apple (V, V*)	Small to medium tree found in shallow sandy soils in open woodland, swamp woodland and wet heath. The main occurrences of this species are in the Wyong and Lake Macquarie LGA's (from Charmhaven to Wyee and Morisset, and north to near Toronto), with disjunct populations also in Port Stephens LGA (south of Karuah).	**High** A large population of this species was located on both sides of Kanangra Drive within the north of the site. The largest portion of this population occurs within the conservation lands.	**Moderate** Part of this population will be removed as part of the proposal, however removal will be kept to a minimum due to the requirement for road setbacks within the Development Estate. The current proposal is unlikely to adversely impact upon this species, due to the high proportion of the population and potential habitat which will be retained within conservation lands to the west of Kanangra Drive within the current proposal.
Caladenia porphyrea (E)	An endemic Australian orchid, *C. porphyrea* grows in coastal sclerophyll forest on sandy soils. In NSW, this species has a highly restricted geographic distribution. It has been recorded from 2 localities in the Wyong local government area north of Gosford approximately 2 km apart. At these locations it covers areas of about 2 ha and 0.2 ha respectively.	**Moderate** Flora surveys were conducted within the flowering season for this species, in the Development Estate and the areas to the south of the DA area. Whilst, sub-optimal habitat for this species occurs throughout the DA area the dense cover of *Dodonaea triquetra* reduces the area of habitat. Not all areas of the conservation lands to the north were survey and therefore this species could be present within that area.	**Low** Although there is some sub-optimal habitat for this species to occur within the Development Estate lands, those areas representing the best habitat opportunities for this species will be conserved within the current proposal.
Caladenia tessellata Tessellated Spider Orchid (E, V*)	A small terrestrial orchid, which regrows its single leaf on an annual basis. It is known to occur in grassy woodland and locally it has potential to occur within Coastal Plains Scribbly Gum Woodland. It has been recorded within Munmorah State Recreation Area to the south of the site.	**Moderate** Flora surveys were conducted out of the flowering season for this species, so it was not recorded within the site. However, habitat assessment suggests that there is potential for this species to occur in woodland habitats with a heathy to grassy understorey of which those in the best condition occur west of Kanangra Drive within conservation lands.	**Low** Although there is some potential for this species to occur within the Development Estate lands, those areas representing the best habitat opportunities for this species will be conserved within the current proposal.
Callistemon linearifolius (V)	Shrub that grows in dry sclerophyll forest on the coast and adjacent ranges. Significant populations recently found within the Lower Hunter, including Werakata National Park. Re-sprouting / juvenile specimens difficult to distinguish from other *Callistemon* species such as *C. rigidus* or *C. linearis* without the aid of flowering parts. Locally this species has been recorded where dry forest habitats interface with salt tolerant vegetation communities, such as Swamp Oak Rushland Forest and Riparian Melaleuca forest.	**Moderate** Potential habitat for this species occurs on the western and eastern limits of the site where dry forest habitats merge with Swamp Oak and Swamp Sclerophyll vegetation assemblages bordering Crangan Bay in the east and Tiembula Creek in the west.	**Low** The potential riparian habitats within the Development Estate will be retained as part of the development proposal. In addition, large areas representing potential habitat for this species will be retained within the conservation lands, it is considered unlikely that the current proposal will adversely impact upon this species.

Species	Habitat Description and Known Populations	Chance of Occurrence within Site	Likely Level of Impact within Development Estate
Cryptostylis hunteriana Leafless-tongue Orchid (V, V*)	A cryptic Saprophytic orchid species that flowers between December and February. Distribution limits N-Gibraltar Range S- south of Eden. Grows in a variety of habitats from tall open forests to swamp heath on sandy soils. Local records exist from the Wallarah peninsula to the north of the site (Atlas of NSW Wildlife data).	**Moderate – High** The relatively wide range of possible habitats that this species potentially occurs within and the ubiquitous presence of a closely related species, *C. subulata*, with which this species is sometimes associated, suggests that it may occur within any of the site's habitats, except those that are very wet or saline in nature. However, it is considered that the optimal habitats are in the more grassy habitats, which adjoin the Coastal Plains Peppermint – Apple Forests along the foreshore of Lake Macquarie.	**Low - Moderate** Although there is some potential for this species to occur within the Development Estate lands, those areas representing the best habitat opportunities for this species will be conserved within the current proposal.
Dendrobium melaleucaphilum Spider Orchid (E)	Epiphytic orchid growing mostly growing on *Melaleuca styphelioides*, but occasionally on rainforest trees or rocks. Extends from south of the Blue Mountains to Queensland. Preferred habitat is coastal swamp forests.	**Low – Moderate** Although the favoured host plant for this orchid, *Melaleuca styphelioides*, for this orchid was recorded within the site during flora surveys, there are no known records for this orchid species in the Lake Macquarie area and it was not recorded during flora surveys. Nevertheless due to the occurrence of potential habitat its presence within the site cannot be totally discounted.	**Low** Unlikely to be adversely affected by the current proposal due to the setting aside of potential habitat for conservation purposes.
Diuris praecox Newcastle Doubletail (V, V*)	Found predominantly in coastal Eucalypt forests on hilltops or slopes. This species has been recorded at a number of dry forest locations to the southeast of Lake Macquarie.	**Moderate** There is opportunity for this species to occur within open forest habitats within the site, but much of the site is represented by open woodland habitats, which are not considered likely to support this species.	**Low** Although there is low potential for this species to occur within the Development Estate lands, those areas representing the best habitat opportunities for this species will be conserved within the current proposal.
Eucalyptus camfieldii Camfield's Stringybark (V)	Tree or mallee to 10m high, but often less. Rare and localised, in coastal shrub heath on sandy soils on sandstone, often restricted drainage. Records from the Hunter Sub-bioregion are largely in near-coastal areas from the Port Stephens LGA to the Central Coast. An isolated stand of trees consistent with this species has been recorded near Kurri Kurri (K. Hill pers. comm.). A local record to the southwest of the site is reported in the Atlas of NSW Wildlife data.	**Moderate** Local status of this species is not clear, due to widespread presence of *Eucalyptus capitellata* within the site, a species to which *E. camfieldii* is very closely aligned. However, due to the abundance of potential habitat within the site and its known occurrence within the locality, the likelihood of it occurring within the site cannot be discounted.	**Low – Moderate** Although there is potential for this species to occur within the Development Estate lands, those areas representing the best habitat opportunities for this species will be conserved within the current proposal.
Genoplesium insignis Variable Midge Orchid (E)	Occurs within a restricted distribution between Chain Valley Bay and Wyong in the Wyong LGA. Habitat is described as a *Themeda australis* ground cover layer with shrubs and *Eucalyptus haemastoma*, *Corymbia gummifera*, *Angophora costata* and *Allocasuarina littoralis* in the canopy layer. This species has been recorded within Lake Macquarie State Recreation Area to the south of the site.	**Moderate – High** The presence of records within the local area and the occurrence of habitat as described from other locations where this species has been recorded suggests that this species is likely to occur within both the conservation lands and the Development Estate within the site.	**Low – Moderate** Although there is potential for this species to occur within the Development Estate lands, those areas representing the best habitat opportunities for this species will be conserved within the current proposal.
Melaleuca biconvexa Biconvex Paperbark (V, V*)	A shrub to small tree, which grows in poorly drained areas from Jervis Bay to Port Macquarie. Records in the Hunter Region are confined to western Lake Macquarie (Atlas of NSW Wildlife data).	**Low** The closest records for this species occur to the west of Lake Macquarie and this species was not recorded during flora surveys conducted within the site. Therefore it is considered unlikely to exist within the site.	**Low** It is unlikely that the current proposal will represent a threat to this species due to the unlikelihood of it occurring within the site.

Species	Habitat Description and Known Populations	Chance of Occurrence within Site	Likely Level of Impact within Development Estate
Microtis angusii Angus's Onion Orchid (E, E*)	Record from the Terry Hill's district of Sydney. Occurs upon disturbed soil horizons that were originally ridgetop lateritic soils supporting a distinctive open to low open forest community, Duffy's Forest Vegetation Community, which is listed as an EEC. Suspected occurrences in the southern Lake Macquarie hinterland are derived from a tentative record by Bell (1998) in the Lake Macquarie State Recreation area, which occurs to the south of Gwandalan.	**Moderate** The presence of records within the local area and the occurrence of habitat as described from other locations where this species has been recorded suggests that this species is likely to occur within both the conservation lands and the Development Estate within the site.	**Low – Moderate** Although there is potential for this species to occur within the Development Estate lands, those areas representing the best habitat opportunities for this species will be conserved within the current proposal.
Syzygium paniculatum Magenta Lilly Pilly (V, V*)	A shrub to small tree, found in sub-tropical and littoral rainforest on sandy soils or sheltered gullies mostly near water courses. Distribution between Bulahdelah and Jervis Bay. Hunter Region records confined to the Lake Macquarie hinterland (Atlas of NSW Wildlife data).	**Low** Marginal habitat for this species occurs within the drainage flats and associated mesic vegetation assemblages of Mangrove Gully and Strangers Gully. Investigation of Lilly Pilly species in these areas identified all species to be *Acmena smithii*.	**Low** It is unlikely that the current proposal will represent a threat to this species due to the unlikelihood of it occurring within the site. Notwithstanding, any possible occurrences within potential habitat will be retained as conservation lands within the current proposal.
Tetratheca glandulosa (V, V*)	Tetratheca glandulosa (Black-eyed Susan) is a small erect or spreading shrub growing to 50cm high. It is found in heath and woodland communities and prefers well-drained soils in an open sunny position	**Low – Moderate** A small amount of sub-optimal habitat exists within the site. Despite searches being conducted during the flowering period, no individuals were recorded within the site. It is therefore considered that this species has a low – moderate chance of occurrence on site	**Low** Considered unlikely to be adversely affected by the current proposal due to suitable habitat existing within the Conservation Estates.
Tetratheca juncea Black-eyed Susan (V)	Occurs in a variety of forested and heathy habitats. Locally found in Open Forests and Woodlands with dense, undisturbed understorey, often in association with *Angophora costata* / *Corymbia gummifera* on slopes with south-easterly aspects. A number of records exist from the local area including the Gwandalan peninsula (Atlas of NSW Wildlife data).	**High** A large population of this species (over 10,000) was located throughout the Coastal Plains Scribbly Gum Woodland and Coastal Plains Smooth-barked Apple Forest within the Gwandalan site. The distribution of the species was spread throughout both the Development Estate and the offset lands, with the majority occurring within the conservation lands.	**Moderate - Low** Part of this population will be removed as part of the proposal (34%), however removal will be kept to a minimum, where possible, due to the requirement for road setbacks within the Development Estate. The current proposal is unlikely to adversely impact upon this species, due the high proportion of the population (74%) which will be retained within conservation lands to the south of the Development Estate within the current proposal and the large populations (over 29,000) which will be conserved within the Wallarah Peninsula.
Herpetofauna			
Crinia tinnula Wallum Froglet (V)	Occurs in coastal, low-lying acid Paperbark forest, within the 'wallum country' (often on sandy soils). Regional records for this species are confined to three main areas; Lake Macquarie, Central Coast and Medowie and Port Stephens (Atlas of NSW Wildlife data).	**High** This species was recorded in three areas within the site, being, permanent swamp sclerophyll wetlands within the lower catchments of Mangrove Gully and Strangers Gully in the east and Tiembula Creek in the west.	**Moderate** The habitats within which this species occurs within the site will be retained within areas dedicated to conservation lands, particularly those occurring in Mangrove Gully and Tiembula Creek. However, minimisation of potential impacts to the population occurring within Strangers Gully will be dependent upon careful management of stormwater from surrounding residential development represented by the proposed Development Estate.
Hoplocephalus bitorquatus Pale-headed Snake (V)	A nocturnal and partially arboreal snake, which inhabits a wide range of habitats from rainforest to drier Eucalypt forest. This species is patchily distributed from Tuggerah to Cape York Peninsula (Cogger 1996). Records in the Hunter Sub-bioregion exist from Paterson (Atlas of NSW Wildlife data).	**Low – Moderate** Due to its generalist habitat requirements, this species could potentially exist in any of the tall open forest habitats within the site, particularly within the catchments of Mangrove Gully and Strangers Gully in the east and Tiembula Creek in the west.	**Low** The habitats within which this species might potentially occur within the site will be retained within areas dedicated to conservation lands. Therefore it is unlikely that the current proposal will threaten the viability of any potential local population of this species.

Species	Habitat Description and Known Populations	Chance of Occurrence within Site	Likely Level of Impact within Development Estate
Hoplocephalus stephensii Stephen's Banded Snake (V)	A nocturnal and partially arboreal snake that inhabits a range of habitats from rainforests to both wet and dry sclerophyll forests from Gosford north into southern QLD (Swan *et. al*. 2004).	**Low – Moderate** Due to its generalist habitat requirements, this species could potentially exist in any of the tall open forest habitats within the site, particularly within the catchments of Mangrove Gully and Strangers Gully in the east and Tiembula Creek in the west.	**Low** The habitats within which this species might potentially occur within the site will be retained within areas dedicated to conservation lands.
Litoria aurea Green and Golden Bell Frog (E, V*)	Inhabits swamps, lagoons, streams and ponds as well as dams, drains and storm water basins. Thought to be displaced from more established sites by other frog species, thus explaining its existence on disturbed sites. Previously widespread within the Sydney Basin Bio-region, but now sparsely distributed within the Lower Hunter and Central Coast areas.	**Low** Wetland habitats within the site are commensurate with potential habitat for this species, but the marked decline of this species from those areas which it once frequented and the absence of records from the locality strongly suggest that this species is unlikely to occur within the site. This species was not recorded within the site during fauna surveys encompassing potential habitat.	**Low** The occurrence of this species within the site is unlikely. In any case, however, habitats within which this species might potentially occur will be retained within areas dedicated to conservation lands.
Litoria littlejohni Little John's Tree Frog (V, V*)	A pale brown frog with dark speckles, which occurs along permanent rocky creeks with thick fringing vegetation associated with Eucalypt woodlands and heaths among sandstone outcrops. Occurs on the plateaus and eastern plains of the Great Dividing Range. Records within the Hunter Region are from within the Watagan National Park.	**Low** This frog is not likely to occur within the study area, given the apparent specificity of habitat to sandstone –based creeks.	**Low** Considered unlikely to be affected by the proposal.
Mixophyes balbus Southern Barred Frog (E, V*)	A relatively large and muscular frog, growing to about 8 cm in length. Stuttering Barred Frogs occur along the east coast of Australia from southern Queensland to north-eastern Victoria. The species has suffered a marked decline in distribution and abundance, particularly in south-east NSW. Found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range.	**Low** This species is unlikely to occur within the site as its known to prefer foothills and escarpment areas well to the west of the site in the Watagan Mountains.	**Low** Considered unlikely to be affected by the proposal.
Mixophyes iteratus Giant Barred Frog (V)	A large frog up to 115 mm in length. It inhabits rainforests, moist eucalypt forest and nearby dry eucalypt forest, at elevations below 1000m. Found in coastal and upland areas from south-eastern Queensland to the Hawkesbury River in NSW. North-eastern NSW, particularly the Coffs Harbour-Dorrigo area, is now a stronghold. Deep damp leaf-litter is preferred shelter and foraging sites for this frog.	**Low** Given the preference of this frog for rainforest and wet sclerophyll forest within mountainous country, it is unlikely to occur within the site.	**Low** Considered unlikely to be affected by the proposal.
Pseudophryne australis Red-crowned Toadlet (V)	The Red-crowned Toadlet has a restricted distribution. It is confined to the Sydney Basin, from Pokolbin in the north, the Nowra area to the south, and west to Mt Victoria in the Blue Mountains and occurs in open forests, mostly on Hawkesbury and Narrabeen Sandstones. Inhabits periodically wet drainage lines below sandstone ridges that often have shale lenses or cappings. Shelters under rocks and amongst masses of dense vegetation or thick piles of leaf litter. Breeding congregations occur in dense vegetation and debris beside ephemeral creeks and gutters. Disperses outside the breeding period, when they are found under rocks and logs on sandstone ridges and forage amongst leaf-litter.	**Low** This frog has quite specific habitat requirements being restricted to substantial areas of Hawkesbury sandstone. It is therefore unlikely to occur within the site.	**Low** Considered unlikely to be affected by the proposal.
Avifauna			
Lophoictinia isura Square-tailed Kite (V)	Inhabits open forests and woodlands, particularly those on fertile soils with abundant passerines. They may also range in nearby open habitats but not into extensive treeless regions. This species is notably absent from alpine regions and small isolated remnant woodlands in large open areas. Records exist from the Cessnock and Maitland LGA's and there are records for this species from Cooranbong in the southwest of the Lake Macquarie LGA (Atlas of NSW Wildlife data; HBOC records). Records for this species within the Lower Hunter are generally limited to Autumn.	**Low – Moderate** Due to the generalist habitat requirements of this species, it could potentially occur within the site on a seasonal basis. Records in the Hunter Sub-bioregion are generally sparse and it would be difficult to locate during targeted surveys.	**Low** Given that those areas most suitable as hunting habitat for this species will be retained within conservation areas it is unlikely that the current proposal will represent a significant threat to this species.

Species	Habitat Description and Known Populations	Chance of Occurrence within Site	Likely Level of Impact within Development Estate
Pandion haliaetus Osprey (V, M*)	Requires water bodies for fishing in close proximity (usually <1km) to suitably tall nesting site such as dead tree, power pole etc. Recorded from various sites around Lake Macquarie, Port Stephens and the Hunter River Estuary. An accidental species on freshwater wetlands away from the coast. Coastal records for this species occur to the southeast of the site.	**Moderate** Ospreys have been recorded in southern Lake Macquarie and the waters of Crangan Bay offer excellent hunting opportunities for this species. A large unoccupied nest, potentially belonging to this species, occurs outside of the Development Estate to the west of Mangrove Gully's mouth. Note: The nesting habits of Ospreys and White-bellied Sea Eagles are very similar. Targeted ground searches for foraging material and / or white wash proved fruitless. Given the frequent observations of White-bellied Sea Eagles in the vicinity of the site it is most likely that the nest belongs to this species. The nest is a sufficient distance from the Development Estate to prevent disturbance to nesting birds.	**Low** Potential nesting habitat for this species will be retained within the current proposed.
Ixobrychus flavicollis Black Bittern (V)	Solitary species, living near water (estuarine to brackish) in mangroves and other trees which need to form only a narrow fringe of cover. A riparian species that occasionally ventures into the open within estuarine habitats.	**Moderate** This species is known to occur along the lower tidal sections of creeks entering Lake Macquarie (Author pers. obs. HBOC) and it is possible that this species may use the lower reaches of Mangrove Gully and Tiembula Creek for foraging and possible nesting purposes.	**Low – Moderate** The habitats within which this species potentially occurs within the site will be retained within areas dedicated to conservation lands, including those occurring in Mangrove Gully and Tiembula Creek. Despite the conservation of these lands, there is potential for the Bittern's estuarine foraging habitats to be adversely impacted upon by increases in stormwater and sediment flows unless sediment and stormwater management plans are incorporated into the planning, construction and residential phases of the current proposal.
Callocephalon fimbriatum Gang-gang Cockatoo (V)	Occurs in forests and woodlands where it forages on the seed capsules of Eucalypts. Sedentary, seasonally nomadic or part-migratory, this species shows a general trend to leave highland habitats in winter for more lowland districts. Requires large Eucalypt tree hollows for nesting. Records exist from the Watagan Mountains and adjacent lowlands and foot hills (Atlas of NSW Wildlife data; Author pers. obs.).	**Low – Moderate** Most local records for this species occur from the Watagan Mountains and their adjacent lowlands, well to the west of the site. However, seasonal movements of this species to areas east of the Watagans have been observed (Author pers. obs.) and this species is known to feed on the fruit of *Eucalyptus signata*, which is abundant within the site. Therefore its use of the site on at least an intermittent basis cannot be discounted.	**Low** Areas representing potential foraging habitat for this species will be retained within the current proposal.
Calyptorhynchus lathami Glossy Black-Cockatoo (V)	Occurs in forests and woodlands where it forages predominantly on *Allocasuarina* cones. Requires large Eucalypt tree hollows for nesting. Records within the Hunter Sub-bioregion predominantly from relatively undisturbed forested areas on the ranges such as the Watagan Forests, with isolated records from the valley floor remnants. Locally there are records from Gwandalan and Point Wollstonecraft (Atlas of NSW Wildlife data) to the north of the site.	**High** Due to the occurrence of records within the vicinity of the site and the abundant presence of *Allocasuarina littoralis* (Black She-oak), which is a known feed species for Glossy Black-Cockatoos, it is highly likely that this species occurs within the site on at least an intermittent basis.	**Low** Although it is likely that a small amount of foraging resources for this species may be lost during the process of development, large areas containing foraging habitat and potential nesting habitat will be retained and protected as conservation lands under the current proposal.
Climacteris picumnus subsp. *victoriae* Brown Treecreeper (V)	Occurs through central NSW on the western side of the Great Dividing Range and sparsely scattered to the east of the Range in drier areas such as the Cumberland Plain of Western Sydney, and in parts of the Hunter, Clarence, Richmond and Snowy River valleys. Frequents drier forests and woodlands, particularly open woodland lacking a dense understorey, but also grasslands where there are sufficient logs, stumps and dead trees nearby. Within the Lower Hunter Valley, this species is known from Werakata National Park, Rothbury, the HEZ and Ellalong (Atlas of NSW Wildlife).	**Low** This species was not recorded within the site during fauna survey. Birds southeast of the Sugarloaf population are rare and as such the chance of occurrence is low	**Low** Considered unlikely to be adversely affected by the proposal due to the lack of records within the vicinity of the Development Estate. Habitat will retained within the proposed Conservation Estates

Species	Habitat Description and Known Populations	Chance of Occurrence within Site	Likely Level of Impact within Development Estate
Xanthomyza phrygia Regent Honeyeater (E, E*)	Nomadic Honeyeater that disperses to non-breeding areas, including the coast, in winter, where flowering trees are sought. Within the Lake Macquarie LGA this species is generally associated with *Eucalyptus robusta* (Swamp Mahogany). Local occurrences are during winter months when this species flowers, although their stronghold is west of the great divide and it appears that movements to the coast only occur when foraging resources to the west and, to some extent, the Central to Lower Hunter Valley fail.	**Moderate** Potential foraging habitat for this species in the form of winter-flowering eucalypts, such as *E. robusta* and *E. tereticornis*. Therefore its seasonal presence within the site on at least an intermittent basis cannot be discounted.	**Low** Those areas representing potential foraging habitat for this species will be retained within the current proposal.
Lathamus discolor Swift Parrot (E, E*)	On the mainland this species frequents Eucalypt forests and woodlands with large trees having high nectar production during winter. Mainland winter foraging sites often vary from year to year. Nests only in Tasmania. When recorded within the Lake Macquarie LGA this species is often associated with winter flowering eucalypt species such as *E. robusta* and *E. tereticornis* (Author pers. obs.), but they are known to forego nectar resources for lerps, which occur on a variety of eucalypt species. Locally this species has been recorded on Point Wollstonecraft to the north, the Wallarah Peninsula to the northeast and Wyee Point to the west (Atlas of NSW Wildlife data).	**Moderate – High** Due to the occurrence of records within the vicinity of the site, its high mobility and the presence of winter-flowering eucalypts, such as *E. robusta* and *E. tereticornis* within the site, it is highly likely that this species occurs within the site on at least an intermittent basis.	**Low** Those areas representing potential foraging habitat for this species will be retained within the current proposal.
Glossopsitta pusilla Little Lorikeet (V)	*Glossopsitta pusilla* extends from Cairns to Adelaide coastally and to inland locations. Commonly found in dry, open eucalypt forests and woodlands. Can be found in roadside vegetation to woodland remnants. *G. pusilla* feeds on abundant flowering Eucalypts, but will also take nectar from, *Melaleuca* sp and *Mistletoe* sp. *Eucalyptus albens* (White Box) and *E. melliodora* (Yellow Box) are favoured food sources on the western slopes in NSW. On the eastern slopes and coastal areas favoured food sources are *Corymbia maculata* (Spotted Gum), *E. fibrosa* (Broad-leaved Ironbark), *E. robusta* (Swamp Mahogany) and *E. pilularis* (Blackbutt). Nesting takes place in hollow bearing trees.	**High** This species was recorded within the site. Habitat within the site is considered suitable for both foraging and roosting and records occur within the locality.	**Low – Moderate** Although it is likely that a small amount of potential habitat for this species may be lost during the process of development. Extensive areas of high quality foraging and nesting habitat for this species will be retained as Conservation Lands.
Ninox strenua Powerful Owl (V)	Occurs in sclerophyll forests and woodlands where suitable prey species occur (being predominantly arboreal mammals). Requires large hollows, usually in Eucalypt trees, for nesting. Roosts in dense vegetation within such areas. Records from the Hunter Sub-bioregion are fairly widespread (HBOC records; RPS ecologists pers. obs.).	**Moderate – High** A 2002 record (Atlas of NSW Wildlife data) for this species occurs just outside the southern boundary of the western portion of the site near Tiembula Creek and there is a 2003 (Atlas of NSW Wildlife data) record from the eastern side of Crangan Bay. Arboreal mammals, which are the preferred prey of this species, were found to occur at moderate abundances within the site, so it is likely that the site represents part of the home range of individuals from this species. Despite targeted searches, including call playback surveys, this species was not recorded within the site during fauna surveys. Habitat assessment noted hollows of sufficient size to represent potential breeding sites for this species.	**Low - Moderate** Although it is likely that a small amount of foraging habitat for this species may be lost during the process of development, large areas containing foraging habitat and potential nesting habitat will be retained as conservation lands under the current proposal.
Tyto novaehollandiae Masked Owl (V)	Found in a range of habitats, locally within sclerophyll forests and woodlands where appropriate / preferred prey species occur (being predominantly terrestrial mammals). Requires large Eucalypt hollows for nesting and prefers to roost in these hollows as well. Records from the Hunter Sub-bioregion are fairly widespread within the sub-coastal districts and often of road kill birds (HBOC records; RPS ecologists pers. obs.). Local records for this species occur on Point Wollstonecraft, several on the Wallarah Peninsula and within the site to the east of Mangrove Gully.	**High** There are a number of records for this species within the vicinity of the site and the terrestrial mammal species that they prefer occur within the site in abundance. Therefore it is highly likely that the site represents part of the home range of individuals of this species. Hollows of sufficient size to represent potential breeding sites for this species were noted during habitat assessment.	**Low - Moderate** Although it is likely that a small amount of foraging habitat for this species may be lost during the process of development, large areas containing foraging habitat and potential nesting habitat will be retained as conservation lands under the current proposal.

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Tyto tenebricosa Sooty Owl (V)	Occurs in wet Eucalypt forest and rainforest with tall emergent trees, often in easterly facing gullies. Within these areas this species hunts for a range of mainly mammalian prey at all levels of the forest strata. Roosts in tree hollow or dense canopy vegetation. Also nests in large Eucalypt tree hollows. Most Hunter records exist from the Watagan mountains (Atlas of NSW Wildlife data), but this species has also been observed to the southwest of Awaba (RPS ecologist pers. obs.).	**Low** Despite the presence of mesic vegetation assemblages in Mangrove Gully, these communities cannot be classified as wet sclerophyll and are not of sufficient extent or structural diversity to support this species, despite a record existing for this species in the north on the Wallarah Peninsula.	**Low** The current proposal is unlikely to impact upon this species due to a lack of suitable habitat within the site.
Mammals			
Planigale maculata Common Planigale (V)	A cryptic species known from a variety of habitats ranging from rainforest, wet and dry sclerophyll forests to grasslands, marshlands and rocky areas. In these habitats it shelters under logs and rocks and any available burrows such as cracking soils. It is a ferocious predator of small insects, often tackling prey of its own size. Within the Hunter Sub-bioregion, no records exist on the Atlas of NSW Wildlife. Records from the wider locality occur only from the Watagan Mountains and Barrington Tops National Park	**Low** Given its generalist habitat requirements it could potentially occur anywhere containing wooded habitat, although given the complete lack of records in the Lake Macquarie LGA outside of the Watagan Mountains it is considered unlikely to occur within the site.	**Low** Considered unlikely to be affected by the proposal.
Dasyurus maculatus Spotted-tailed Quoll (V)	Found in a variety of forested habitats where suitable prey species occur. This species creates a den in fallen hollow logs or among rocky outcrops. Generally does not occur in otherwise suitable habitats that are in close proximity to urban development, although isolated records from such areas do exist. In the southern Lake Macquarie locality there are a number of records, including a 1998 record from Point Wollstonecraft.	**Low – Moderate** The chances of occurrence are relatively low despite the occurrence of local records, due to the levels of ongoing disturbance within the site.	**Low** Considered unlikely to be resident although those areas of greatest potential to represent habitat for this species will be retained as conservation areas within the current proposal.
Petaurus australis Yellow-bellied Glider (V)	Usually associated with tall, mature wet Eucalypt forest. Also known from tall dry open forest and mature woodland. The diverse diet of this species is primarily made up of Eucalypt nectar, sap, honey dew, manna and invertebrates found under decorticating bark and pollen. Tree hollows for nest sites are essential, as are suitable food trees in close proximity. Most records in the Lower Hunter Region occur in the Watagan Mountains and other areas exhibiting significant stands of forest (Atlas of NSW Wildlife data).	**Low** No coastal records occur for this species in the vicinity of the site.	**Low** The current proposal is unlikely to impact upon this species due to a lack of suitable habitat within the site.
Petaurus norfolcensis Squirrel Glider (V)	Occurs in Eucalypt forests and woodlands where it feeds on sap exudates and blossoms. In these areas tree hollows are utilised for nesting sites. Also requires winter foraging resources when the availability of normal food resources may be limited, such as winter-flowering shrub and small tree species. Widely distributed across the lower Hunter Sub-bioregion, few records from the Upper Hunter (Atlas of NSW Wildlife data). Locally there are a number of records for this species on the Gwandalan peninsula.	**High** This species was recorded in Swamp Oak forest in the site's southeast and in *Eucalyptus gummifera* (Red Bloodwood) stands on the fringes of Strangers Gully where it was observed feeding on sap. Glider feeding scars were noted within Bloodwood stands on the eastern and western sides of Kanangra Drive, although the closely related Sugar Glider was also observed feeding on Bloodwood sap within the site during nocturnal surveys.	**Low - Moderate** Although it is likely that a small amount of foraging habitat for this species may be lost during the process of development, large areas containing foraging habitat and potential nesting habitat will be retained as conservation lands under the current proposal.
Phascolarctos cinereus Koala (V)	Occurs in forests and woodlands where it requires suitable feed trees (particularly *Eucalyptus* spp.) and habitat linkages. Will occasionally cross open areas, although it becomes more vulnerable to predator attack and road mortality during these excursions. Records from the Hunter Sub-bioregion are generally scarce, with a small number of records from Cessnock, Singleton and Muswellbrook LGA's. Within the Greater Hunter Region it is largely confined to the Port Stephens area, the Lake Macquarie hinterland and the Watagan Mountains (Atlas of NSW Wildlife data).	**Low – Moderate** A single record for Koalas occurs at the southern end of the site within Mangrove Gully. No evidence of Koalas was observed during fauna surveys.	**Low** Those areas representing potential foraging habitat for this species will be retained within the current proposal.

Species	Habitat Description and Known Populations	Chance of Occurrence within Site	Likely Level of Impact within Development Estate
Cercartetus nanus Eastern Pygmy Possum (V)	Occurs from rainforest through sclerophyll forest to tree heath. Favoured food includes banksias, myrtaceous shrubs and trees and insects. Nesting sites are generally in drier habitats. Records in the Hunter Sub-bioregion are very scarce. Within the Greater Hunter Region records exist from the Watagan Mountains and Barrington Tops National Park (Atlas of NSW Wildlife data).	**Low - Moderate** No indications that this species occurs within the site were observed during fauna surveys, although there are areas of heathy habitat, particularly to the west of Kanangra Drive, which appear to contain suitable resources for this species.	**Low** Those areas representing potential habitat for this species will be retained within the current proposal.
Pteropus poliocephalus Grey-headed Flying-fox (V, V*)	Forages over a large area for nectar / fruits etc. Seasonally roosts in communal base camps situated within wet sclerophyll forests or rainforest. Frequently observed to forage in flowering Eucalypts. May occur anywhere within the Hunter Sub-bioregion where food or roosting resources are available.	**High** Recorded at a number of locations within the site associated with flowering *E. robusta.* There are no roosting camps for this species in the vicinity of the site.	**Low - Moderate** Those areas representing potential foraging habitat for this species will be retained within the current proposal.
Miniopterus schreibersii Eastern Bentwing-Bat (V)	This species utilises a range of habitats for foraging, including rainforest, wet and dry sclerophyll forests, woodlands and open grasslands. Requires caves or similar structures for roosting habitat. Widely distributed across the Hunter Sub-bioregion, particularly in sub-coastal districts (Atlas of NSW Wildlife data). A number of records for this species occur within the vicinity of the site, including a record from the northern end of the site.	**High** This species is likely to use the site regularly as part of its foraging range, but no roosting habitat is known within the site.	**Low - Moderate** Although it is likely that a small amount of foraging habitat for this species may be lost during the process of development, large areas containing foraging habitat will be retained as conservation lands under the current proposal and foraging opportunities will continue to exist within the Development Estate.
Miniopterus australis Little Bentwing-bat (V)	Prefers to forage in well-vegetated areas, such as within wet and dry sclerophyll forests and rainforests. Requires caves or similar structures for roosting habitat. Largely confined to more coastal areas in the Hunter region (Atlas of NSW Wildlife data). A number of records for this species occur within the local area (Atlas of NSW Wildlife data).	**High** This species was recorded during bat surveys and is likely to use the site regularly as part of its foraging range, but no roosting habitat is known within the site.	**Low - Moderate** Although it is likely that a small amount of foraging habitat for this species may be lost during the process of development, large areas containing foraging habitat will be retained as conservation lands under the current proposal and foraging opportunities will continue to exist within the Development Estate.
Mormopterus norfolkensis Eastern Freetail-bat (V)	This species forages predominantly in dry forests and woodlands east of the divide. It roosts in tree hollows, under bark and within man-made structures. Found within a scattered distribution across the Lower Hunter Region. Locally it occurs within the Lake Macquarie hinterland and a record exists from the north of the site (Atlas of NSW Wildlife data).	**Moderate – High** This species is likely to use the site regularly as part of its foraging range, and may use the abundant hollows within the site for roosting habitat.	**Low - Moderate** Although it is likely that a small amount of foraging habitat for this species may be lost during the process of development, large areas containing foraging and roosting habitat will be retained as conservation lands under the current proposal and foraging opportunities will continue to exist within the Development Estate.
Saccolaimus flaviventris Yellow-bellied Sheathtail-bat (V)	Occurs in a range of habitats from rainforest to arid shrubland, roosts in tree-hollows. Near coastal records occur to the south in the Wyong and Gosford LGA's (Atlas of NSW Wildlife data).	**Moderate - High** Due to its mobility and the occurrence of other records in near coastal districts to the south it is likely that this species uses the site on at least an intermittent basis. Potential roosting habitat for this species occurs within the site.	**Low - Moderate** Although it is likely that a small amount of foraging habitat for this species may be lost during the process of development, large areas containing foraging and roosting habitat will be retained as conservation lands under the current proposal and foraging opportunities will continue to exist within the Development Estate.
Falsistrellus tasmaniensis Eastern False Pipistrelle (V)	This species is found in a variety of forest types such as open forests, woodlands and wetter sclerophyll forests (usually with trees >20m). This species roosts in tree hollows. Few records occur within the Hunter Sub-bioregion, but locally a record for this species occurs on Pulbah Island to the north (Atlas of NSW Wildlife data).	**Moderate - High** Due to its mobility and the occurrence of records within the locality it is likely that this species uses the site on at least an intermittent basis. Potential roosting habitat for this species occurs within the site.	**Low - Moderate** Although it is likely that a small amount of foraging habitat for this species may be lost during the process of development, large areas containing foraging and roosting habitat will be retained as conservation lands under the current proposal and foraging opportunities will continue to exist within the Development Estate.