Ecological Assessment Report

Southern Lake Macquarie Lands

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Disclaimers

Executive Summary

Introduction

RPS Australia East Pty Ltd (RPS) has been commissioned by Rosegroup Pty Ltd to undertake an Ecological Assessment Report (EAR) over land at Catherine Hill Bay (CHB) and Gwandalan, for proposed development and offsets as outlined within the Lower Hunter Regional Strategy. The proposal is to be assessed under Part 3A of the Environmental Planning and Assessment Act 1979. The proposal has previously been assessed under the Commonwealth Environment Protection & Biodiversity Conservation Act 1999 with approval granted with conditions on the 27 February 2009 under Section 133 of this Act (attached as Appendix A). This approval was subject to NSW assessment under the agreement relating to Environmental Impact Assessment between the Commonwealth and NSW.

The report herewith builds on previous works undertaken over several years by Wildthing and EcoBiological, and provides an overall summation of ecological findings to date, impact assessment of development / conservation outcomes, and recommendations for moving forward.

Background

Previous ecological investigations have been undertaken across various portions of the land over the past four years. RPS was commissioned to produce an EAR that collates and builds on previous ecological investigations and provides the necessary level of detailed information for the assessment of the proposal under relevant legislation.

The overall proposal includes the development of up to 60ha of land at CHB and up to 18ha of land at Gwandalan. As an environmental offset for these proposals approximately 294 ha of land for conservation has been transferred to the NSW Minister of the Environment.

The majority of land subject to the proposal, and including the offsets area, is collectively referred to as 'the site' and is located between the coast at CHB and the shores of Lake Macquarie at Crangan Bay, with a smaller portion of land located at Kanangara Drive, Gwandalan. The site includes incorporating development of up to 60ha at CHB and up to 18ha at Gwandalan, referred to as the 'Catherine Hill Bay (CHB) Development Lands' and the 'Gwandalan Development Lands' respectively.

This report also includes consideration of the 294 ha of land to offset ecological impacts, referred to as the 'Offset Lands'. Offset Lands have been transferred to the Minister of the Environment. This report has been prepared with due reference to the Draft Guidelines for Threatened Species Assessment as relates to Part 3A applications.

Methods

This assessment has due regard to DECC's Threatened Species Assessment Guidelines. These guidelines refer the user to consult the Threatened Biodiversity Survey and Assessment Guidelines – Working Draft (DEC 2004) and any relevant recovery plans and threat abatement plans for ecological assessment. In brief the methods employed to assess the ecological merit of the site involved the following:

- Literature review
- Field investigations incorporating flora identification and vegetation mapping, and targeted surveys for significant flora species
- Habitat identification and assessment
- Fauna survey work, including targeted surveys for significant fauna species
- Data collation and interpretation, leading to EAR production

The works undertaken are considered to provide a detailed baseline dataset that enables a sufficient level of assessment and reporting to occur to satisfy the relevant legislation.

Results

Flora
The combined results of various flora surveys undertaken have confirmed the presence of two threatened flora species and four Endangered Ecological Communities within the site.
Threatened species recorded include:

- *Cryptostylis hunteriana*

C. hunteriana was identified within the Narrabeen Doyalson Coastal Woodland within the northern section (Hamlet 6) of the CHB Development Lands.

Nine patches of *C. hunteriana* were found resulting in 43 flowering stems being recorded within the Narrabeen Doyalson Coastal Woodland of the CHB proposed offset area.

C. hunteriana has a history of flowering sporadically, going for years at a time not producing any flower which makes it difficult to accurately determine potential population sizes. However, the works undertaken to date within both proposed Development Lands (one clump, 10 specimens) and within proposed offset areas (nine clumps, 43 specimens) would seemingly indicate that the level of conservation of this species would be greater than the 4:1 ratio applied at an elementary level across all other facets of biodiversity assessed for this proposal.

- *Tetratheca juncea*

A total of 1,607 *Tetratheca juncea* plants were located during the targeted surveys within the site A total of 369 *T. juncea* clumps would be removed as part of the proposal (189 recorded within the CHB Development Lands and 180 recorded by Wildthing (2003b) within the Gwandalan Development Lands).

A total of 1024 *Tetratheca juncea* clumps were recorded during the targeted surveys within the Offset Lands.

A number of other threatened flora species were considered to have potential habitat within the site. Separate targeted searches were undertaken by previous surveys which have occurred within the site (Wildthing, 2003a; 2003b; 2004a; 2004b; 2004c; EcoBiological, 2006a; 2006b)

Endangered Ecological Communities included:

- Coastal Sand Mahogany-Paperbark Swamp Forest (**EEC Swamp Scerlophyll Forest**);
- Estuarine Swamp Oak Forest (**EEC Swamp Oak Floodplain Forest**);
- Estuarine Mangrove-Saltmarsh Complex (**EEC Saltmarsh**);
- Freshwater Wetland Complex (**EEC – Freshwater Wetlands on Coastal Floodplains**);

Only a very small amount of one EEC would be affected by the proposal. Additionally, any long-term discernable impacts are considered likely to be minimal. The offset areas far exceed the areas to be affected either directly or indirectly by development.

Fauna

A total of 15 threatened fauna species were recorded or considered likely to occur within the Development Lands and had a moderate chance of potential impact. These species included Wallum Froglet, Glossy Black-Cockatoo, Regent Honyeater, Swift Parrot, Powerful Owl, Masked Owl, Eastern Pygmy Possum, Grey-headed Flying-fox, Little Bentwing-bat, Eastern Bentwing Bat, Eastern Freetail Bat, Yellow-bellied Sheathtailed Bat, Eastern False Pipistrelle, Large-footed Myotis and Greater Broad-nosed Bat.

Potential breeding habitat exists within the Gwandalan Development Lands for the Masked Owl and Glossy Black Cockatoo which were recorded onsite. Targeted surveys were undertaken for both these species.

Glossy Black Cockatoos were observed flying over the north western part of the site except on one occasion when four birds landed briefly within the site and then moved on. No foraging was observed when the species was observed within the site. The species was recorded on each occasion in the late afternoon prior to dusk and are considered likely to be the same birds. Potentially, these birds were flying from a feed site (somewhere east of the site) to their roosting site (somewhere west of the site). There were no indications of breeding or attempted breeding during the survey period for Glossy Black Cockatoo.

The Masked Owl was recorded from the site in 2003 by Wildthing Consultants. However, targeted searches on six separate occasions from March to August 2009 including spotlighting, stag watching, call playback and secondary indications searches failed to find any observations, signs or breeding evidence of Masked Owl.

Relevant recommendations are provided below to assist in minimising any potential impacts on the abovementioned species / communities.

Conclusion & Recommendations

The outcomes for the site were formulated on existing ecological information. The studies undertaken herewith confirm that development of a small portion of the site is adequately offset for ecological outcomes by the dedication of the Offset Lands The quantum of the Offset Lands, when viewed holistically with proximate existing and proposed conservation reserve areas, provides a robust long-term outcome for local species and communities.

The field and desktop studies have recorded the following parameters of ecological significance within both the Offset Lands and the development estate:

- native vegetation commensurate with those listed as EEC's;
- threatened flora species recorded within and adjacent to the proposed development;
- threatened fauna species recorded within and adjacent to the proposed development;
- habitat for threatened flora and fauna species known from within and adjacent to the proposed development; and
- other areas containing native vegetation with varying degrees of modification / degradation.

Given that the measures have been taken to avoid ecological impacts and that where native vegetation may be affected, efforts have been made to avoid particularly sensitive areas where practical, it is considered unlikely that any significant impacts would occur upon threatened species, communities or populations. The large areas of Offset Lands set aside as part of the development provide excellent long-term ecological outcomes across the site. As a result of conservation of these Offset Lands, coupled with other large land parcel dedications in the locality, a large vegetation corridor will be created across the Wallarah Peninsula. These Offset Lands will link three state conservation areas of Lake Munmorah State Conservation Area, Lake Macquarie State Conservation Area and Wallarah National Park. This large tract of native vegetation will provide conserved habitat for a wide variety of native flora and fauna.

Therefore, it has been concluded that, providing the recommended mitigation measures are adopted, the proposed development should not significantly impact upon threatened or regionally significant flora and fauna, ecological communities or populations. The implementation of operative environmental management practices should also ensure that the ecological impact of the project is minimised.

The following recommendations have been outlined to ensure that the ecological impact of the proposal is minimised as far as possible:

- A management plan will be prepared for the removal of *Cryptostylis hunteriana* within the CHB Development Lands, this is to be undertaken in accordance with the EPBC approval (attachment 1).
- Protection and minimisation of disturbance to White-bellied Sea-eagle nest occurring in the Offset Lands in consultation with DECC.
- Strict management of stormwater runoff from both CHB and Gwandalan Development Lands must occur to minimise potential impacts on EECs, SEPP 14 wetlands and known Wallum Froglet habitat.
- Implement the following SEPP 14 buffers:

- A primary riparian buffer of 50 m from wetland vegetation, where no land uses are permitted that significantly detract from the potential of the buffer to achieve the goal of wetland protection. This buffer would consist predominantly of existing fringing vegetation.
- Where these buffers are unable to be implemented within the proposed development design, additional control measures should be investigated in consultation with experienced wetland hydrologists and engineers to ensure that potential impacts on the SEPP 14 wetland are minimised.

- A weed management and monitoring plan for the CHB Development Lands should be developed and implemented to minimise the potential for the invasion of aquatic and terrestrial weed species into the SEPP 14 wetland and buffer zones. The weed management and monitoring plan for CHB Development Lands should be developed in consultation with DECC to ensure consistency with management strategies undertaken for the adjacent Munmorah SCA and Offset Lands;
- The management of the development and conservation land interface is critical to ensure that no direct or indirect impacts occur in the short and long term on dedicated Offset Lands. As such, appropriate management plans should be prepared and implemented within the CHB and Gwandalan Development Lands in consultation with DECC to ensure consistency of management strategies with adjacent Offset Lands.
- The minimum amount of clearing should take place as a general objective of the project, particularly within those areas that currently contain identified native vegetation communities. These areas have been described within this report. This is especially important within those areas identified as containing vegetation consistent with EEC's.
- Mature and / or hollow-bearing trees should be retained wherever feasible and with regards to public safety within the development framework, particularly within Gwandalan Development Lands where there are no offsets immediately adjacent to the site.
- Pre-clearance surveys should be conducted within the development areas during the period before construction commencement in order to identify any breeding or nesting activities by native fauna within wooded areas. No breeding attempts or active nests should be disrupted as far as is practical during the course of the project.
- During the construction phase, for any tree removal within forested areas, and in particular where hollow-bearing trees may be removed, all works should be supervised by an ecologist to recover any native fauna that are potentially displaced. Furthermore, where such risks occur, site-specific ecological advice should be sought to minimise impacts during the entire process. A clearing protocol should be adopted for the removal of trees containing suitable habitat hollows as follows (this is considered as a guideline, variations on the methods employed may be required to accommodate site specific factors):
  - All hollow bearing trees are to be flagged by an ecologist prior to the commencement of works on site.
  - Underscrubbing of the entire site should be carried out by a 4x4 tractor with a slashing deck, this will minimise the establishment of degradation processes and leave a layer of mulch to aid in soil retention in the event of adverse weather. At this time felling of non habitat trees can take place, however a matrix of trees must be maintained to allow animal movement into the designated refuge area.
  - After a period of two weeks, clearing of habitat trees should commence. Clearing must be

carried out moving from the fringe of the matrix towards the refuge area. Trees should be 'soft felled' and inspected immediately by an ecologist for displaced fauna. All trees must be left for a minimum of two nights prior to being moved to a stockpile, to allow resident fauna to vacate tree hollows.

***Note**: Clearing should ideally take place outside of the main breeding seasons of resident fauna, preferably during late Autumn and Winter.*

- Species selection for future landscaping works and seed stock for revegetation should be limited to locally occurring native species to maintain local genetic diversity. This should include Eucalyptus robusta and other regionally significant species.
- Appropriate vegetation, habitat and bushfire management plans should be included under an overarching Environmental Management Plan for the Gwandalan site.
- Where possible, earthworks (and certainly all works in the vicinity of drainage lines) should be undertaken during appropriate (i.e. dry) weather conditions. This will ensure that any potential erosion events will be intercepted and that no downstream impacts occur within any of the drainage lines. This will help to maintain existing habitat characteristics for native fauna in those areas, including those for threatened species.
- Nutrient and sediment control devices should be erected pre-clearing and post-construction works in sensitive areas where degradation processes may be triggered such as areas adjacent to watercourses until suitable rehabilitation has occurred to maintain surface integrity. Furthermore, stockpiles should be subject to individual sediment and nutrient control devices.
- Where possible, landscape sediment retention ponds with fringing wetland vegetation (eg Typha sp.) to provide habitat for species such as Green and Golden Bell Frog.

Terms & Abbreviations

Abbreviation	Meaning
aff.	Affinity
CHB	Catherine Hill Bay
CHB Development Lands	proposed lands to be developed at Catherine Hill Bay
CMA	Catchment Management Authority
DBH	Diameter at Breast Height (centimetres)
DEWHA	Department of the Environment, Water, Heritage and the Arts
DECCW	NSW Department of Environment, Climate Change Water
DEWHA	Commonwealth Department of Environment and Water Resources
LHRCP	Lower Hunter Regional Conservation Plan
DoP	NSW Department of Planning
EAR	Ecological Assessment Report
EEC	Endangered Ecological Community
EMP	Environmental Management Plan
EPA Act	*NSW Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
FM Act	NSW *Fisheries Management Act 1994*
ha	hectare
HBOC	Hunter Bird Observers Club
Hwy	Highway
LGA	Local Government Area
LHRS	Lower Hunter Regional Strategy
NPWS	NSW National Parks and Wildlife Service
Offset Lands	Lands to be dedicated to conservation
PFC	Projected Foliage Cover
RPS Australia East Pty Ltd	RPS
RPS HSO	RPS Harper Somers O'Sullivan
ROTAP	Rare or Threatened Australian Plants (Briggs & Leigh 1995)
Ssp. or subsp	Subspecies
Sp	Singular Species
Spp	Multiple Species
SSS	State Significant Site
TSC Act	NSW *Threatened Species Conservation Act 1995*
Var.	Variety

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Qualifications of Personnel

1 Introduction

RPS has been commissioned by Rosegroup Pty Ltd to undertake an *Ecological Assessment Report* (EAR) over land at Catherine Hill Bay (CHB) and Gwandalan, to inform proposed development and associated conservation offsets as outlined within the Lower Hunter Regional Strategy and the EPBC approval. The proposal is to be assessed under Part 3A of the *Environmental Planning and Assessment Act 1979*, as amended by the *Environmental Planning and Assessment Amendment Act 1997*. Due recognition and consideration of the *Threatened Species Conservation Act 1995* and the *Fisheries Management Act 1994* has been made throughout this assessment. The proposal has also been assessed under the Commonwealth *Environment Protection & Biodiversity Conservation Act 1999* and approval granted with conditions on the 27 February 2009 under Section 133 of this Act (attached as Appendix A).

1.1 Background

The proposal includes the development of up to 60 ha of land at CHB for residential purposes, up to 16 ha of land at Gwandalan and the provision of 294 ha of land to conservation (transferred to the Minister for the Environment). An approval for residential, retail and commercial purposes, an "action", over 60 hectares at Catherine Hill bay site and 18 hectares at Gwandalan was made under the Commonwealth EPBC Act in February 2009 (attached as Appendix A). The approval requires the action to be under taken "generally as described in the final Catherine Hill Bay and Gwandalan Concept Plan including the dedication of lots 104, 105 and 107 as conservation areas". The land dedications were the environmental offsets for the development (actions) at Catherine Hill Bay and Gwandalan. This approval was subject to NSW assessment under the agreement relating to Environmental Impact Assessment between the Commonwealth and NSW.

Previous ecological investigations have been undertaken over the past four years across various portions of the land. This EAR collates builds on previous ecological investigations and provides the necessary level of detailed information for the assessment of the proposal under relevant legislation.

1.2 Site Particulars

Locality – The site occurs within the Wallarah Peninsula with the study sites situated on the southern end of the Costal Hamlet known as Catherine Hill Bay and at Gwandalan on the south-western side of Lake Macquarie.

LGA – Lake Macquarie City Council and Wyong Shire Council

Title(s) – *CHB* - Lot 2 DP 809795, Lot 2031 DP 841175, Lot 6 DP 774923, Lot 5 DP 774923; *Gwandalan* – Lot 3 DP588205.

Area – The site includes 60ha of land to be developed at CHB, 16 ha of land to be developed at Gwandalan (approximately 2 ha of vegetated land is to be remain as a park area) and the 294 ha of land dedicated as Offset Lands to the NSW Government.

Boundaries – The land at Gwandalan is bounded by the shores of Lake Macquarie to the north-east, Lake Macquarie State Conservation Area (SCA) to the north, private vegetated land to the west and existing residential development to the south-east. The remainder of the site extends from the coast at CHB in the east, to the shores of Lake Macquarie at Crangan Bay in the west, by the Village of CHB and privately owned lands to the north and finally by Munmorah SCA to the south.

Current Land Use – Landuse at Gwandalan includes residential and recreational facilities, pastures for grazing, maintenance of parkland-type vegetation and relatively unmanaged remnant bushland. The lands at CHB include portions that have been highly disturbed by mining and large tracts of natural bushland that are not in current use.

Topography – The majority of the site is characterised by undulating low coastal hills, gently sloping to the shores of Lake Macquarie. The site rises to the headland at CHB where a steep drop to the ocean occurs.

1.3 Description of the Proposal

The majority of land subject to the proposal, collectively referred to as 'the site' is located between the coast at CHB and the shores of Lake Macquarie at Crangan Bay, with a smaller portion of land located at Kanangara Drive, Gwandalan. The site includes two proposed residential developments; the first includes development of up to 60ha at CHB and up to 18ha at Gwandalan, referred to as the 'CHB Development Lands' and the 'Gwandalan Development Lands' respectively. This report also includes consideration of the 294 ha of land to offset potential ecological impacts, referred to as the 'Offset Lands'. Offset Lands have been transferred to the NSW Minister of the Environment. This report has been prepared with due reference to the Draft Guidelines for Threatened Species Assessment as relates to Part 3A applications.

Rosegroup companies owned approximately 391 ha of land in the Lower Hunter Region which is included in the Lower Hunter Regional Strategy (LHRS) (DoP, 2007) and the Lower Hunter Conservation Plan (LHCP) (DECC, 2006) for urban development and conservation. Rosegroup companies form one of four major landowners within the region that play a significant role in achieving the LHRS's environmental and conservation outcomes and sustainable growth. The Rosegroup companies holdings have been reduced by the dedication of 294 ha (about 75 per cent) of their land as conservation offsets for the development of up to 76 ha (20 per cent) of the total land holdings consistent with the regional strategies.

The locality of the site within a regional context is presented in Figure 1-1, whilst the subject lands are presented in Figure 1-2.

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

LAKE MACQUARIE

Gwandalan Development Lands

GWANDALAN

NORDS WHARF

Crangan Bay

PACIFIC HIGHWAY

WALLARAH NATIONA PARK

Middle Camp

Catherine Hill Bay

LAKE MACQUARIE STATE RECREATION AREA

MUNMORAH STATE RECREATION AREA

N

0 0.5 1
Kilometres

SCALE: 1: 20040.43 AT A3 SIZE

TITLE:	FIGURE 1-1 SITE LOCALITY	LOCATION:	CATHERINE HILL BAY	DATUM: PROJECTION:	N/A MGA ZONE 56 (GDA 94)	DATE: PURPOSE:	23/9/2010 ECOLOGY

LAYOUT REF: J:\JOBS\24k\24619 - Catherine Hill Bay ....\Mapinfo\Work\Ecological Ass. Report 2010\24619 FIGURE 1-1 Site Locality B-A3
VERSION (PLAN BY): B A3 (NW-MD)

CLIENT: ROSE CORP PTY LTD
JOB REF: 24619

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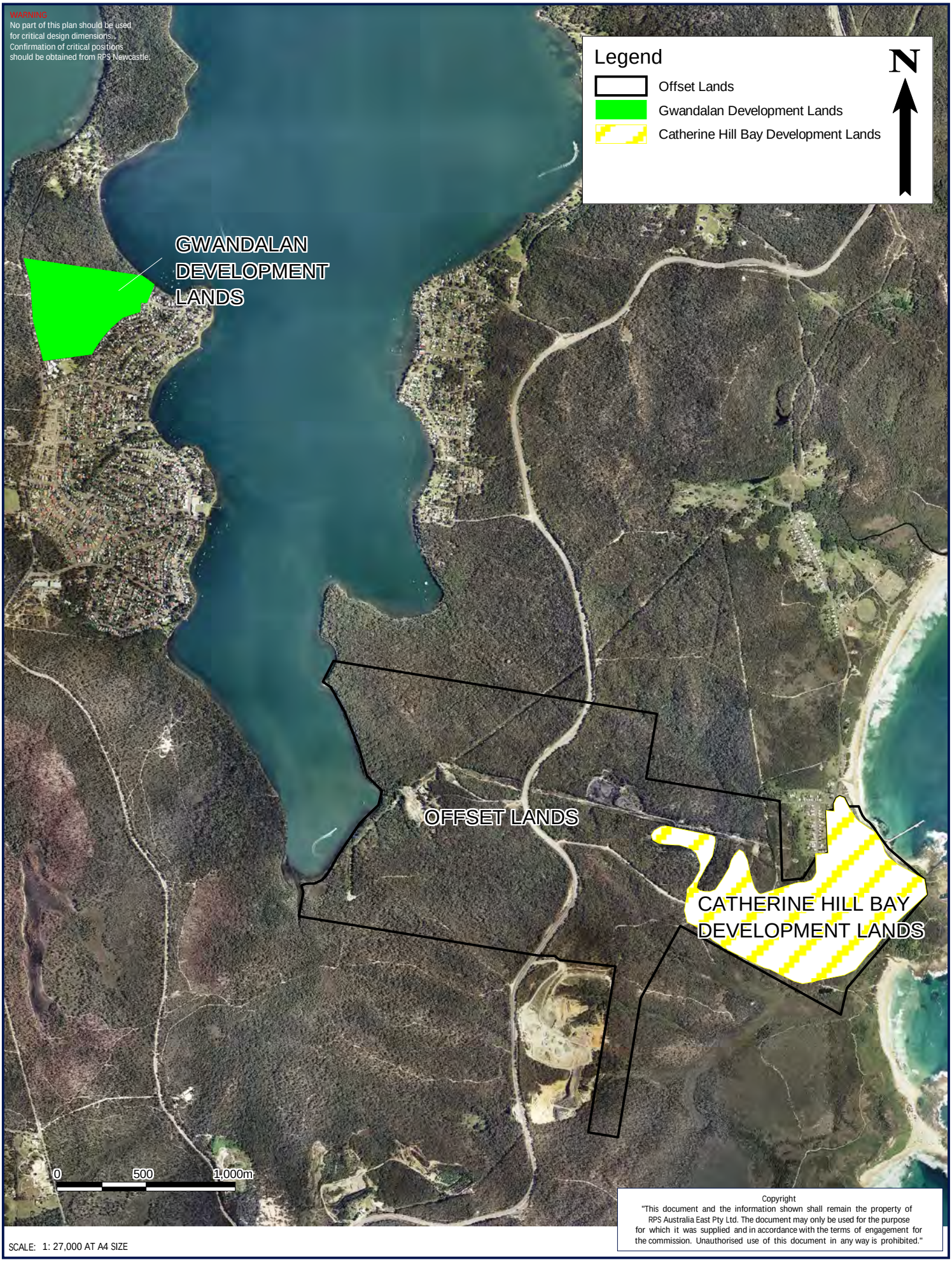

SCALE: 1: 27,000 AT A4 SIZE

TITLE: FIGURE 1-2 DEVELOPMENT & OFFSET LANDS

LOCATION: CATHERINE HILL BAY

DATUM: N/A
PROJECTION: MGA ZONE 56 (GDA 94)

DATE: 23/9/2010
PURPOSE: ECOLOGY

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LAYOUT REF: 24619 Fig 1-2 Dev & Offset Lands B-A4
VERSION (PLAN BY): B A4 (NW-MD)

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RPS

1.4 Scope of the Study

This study is intended to investigate the potential ecological impacts of the proposal, and to meet the relevant legislative requirements The primary impacts are likely to be associated with the removal of vegetation both in terms of direct impacts upon native stands of vegetation and to a lesser extent, upon habitat for native fauna within and directly adjacent to the Development Lands.

The purpose of this EAR is to collate and review information from previous investigations and to provide further information to fill any knowledge gaps. This report relies on the findings of previous investigations (Wildthing, 2003a; 2003b; 2004a; 2004b; 2004c; EcoBiological, 2006a; 2006b; and RPS HSO, 2007) and should be read in conjunction with these reports.

Whilst the primary focus of ecological investigations has been the proposed Development Lands, due consideration has been given to the ecological attributes of proposed Offset Lands.
At the state level, the proposal is to be assessed pursuant to Part 3A of the EPA Act. The 'Key' Assessment requirement for investigations as relevant to this report is:

"Address the impact of the development on threatened species and their habitats having regard to DECC's Threatened Species Assessment Guidelines and detailed measures proposed to avoid or mitigate impacts on threatened species and their habitat."

1.5 Definitions

The definitions given below are relevant to the report:

- **'development'** has the same meaning as in the NSW *Environmental Planning and Assessment Act 1979*.
- **'activity'** has the same meaning as in the NSW *Environmental Planning and Assessment Act 1979*.
- **'proposal'** is the development, activity or action proposed. Other terminology used for the 'proposal' includes the **'current proposal'** or **'development proposal'**.
- The **'Site'** refers to the entire land holding, inclusive of development and conservation areas.
- The **'Development Lands'** refers to the area(s) scheduled for development.
- The **'Offset Lands'** refers to the area(s) already dedicated for conservation.

All other definitions are the same as those contained in the NSW *TSC Act*.

1.6 Qualifications and Licensing

Qualifications

The principal author of this report was Craig Anderson BAppSc (EAM), with additional input from Sarah Jones (B.Env.Sc.,GDIP.DBPA) and Matt Doherty BLMC. Resumes of all RPS ecologists involved in the project are documented in Appendix D.

Licensing

Research was conducted under the following licences:

- NSW National Parks and Wildlife Service Scientific Investigation Licence S10300 (Valid 30 November 2010);
- Animal Research Authority (Trim File No: 01/1142) issued by NSW Agriculture (Valid 12 March 2011);
- Animal Care and Ethics Committee Certificate of Approval (Trim File No: 01/1142) issued by NSW Agriculture (Valid 12 March 2013); and
- Certificate of Accreditation of a Corporation as an Animal Research Establishment (Trim File No: 01/1522 & Ref No: AW2001/014) issued by NSW Agriculture (Valid 22 May 2011).

1.7 Certification

As the principal author, I, Craig Anderson, make the following certification:

- The results presented in the report are, in the opinion of the principal author and certifier, a true and accurate account of the species recorded, or considered likely to occur within the site;
- All research workers have complied with relevant laws and codes relating to the conduct of flora and fauna research, including the *Animal Research Act 1995, National Parks and Wildlife Act 1974* and the *Australian Code of Practice for the Care and Use of Animals for Scientific Purposes*.

Signature of Principal Author and Certifier:

Matthew Doherty
Manager Ecology / GIS
RPS
September 2010

2 Methods

The development of the EAR for the Gwandalan and CHB Development Lands comprised of the following aspects:

- **Literature Review -** Collation and review of existing flora and fauna datasets and survey reports relevant to the locality of the site.
- **Vegetation survey & mapping datasets** – The vegetation assessment included a review of the Lower Hunter Central Coast Regional Environmental Management Strategy (LHCCREMS) regional vegetation mapping (House, 2003). Broad-scale vegetation mapping was undertaken for lands not previously surveyed, and combined with existing vegetation mapping undertaken during previous investigations to enable a complete lands vegetation map to be produced.
- **Threatened species surveys and habitat investigations** – Targeted surveys for threatened flora and fauna species considered likely to occur within the site were undertaken as part of previous investigations. Further threatened species surveys were undertaken to ensure adequate survey effort and coverage was achieved as part of this EAR.

Table 2-1 below summarises the field survey methods and survey effort carried out within the site in comparison with DECC's Threatened Species Assessment Guidelines. The following sections contain a detailed description of the methods undertaken for this EAR. The methods used to conduct previous ecological investigations are contained within the relevant reports (Wildthing, 2003a; 2003b; 2004a; 2004b; 2004c; EcoBiological, 2006a; 2006b; and RPS HSO, 2007a) and should be read in conjunction with this EAR for completeness. The survey coverage covered during the different surveys within the site is summarised in Figure 2-1.

The works undertaken are considered to provide a detailed baseline dataset that enables a sufficient level of assessment and reporting to occur to satisfy the relevant legislation.

Table 2-1: Combined Survey Effort of Flora and Fauna Investigations within proposed development and Offset Lands at Catherine Hill Bay and Gwandalan

	Wildthing (2003a) SEE for Part Lot 6 DP774923, December	Wildthing (2003b) Ecological Constraints Study for Lot 3 DP588206, October	Wildthing (2004a) SEE for Part Lot 2 DP809795, February	Wildthing (2004b) SEE for Part Lot 6 DP774923, February	Wildthing (2004c) SEE for Part Lot 5 DP774923 and Part Lot 2031 DP841175, July	EcoBiological (2006a) Targeted Threatened Species Assessment for Lot 6 DP 774923, Lot 2 DP 809795 and Lot 4 DP 129341, May	EcoBiological (2006b) Environmental Constraints Assessment: Lot 6 DP 774923, Lot 2 DP 809795, Lot 5 DP 774923, Lot 2031 DP 841175 and Lot 4 DP 129341, October	RPS HSO (2007d) EPBC Act Addendum Report, Lot 3 DP 588206, Kanangara Drive, September	RPS HSO (2007) Catherine Hill Bay and Gwandalan development and Offset Lands, November	RPS HSO (2008) *Tetratheca juncea* surveys within proposed Offset Lands	RPS HSO (2008) *Cryptostylis hunteriana* searches proposed Offset Lands CHB	RPS HSO (2009) Targeted Glossy Black-Cockatoo and Masked Owl Surveys within Gwandalan Development Lands	Combined Total	Minimum DECC (2004) Requirements
Season	Spring (November)	Winter (June and August) and Spring (October)	Summer (December)	Summer (February)	Winter (June)	Various see each component below	Spring (October)	Winter (August) and Spring (September)	Spring (November)	Winter (21st, 23rd and 25th July)	Summer (December)	Autumn (March, April, May) and Winter (June, July, August)	Spring, Summer and Winter	All seasons preferred
Location	Southern Crangan Bay Offset Lands (site 90 ha)	Gwandalan Development Lands - Kanangara Drive (site 26 ha)	CHB Development Lands (site 90 ha)	CHB Development Lands - Coal Prep Plant (site 4 ha)	CHB Coal storage area - part Development Lands and part Offset Lands (site 34 ha)	CHB Development Lands (site 71.2 ha)	CHB Development Lands (site 72.7 ha)	Gwandalan Development Lands - Kanangara Drive (site 26 ha)	All lands - see each component below	Proposed Offset Lands at CHB and Gwandalan	Proposed Offset Lands at CHB	Gwandalan Development Lands	All CHB and Gwandalan lands	-
Flora Survey Work	10 x quadrats, 7 x transects and random meanders	6 x quadrats, 6 x transects and random meanders.	7 x quadrats, 6 x transects and random meanders	2 x quadrats, 2 x transects and random meanders	2 x quadrats, 6 x transects and random meanders	Targeted surveys for: *Tetratheca juncea* - Aug-Dec; *Caladenia tessellata* - Sept-Oct; *Cryptostylis hunteriana* - Dec-Feb; *Diuris praecox* - July-Aug; *Microtis angusii* - Sept-Nov.	Random meanders undertaken for vegetation mapping. Targeted *Tetratheca juncea* surveys.	Random meanders undertaken for the following targeted flora species: *Caladenia tessellata* *Diuris praecox* *Microtis angusii* *Syzygium paniculatum* Habitat assessment was carried out for *Cryptostylis hunteriana*	*Tetratheca juncea* counts (November) - CHB Development Lands Vegetation mapping (November) - previously unmapped Offset Lands 18 Quadrats and random meanders were undertaken. Targeted *Cryptostylis hunteriana* - Gwandalan and CHB Development Lands SEPP 14 wetland boundary determined via vegetation assemblages	A Random Meander was undertaken in potential habitats using the method described by Cropper (1993) to search for clumps of T. juncea. Once T. juncea was identified within an area of habitat parallel transects spaced at 10m-20m apart were placed within that area. Parallel transects were undertaken following the contours to identify as many T. juncea clumps as possible. T. juncea clumps were counted using the counting method outlined by Payne et al. (2002). T. juncea clumps were recorded using a Trimble GEOXH GPS with post processing.	Targeted surveys for *C. hunteriana* within the proposed Offset Lands at CHB. The survey methodology consisted of parallel transects of approximately 10-20m's apart and reduced to 5-10m's apart when *Cryptostylis hunteriana* was located. Survey effort was concentrated in the areas mapped as Narrabeen Doyalson Coastal Woodland, Coastal Plains Smooth-Barked Apple Woodland and Narrabeen Wallarah Grassy Woodlands throughout the proposed conservation lands,	-	45 x quadrats, 27 x transects. Random meanders. Delineation of vegetation community boundaries. Targeted threatened flora surveys undertaken in appropriate seasons within CHB and Gwandalan development areas.	Transects - 1 x 100m transect per stratification unit <2 ha; Quadrats - 1 x quadrat per stratification unit <2 ha; Random Meander - One 30 minute random meander per quadrat.
Diurnal Bird Survey	Census points, general observation and call identification	Census points, general observation and call identification	Census points, general observation and call identification	Census points, general observation and call identification	Census points, general observation and call identification	-	-	-	General observations and call identification	-	-	Each monthly survey consisted of 3 hrs diurnal surveying for Glossy Black Cockatoo. Glossy Black Cockatoo surveys included searches for nesting sites, diurnal bird surveys and searches for secondary indications. Targeted surveys were undertaken at potential nesting sites (hollow-bearing trees containing	Census and general observations. Targeted survey for the Glossy Black Cockatoo.	Area search, wetland census, water source

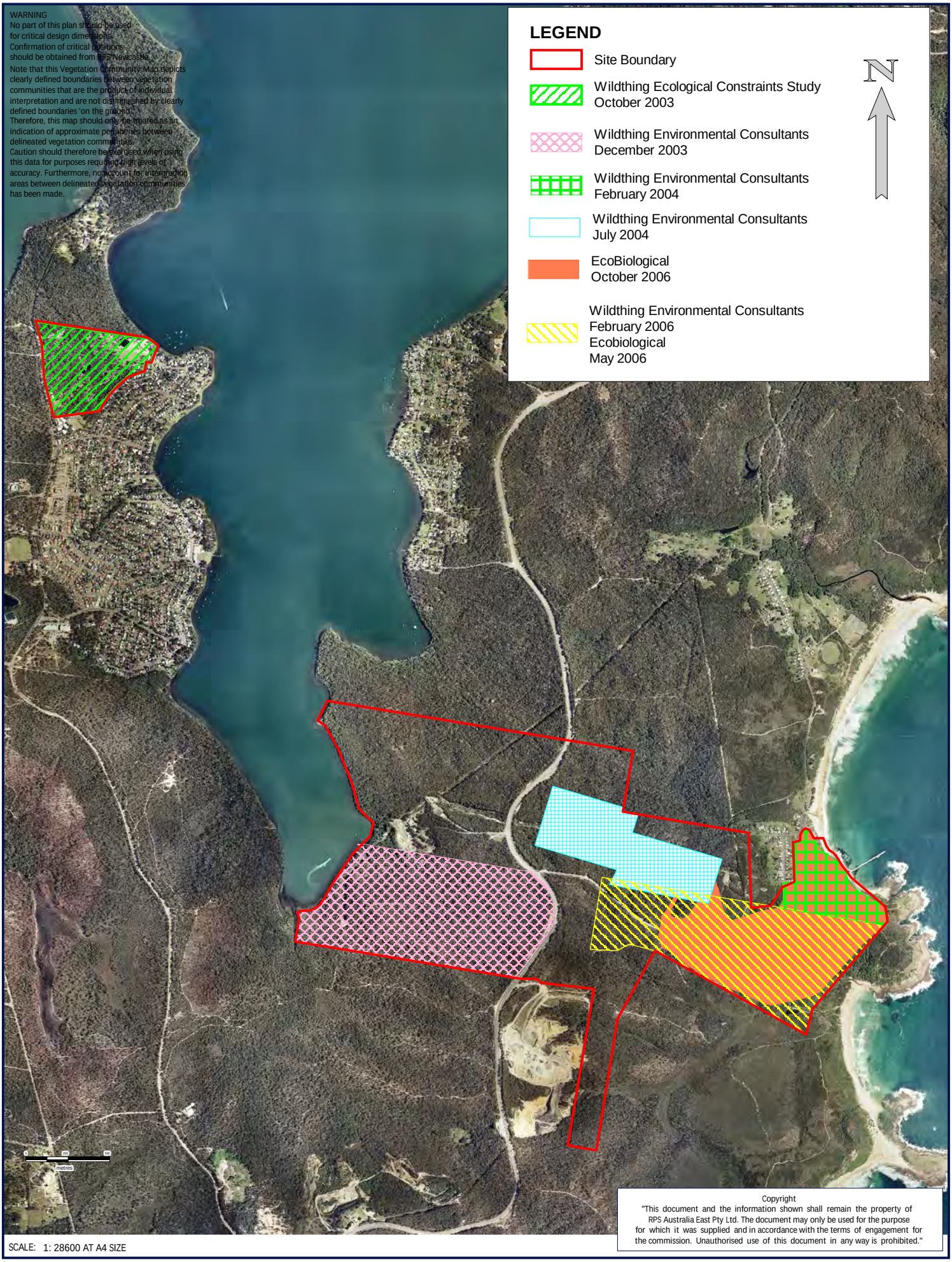
	Wildthing (2003a) SEE for Part Lot 6 DP774923, December	Wildthing (2003b) Ecological Constraints Study for Lot 3 DP588206, October	Wildthing (2004a) SEE for Part Lot 2 DP809795, February	Wildthing (2004b) SEE for Part Lot 6 DP774923, February	Wildthing (2004c) SEE for Part Lot 5 DP774923 and Part Lot 2031 DP841175, July	EcoBiological (2006a) Targeted Threatened Species Assessment for Lot 6 DP 774923, Lot 2 DP 809795 and Lot 4 DP 129341, May	EcoBiological (2006b) Environmental Constraints Assessment: Lot 6 DP 774923, Lot 2 DP 809795, Lot 5 DP 774923, Lot 2031 DP 841175 and Lot 4 DP 129341, October	RPS HSO (2007d) EPBC Act Addendum Report, Lot 3 DP 588206, Kanangara Drive, September	RPS HSO (2007) Catherine Hill Bay and Gwandalan development and Offset Lands, November	RPS HSO (2008) *Tetratheca juncea* surveys within proposed Offset Lands	RPS HSO (2008) *Cryptostylis hunteriana* searches proposed Offset Lands CHB	RPS HSO (2009) Targeted Glossy Black-Cockatoo and Masked Owl Surveys within Gwandalan Development Lands	Combined Total	Minimum DECC (2004) Requirements
												hollows > than 20cm diameter) & involved searches for indications of usage such as whitewash and chewed hollow edges. Stagwatching prior to dusk was also carried out at large nest hollow locations.		
Effort	Undertaken during each site visit	Undertaken during each site visit	Undertaken during each site visit	Census points - 2 over 2 days General observation - undertaken during each site visit	Census points - 4 over 2 days General observation - undertaken during each site visit	-	-	-	Undertaken during other field tasks		-	Conducted once a month for 6 months from March through to August.	Undertaken during all site visits	1ha sample for 20 mins per habitat.
Nocturnal Bird Survey	Spotlighting, call playback and call identification	Spotlighting, stagwatching, call playback and call identification	Spotlighting, call playback and call identification	Spotlighting and call identification	Spotlighting, call playback and call identification	Hollow-bearing tree assessment for large forest owls	-	-	General observations	-	-	3 hrs nocturnal surveying for Masked Owl during March to August. Methods used were stag watching of potential roosts, spotlighting, call playback and searches for secondary indications of presence.	Stagwatching (Gwandalan only), spotlighting, call playback and call identification	Call playback, day habitat search, stagwatching, spotlighting.
Effort	Spotlighting - 12 hours over 5 nights Call playback - 5 nights	Stagwatching - 3.5 hours over 5 nights Spotlighting - 10.75 hours over 8 nights Call playback - 5 nights	Spotlighting - 9 hours over 3 nights Call playback - 3 nights	Spotlighting - 1.5 hours over 2 nights	Spotlighting - 12 person hours over 3 nights Call playback - 3 nights	Undertaken as necessary	-	-	Undertaken during other field tasks	-	-	Conducted once a month over a 6 month period.	Stagwatching - 3.5 hours over 5 nights Spotlighting - 45.25 hours over 21 nights Call playback - 16 nights Gwandalan Site – three hrs once a month for a 6 month period making a total of 18hrs for stagwatching, spotlighting and call playback for the Masked Owl.	Call playback - 5 visits per site for Powerful Owl, Barking Owl and Grass Owl; 6 visits per site for Sooty Owl; 8 visits per site for Masked Owl. Stagwatching - 30 minutes prior and 60 minutes following sunset.
Herpetofauna Survey	Diurnal habitat searches, nocturnal spotlighting and frog call playback	Diurnal habitat searches, nocturnal spotlighting and frog call playback	Diurnal habitat searches, nocturnal spotlighting and frog call playback	Diurnal habitat searches, nocturnal spotlighting and frog call playback	Diurnal habitat searches, nocturnal spotlighting and frog call playback	Targeted amphibian survey: Diurnal habitat searches, nocturnal spotlighting, call playback and dip netting for tadpoles	-	-	General observations		-	-	Diurnal habitat searches, nocturnal spotlighting, call playback and dip netting for tadpoles	REPTILES: Diurnal hand searches, spotlighting and pitfall trapping. November to March. AMPHIBIANS: Diurnal and nocturnal habitat searches. Playback of recorded calls.
Effort	Diurnal habitat searches - 3 hours over 3 days	Diurnal habitat searches - 4 hours over 4 days Spotlighting -	Diurnal habitat searches - 3 hours over 3 days Spotlighting -	Diurnal habitat searches - 2 hours over 2 days Spotlighting -	Diurnal habitat searches - 2 hours over 2 days Spotlighting -	Early March during suitable conditions Spotlighting - 2 nights at each of	-	-	Undertaken during other field tasks	-	-	-	Diurnal habitat searches - 16 hours over 14 days Spotlighting -	REPTILES: Diurnal - 30 minute searches on 2 separate days. Nocturnal - 30

	Wildthing (2003a) SEE for Part Lot 6 DP774923, December	Wildthing (2003b) Ecological Constraints Study for Lot 3 DP588206, October	Wildthing (2004a) SEE for Part Lot 2 DP809795, February	Wildthing (2004b) SEE for Part Lot 6 DP774923, February	Wildthing (2004c) SEE for Part Lot 5 DP774923 and Part Lot 2031 DP841175, July	EcoBiological (2006a) Targeted Threatened Species Assessment for Lot 6 DP 774923, Lot 2 DP 809795 and Lot 4 DP 129341, May	EcoBiological (2006b) Environmental Constraints Assessment: Lot 6 DP 774923, Lot 2 DP 809795, Lot 5 DP 774923, Lot 2031 DP 841175 and Lot 4 DP 129341, October	RPS HSO (2007d) EPBC Act Addendum Report, Lot 3 DP 588206, Kanangara Drive, September	RPS HSO (2007) Catherine Hill Bay and Gwandalan development and Offset Lands, November	RPS HSO (2008) *Tetratheca juncea* surveys within proposed Offset Lands	RPS HSO (2008) *Cryptostylis hunteriana* searches proposed Offset Lands CHB	RPS HSO (2009) Targeted Glossy Black-Cockatoo and Masked Owl Surveys within Gwandalan Development Lands	Combined Total	Minimum DECC (2004) Requirements
	Spotlighting - 12 hours over 5 nights	10.75 hours over 8 nights Call playback - 4 nights	9 hours over 3 nights	1.5 hours over 2 nights	12 person hours over 3 nights Call playback - 3 nights	9 sites Call playback - 2 nights at each of 9 sites							57.25 person hours over 23 nights Call playback - 9 nights	minute search on 2 separate nights. AMPHIBIANS: Diurnal habitat search - 1 hour per stratification unit. Spotlighting - 30 mins on 2 separate nights; Playback - Once on each of 2 separate nights; Nocturnal habitat search - 2 hrs per 200 metre of water body edge.
Bat Survey	Harp trapping, bat call recording (ANABAT) and spotlighting	Harp trapping, bat call recording (ANABAT) and spotlighting	Harp trapping, bat call recording (ANABAT) and spotlighting	Bat call recording (ANABAT) and spotlighting	Bat call recording (ANABAT) and spotlighting	-	-	-	-	-	-	-	Bat call recording, harp trapping and spotlighting	Harp trapping, ultrasonic call recording, sspotlighting and habitat searches. Trip lines and mist netting for targeted surveys.
Effort	Harp trapping - 10 nights at 5 sites Mobile ANABAT recording - 4.5 hours over 4 nights Spotlighting - 12 hours over 5 nights	Harp trapping - 12 nights at 6 sites Mobile and stationary ANABAT recording - 4 hours over 5 nights Spotlighting - 10.75 hours over 8 nights	Harp trapping - 8 nights at 4 sites Mobile ANABAT recording - 3 hours over 3 nights Spotlighting - 9 hours over 3 nights	Mobile ANABAT recording - 0.75 hours on one night Spotlighting - 1.5 hours over 2 nights	Mobile ANABAT recording - 2.25 hours over 3 nights Spotlighting - 12 person hours over 3 nights	-	-	-	-	-	-	-	Harp trapping - 30 trap nights at 15 sites Mobile ANABAT recording - 14.5 hours over 16 nights Spotlighting - 45.25 hours over 21 nights	Harp trapping - 4 trap nights over 2 consecutive nights (October - March) per stratification unit. Ultrasonic call recording - 2 sound recording devices for the entire night (minimum 4 hours) for two nights (October - March) per stratification unit. Spotlighting - 2 x 1 hour spotlighting on 2 separate nights (October - March) per stratification unit.
Terrestrial Mammal Survey	Elliott and cage trapping, spotlighting	Elliott and cage trapping and spotlighting	Elliott and cage trapping, spotlighting	Spotlighting	Spotlighting	-	-	-	-	-	-		Elliott and cage trapping and spotlighting	Elliott 'A', Elliott 'B' and / or cage traps and hair tubes.
Effort	Elliott 'A ' traps - 60 traps for 4 nights = 240 trap nights Cage traps - 36 medium traps for 4 nights = 144 trap nights Spotlighting - 12 hours over 5 nights	Elliott 'A ' traps - 60 traps for 4 nights = 240 trap nights Cage traps - 12 medium traps for 4 nights = 48 trap nights Spotlighting - 10.75 hours over 8 nights	Elliott 'A ' traps - 40 traps for 4 nights = 160 trap nights Cage traps - 24 medium traps for 4 nights = 96 trap nights Spotlighting - 9 hours over 3 nights	1.5 hours over 2 nights	12 person hours over 3 nights	-	-	-	-	-	-		Elliott 'A ' traps - 160 traps for 4 nights = 640 trap nights Cage traps - 72 medium traps for 4 nights = 288 trap nights Spotlighting - 45.25 hours over 21 nights	Elliott 'A' and Elliott 'B' traps - 100 trap nights over 3-4 consecutive nights per stratification unit. Cage traps - 24 trap nights over 3-4 consecutive nights per stratification unit. Hair tubes - 10 large and 10 small placed in pairs for four days and four nights per stratification unit.
Arboreal	Arboreal	Arboreal	Arboreal	Spotlighting	Spotlighting	-	-	-	Targeted	-	-		Arboreal	Arboreal Elliott 'B'

	Wildthing (2003a) SEE for Part Lot 6 DP774923, December	Wildthing (2003b) Ecological Constraints Study for Lot 3 DP588206, October	Wildthing (2004a) SEE for Part Lot 2 DP809795, February	Wildthing (2004b) SEE for Part Lot 6 DP774923, February	Wildthing (2004c) SEE for Part Lot 5 DP774923 and Part Lot 2031 DP841175, July	EcoBiological (2006a) Targeted Threatened Species Assessment for Lot 6 DP 774923, Lot 2 DP 809795 and Lot 4 DP 129341, May	EcoBiological (2006b) Environmental Constraints Assessment: Lot 6 DP 774923, Lot 2 DP 809795, Lot 5 DP 774923, Lot 2031 DP 841175 and Lot 4 DP 129341, October	RPS HSO (2007d) EPBC Act Addendum Report, Lot 3 DP 588206, Kanangara Drive, September	RPS HSO (2007) Catherine Hill Bay and Gwandalan development and Offset Lands, November	RPS HSO (2008) *Tetratheca juncea* surveys within proposed Offset Lands	RPS HSO (2008) *Cryptostylis hunteriana* searches proposed Offset Lands CHB	RPS HSO (2009) Targeted Glossy Black-Cockatoo and Masked Owl Surveys within Gwandalan Development Lands	Combined Total	Minimum DECC (2004) Requirements
Mammal Survey	trapping and spotlighting	trapping, stagwatching, spotlighting and call playback	trapping and spotlighting						Pygmy Possum Elliott trapping within CHB Development Lands				trapping, stagwatching (Gwandalan only), spotlighting and call playback (Gwandalan only)	traps, arboreal hairtubes and spotlighting.
Effort	Elliott 'B' traps - 30 traps mounted on trees for 4 nights = 120 trap nights Modified Elliott 'A' traps - 6 traps mounted on trees for 4 nights = 24 trap nights Spotlighting - 12 hours over 5 nights	Elliott 'B' traps - 30 traps mounted on trees for 4 nights = 120 trap nights Modified Elliott 'A' traps - 6 traps mounted on trees for 4 nights = 24 trap nights Stagwatching - 3.5 hours over 5 nights Spotlighting - 10.75 hours over 8 nights Call playback - 4 nights	Elliott 'B' traps - 15 traps mounted on trees for 4 nights = 40 trap nights Spotlighting - 9 hours over 3 nights	1.5 hours over 2 nights	12 person hours over 3 nights	-	-	-	Elliott 'E' trapping - 45 traps over 4 nights = 180 trap nights	-	-	-	Elliott 'B' traps - 75 traps mounted on trees for 4 nights = 300 trap nights Modified Elliott 'A' traps - 12 traps mounted on trees for 4 nights = 48 trap nights Elliott 'E' traps - 50 traps mounted on shrubs for 4 nights = 200 trap nights Stagwatching - 3.5 hours over 5 nights Spotlighting - 45.25 hours over 21 nights Call playback - 4 nights	Arboreal Elliot 'B' trapping - 24 trap nights over 3-4 consecutive nights per stratification unit. Arboreal hairtubes - 3 tubes in each of 10 habitat trees for at least 4 days and 4 nights. Spotlighting: 2 x 1 hour and 1km, walking at approximately 1km per hour on 2 separate nights.
Koala Survey	SEPP 44 plots, scat searches, spotlighting and general observation	SEPP 44 plots, scat searches, spotlighting and general observation	SEPP 44 plots, scat searches, spotlighting and general observation	SEPP 44 plots, scat searches, spotlighting and general observation	SEPP 44 plots, scat searches, spotlighting and general observation	-	-	-	-	-	-		SEPP 44 plots, scat searches, spotlighting and general observation	Call playback, spotlighting and habitat searches.
Effort	SEPP 44 plots - 35 plots Spotlighting - 12 hours over 5 nights	SEPP 44 plots - 12 plots Spotlighting - 10.75 hours over 8 nights	SEPP 44 plots - 27 plots Spotlighting - 9 hours over 3 nights	SEPP 44 plots - 4 plots Spotlighting - 1.5 hours over 2 nights	SEPP 44 plots - 11 plots Spotlighting - 12 person hours over 3 nights	-	-	-	-	-	-	-	SEPP 44 plots - 89 plots Spotlighting - 45.25 hours over 21 nights	Call playback - 2 sites per stratification unit on 2 separate nights. Spotlighting: 2 x 1 hour and 1km, walking at approximately 1km per hour on 2 separate nights.
Secondary indications and incidental observations	General observation and habitat searches	General observation and habitat searches	General observation and habitat searches	General observation and habitat searches	General observation and habitat searches	Pygmy Possum habitat mapping Hollow-bearing tree survey Glossy Black Cockatoo habitat mapping	-	-	Searches under potential Masked Owl Roost trees within Gwandalan Development Lands for evidence of occupation by the species.	-	-	Searches under potential Masked Owl Roost trees and searches for secondary indications for Glossy Black Cockatoo usage of the Gwandlan development site.	Searches for Masked Owl presence, general observation and habitat searches	Searches of suitable habitat

	Wildthing (2003a) SEE for Part Lot 6 DP774923, December	Wildthing (2003b) Ecological Constraints Study for Lot 3 DP588206, October	Wildthing (2004a) SEE for Part Lot 2 DP809795, February	Wildthing (2004b) SEE for Part Lot 6 DP774923, February	Wildthing (2004c) SEE for Part Lot 5 DP774923 and Part Lot 2031 DP841175, July	EcoBiological (2006a) Targeted Threatened Species Assessment for Lot 6 DP 774923, Lot 2 DP 809795 and Lot 4 DP 129341, May	EcoBiological (2006b) Environmental Constraints Assessment: Lot 6 DP 774923, Lot 2 DP 809795, Lot 5 DP 774923, Lot 2031 DP 841175 and Lot 4 DP 129341, October	RPS HSO (2007d) EPBC Act Addendum Report, Lot 3 DP 588206, Kanangara Drive, September	RPS HSO (2007) Catherine Hill Bay and Gwandalan development and Offset Lands, November	RPS HSO (2008) *Tetratheca juncea* surveys within proposed Offset Lands	RPS HSO (2008) *Cryptostylis hunteriana* searches proposed Offset Lands CHB	RPS HSO (2009) Targeted Glossy Black-Cockatoo and Masked Owl Surveys within Gwandalan Development Lands	Combined Total	Minimum DECC (2004) Requirements
									General observation and habitat searches					
Effort	Undertaken during each site visit	Undertaken during each site visit	Undertaken during each site visit	Undertaken during each site visit	Undertaken during each site visit	Undertaken as necessary	-	-	Undertaken during each site visit	-	-	Undertaken during each site visit	Undertaken during each site visit	As necessary

NB: the legal descriptions of the land at Catherine Hill Bay shown in the table above are no longer current, these titles were amalgamated under DP 1129872.



SCALE: 1: 28600 AT A4 SIZE

TITLE: FIGURE 2-1 ECOLOGICAL SURVEY COVERAGE
LOCATION: CATHERINE HILL BAY
DATUM: N/A
PROJECTION: MGA ZONE 56 (GDA 94)
DATE: 23/9/2010
PURPOSE: ECOLOGY
LAYOUT REF: J:\JOBS\24k\24619 - Catherine Hill Bay\Draft...\Mapinfo\Workspaces\24619 FIGURE 2-1 Ecological Survey Coverage A A4
VERSION (PLAN BY): A A4 (NW-MD)

CLIENT: ROSE CORP PTY LTD
JOB REF: 24619

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

2.1 Literature Review

A review of existing literature relevant to the project was undertaken in an effort to glean as much information as possible on the existing environment and ensure a holistic approach to ecological assessment. Notably several specific flora and fauna investigations and impact assessments within the site and the general locality have been undertaken in recent times. An account of the information considered is listed below.

Note the following list is not considered comprehensive. Additional references can be viewed within Section 9 of this report.

- EcoBiological (2006a) *Targeted Threatened Species Assessment: Lot 6 DP 774923, Lot 2 DP 809795, No. 595 Pacific Highway Crangan Bay*, Rosegroup Pty Ltd.
- EcoBiological (2006b) *Environmental Constraints Assessment: Lot 6 DP 774923, Lot 2 DP 809795, Lot 5 DP 774923, Lot 2031 DP 841175 and Lot 4 DP 129341, No. 595 Pacific Highway Crangan Bay,* Rosegroup Pty Ltd.
- RPS Harper Somers O'Sullivan (2007a) *EPBC Act Addendum Report, Lot 3 DP588206,* Rosegroup Pty Ltd.
- Wildthing Environmental Consultants (2003a) *Statement of Effect on Threatened Flora and Fauna for the proposed development of Part Lot 6 DP 774923, Catherine Hill Bay, NSW, December 2003*, Coastal Hamlets Pty Ltd.
- Wildthing Environmental Consultants (2003b) *Ecological Constraints Study for Lot 3 DP 588206, Kanangara Drive, Gwandalan, NSW, October 2003*, Lakeside Living Pty Ltd.
- Wildthing Environmental Consultants (2004a) *Statement of Effect on Threatened Flora and Fauna for the proposed development of Part Lot 2 DP 809795, Catherine Hill Bay, NSW, February 2004,* Coastal Hamlets Pty Ltd.
- Wildthing Environmental Consultants (2004b) *Statement of Effect on Threatened Flora and Fauna for the proposed development of Part Lot 2031 DP 841175, Catherine Hill Bay, NSW, February 2004*, Coastal Hamlets Pty Ltd.
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- Young, J. (1999). *Northlakes Forest Owl Project*. Report to Lake Macquarie City Council, January 1999.

Biodiversity Databases

- The Atlas of NSW Wildlife
- CANRI
- Atlas of Australian Birds
- FaunaNet
- BioNet
- EPBC Act Database
- PlantNet
- LMCC Wildlife Database

- Australian Museum Fauna Database

2.2 Supplementary Field Investigations

2.2.1 Broad-scale vegetation mapping

Flora surveys and vegetation mapping carried out on the site as a part of recent efforts by RPS HSO (Nov 2007 – August 2009) has been undertaken as follows:

- Aerial Photograph Interpretation (API) to map the community(s) extent into definable map units;
- Confirmation of the community type(s) present (dominant species) via the undertaking of detailed flora surveys and identification;
- Review of previous environmental studies conducted by Wildthing (2003a, 2003b, 2004a, 2004b, 2004c), Ecobiological (2006a, 2006b), and RPSHSO (2007);
- Review of the Natural Vegetation of the Wyong Local Government Area, Central Coast, New South Wales (Bell 2002);
- Review of the Lower Hunter and Central Coast Regional Environmental Management Strategy (LHCCREMS) Vegetation Mapping (NPWS 2000: House 2003) for the site and surrounding areas;
- The conservation status of the derived vegetation communities was considered in light of the findings of the LHCCREMS Vegetation Mapping (2003). Assessment of the potential for the derived vegetation communities to constitute EEC's as listed within the *TSC Act (1995*) and the *EPBC Act (1999)* was also undertaken. The floristic composition, geomorphological characters and geographic distribution were considered when determining whether an EEC was present.
- Flora surveys were carried out across the areas of the site that had not been previously surveyed, with an emphasis on potentially significant species, as outlined below. The general flora survey also included 17 20m X 20m quadrats and one 10m X 40m quadrat throughout the native vegetation within the site (Figure 2-2), as well as Random Meanders in line with methodology termed as the "Random Meander Technique" by Cropper (1993).

The literature review indicated that portions of the site were not covered by previous vegetation mapping. Broadscale vegetation mapping was undertaken by RPS Ecologists within portions of the site that were not previously surveyed to ensure a complete vegetation map of the lands could be produced.

A vegetation map was created for the entire site by combining mapping undertaken previously by Wildthing (2003a, 2003b, 2004a, 2004b, 2004c,) and EcoBiological (2006a, 2006b) with broadscale mapping undertaken recently by RPSHSO Ecologists in areas not previously surveyed.

Note that the current survey was undertaken utilising broadscale vegetation mapping only.

Previous surveys have been more extensive and detailed, particularly within the development areas.

2.2.2 Targeted Flora Survey

The literature review indicated that the Development Lands may require additional targeted threatened flora surveys for the following species listed under *TSC Act* and EPBC Act, namely:

- *Tetratheca juncea* population counts within the CHB Development Lands and reconnaissance within Offset Lands to confirm suspected extensive occurrences;
- *Tetratheca juncea* targeted surveys and counts were undertaken with the conservation lands;
- *Cryptostylis hunteriana* searches within both the CHB and Gwandalan Development Lands; and
- *Cryptostylis hunteriana* searches within the Offset Lands at CHB.

***Tetratheca juncea* (Black-eyed Susan)**

Whilst sub-populations of *Tetratheca juncea* were identified during previous investigations (EcoBiological, 2006a; 2006b), no attempt was made to quantitatively assess the population size. Population counts for *T. juncea* were undertaken within the CHB Development Lands and Offset Lands using the counting method outlined by Payne *et al.* (2002). Sub-populations within the CHB Development Lands identified by EcoBiological (2006b) were targeted for detailed survey consisting of transects spaced 10m apart through suitable habitat. Suitable habitat within the remainder of the CHB Development Lands was searches for *T. juncea* using the Random Meander method described by Cropper (1993). These targeted *T. juncea* surveys within the CHB Development Lands were undertaken 12 - 16 November 2007.

Targeted surveys and counts of *T. juncea* within the Offset Lands was performed by undertaking a Random Meander in potential habitats using the method described by Cropper (1993) to search for clumps of *T. juncea*. Once *T. juncea* was identified within an area of habitat parallel transects spaced at 10m-20m apart were placed within that area. Parallel transects were undertaken following the contours to identify as many *T. juncea* clumps as possible. *T. juncea* clumps were counted using the counting method outlined by Payne *et al.* (2002). *T. juncea* clumps were recorded using a Trimble GEOXH GPS with post processing. These targeted *T. juncea* surveys within the conservation lands were undertaken on the 21st, 23rd and 25th July 2008.

***Cryptostylis hunteriana* (Leafless Tongue Orchid)**

Previous searches for *Cryptostylis hunteriana* within the Gwandalan Development Lands were undertaken outside of the flowering period for the species. As such further targeted surveys were undertaken within the Gwandalan Development Lands on 20 November 2007. Transects were undertaken 10m apart through suitable habitat. At the CHB Development Lands where habitat for this species was similar to that of *T.juncea* this species was also targeted.

Targeted searches were undertaken for *C. hunteriana* within the CHB Offset Lands. The survey methodology consisted of parallel transects of approximately 10-20m's apart and reduced to 5-10m apart when *Cryptostylis hunteriana* was located. Survey effort was concentrated in the areas mapped as Narrabeen Doyalson Coastal Woodland, Coastal Plains Smooth-Barked Apple Woodland and Narrabeen Wallarah Grassy Woodlands throughout the proposed Offset Lands, given that previous records in the Lake Macquarie / Central Coast locality largely correspond with these community types. These searches were undertaken by two ecologists from the 2nd to the 5th December 2008

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

LEGEND

- Site Boundary
- Quadrat Locations (20m X 20m)
- Fauna Trapline

N

Q16 Q15 Q14 Q17 Q13 Q12 Q18 Q11 Q2 Q1 Q9 Q5 Q4 Q3 Q6 Q7

0 500 1,000m

SCALE: 1: 13000 AT A3 SIZE

TITLE: FIGURE 2-2 FIELD SURVEY LOCATIONS

LOCATION: CATHERINE HILL BAY

DATUM: N/A
PROJECTION: MGA ZONE 56 (GDA 94)

DATE: 24/9/2010
PURPOSE: ECOLOGY

LAYOUT REF: J:\JOBS\24k\24619 - Catherine Hill Bay\Draft ....\Mapinfo\Work...\Ecological Ass. Report 2010/4619 Figure 2-2 Field Survey Locations B A3
VERSION (PLAN BY): B A3 (NW-MD)

CLIENT: ROSE CORP PTY LTD
JOB REF: 24619

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

2.2.3 Targeted Glossy Black Cockatoo Survey

Surveys were conducted once a month for six months from March through to August within the Gwandalan Development Lands. Survey dates were:

- 10th March 2009;
- 14th April 2009;
- 12th May 2009;
- 9th June 2009;
- 14th July 2009;and
- 4th August 2009.

Each monthly survey consisted of three hours diurnal surveying for *C. lathami* birds and secondary indications of *C. lathami* (and *T. novaehollandiae),* and three hours nocturnal surveying for *T. novaehollandiae*, with a total of 36 person hours spent within the Gwandalan Development Lands.

Targeted Glossy Black Cockatoo (*C. lathami*) surveys included searches for nesting sites, diurnal bird surveys and searches for secondary indications. Targeted surveys were undertaken at potential nesting sites (hollow-bearing trees containing hollows greater than 20cm diameter) and involved searches for indications of usage such as whitewash and chewed hollow edges. Stagwatching prior to dusk was also carried out at large nest hollow locations.

Searches for secondary indications of *C. lathami*, such as chewed *Allocasuarina* sp. cones were also undertaken during diurnal surveys. *Allocasuarina littoralis* (Black She-oak) was found to be present on site, which is a favoured feed species of *C. lathami.* Surveys were focused on the north western section of the site where a small stand of *A. littoralis* exists and were also undertaken around isolated trees within the site.

2.2.4 Targeted Masked Owl Survey

Targeted Masked Owl (*Tyto novaehollandiae*) surveys were undertaken on the Gwandalan Development Lands during the period of March to August 2009. Survey dates were:

- 10th March 2009;
- 14th April 2009;
- 12th May 2009;
- 9th June 2009;
- 14th July 2009;and
- 4th August 2009.

Methods used were stag watching of potential roosts, spotlighting, call playback and searches for secondary indications of presence. Past reports (Wildthing Consultants 2003) recorded the presence of *T.novaehollandiae* during the month of July. *T. novaehollandiae* requires large hollows for breeding purposes. Hollow-bearing trees containing hollows greater than 20cm in diameter were targeted for stag watching and searches for evidence of occupation and breeding. These locations were spread across the site. Diurnal surveys for *T. novaehollandiae* consisted of targeted searches for secondary indication such as feathers, faeces and disgorged food pellets. These secondary indications can be found around the bases of trees containing large hollows used for nesting and searches were concentrated in these areas. Nocturnal spotlighting also targeted these same hollows. Spotlighting was also carried out across the whole site to establish the potential usage and presence of *T. novaehollandiae.*

Owl call playback was carried out in the north western section of the Gwandalan site. A rise in the topography allowed a good vantage point to play calls which would be heard across the entire site. Owl call playback involved broadcasting pre-recorded calls for *T. novaehollandiae* and other possible owl species using a MP3 player and megaphone, with broadcasts interspersed with listening periods. Owl call playback was undertaken on dusk and early evening. Owl call playback was followed by spotlighting throughout the site.

2.2.5 Targeted Eastern Pygmy Possum Survey

Potential Eastern Pygmy Possum (*Certaceus nanus*) habitat was identified within the CHB Development Lands by EcoBiological (2006a; 2006b). To further investigate the potential occurrence of the species, a targeted trapping survey using 45 Elliott 'E' size traps was undertaken within the CHB Development Lands. Traps were placed within shrubs and small trees within suitable habitat for four nights giving a total of 180 trap nights undertaken within the CHB Development Lands. Traps were baited with rolled oats, peanut butter and honey, and a honey and water mix was sprayed around each trap as a lure each day. Targeted Eastern Pygmy Possum surveys were undertaken 12-16 November 2007. Location of trapping sites is indicated in Figure 2-2.

2.2.6 Opportunistic Observations

Opportunistic flora and fauna observations were made within the site whilst undertaking all other field activities. Such observations were noted and added to the base dataset to ensure completeness.

In particular, searches were made around the bases of potential Masked Owl (*Tyto novaehollandiae*) roost trees encountered for evidence of use by the species such as whitewash, owl pellets, prey remains etc within the Gwandalan Development Lands.

2.3 Survey Dates, Type and Prevailing Conditions

Table 2-2 depicts the dates, survey type and prevailing weather during the ecological investigations conducted by RPS HSO Ecologists during the November 2007, the July and December 2008 and March – August 2009 survey periods.

Table 2-2: Survey Dates, Type & Prevailing Weather

DATE	SURVEY TYPE	WEATHER					
		Temp	*Rain (24 hrs to 9:00am)*	*Sun*		*Moon*	
				Rise	*Set*	*Rise*	*Set*
12/11/2007	Targeted Eastern Pygmy Possum trapping (set traps) Targeted *Tetratheca juncea* counts within CHB Development Lands Targeted *Cryptostylis hunteriana* searches within CHB Development Lands	15.9-24^{0}C	0mm	5:46	19:29	6:42	21:49
13/11/2007	Targeted Eastern Pygmy Possum trapping (check traps) Targeted *Tetratheca juncea* counts within CHB Development Lands Targeted *Cryptostylis hunteriana* searches within CHB Development Lands	15.9-22.4^{0}C	0mm	5:45	19:30	7:29	2242
14/11/2007	Targeted Eastern Pygmy Possum trapping (check traps) Vegetation mapping and *Tetratheca juncea* reconnaissance within Offset Lands	15.9-22^{0}C	0mm	5:44	19:31	8:22	23:30
15/11/2007	Targeted Eastern Pygmy Possum trapping (check traps) SEPP 14 wetland boundary mapping Vegetation mapping and *Tetratheca juncea* reconnaissance within Offset Lands	18.2-21.8^{0}C	0mm	5:44	19:32	9:21	-
16/11/2007	Targeted Eastern Pygmy Possum trapping (remove traps) Vegetation mapping within Offset Lands	19.1 – 22.6^{0}C	0mm	5:43	19:33	10:23	00:13
19/11/2007	Vegetation mapping within Offset Lands	18.6-24.8^{0}C	0mm	5:41	19:36	13:34	01:54
20/11/2007	Targeted *Cryptostylis hunteriana* searches at Gwandalan Development Lands Searches under potential Masked Owl roost trees for signs of evidence	18.8-22.5^{0}C	0mm	5:41	19:37	14:39	02:23
21/07/08	Targeted *Tetratheca juncea* counts within conservation lands						
22/07/08	Targeted *Tetratheca juncea* counts within conservation lands						
23/07/08	Targeted *Tetratheca juncea* counts within conservation lands						
2/12/2008	Targeted *Cryptostylis hunteriana* searches at CHB conservation lands						
3/12/2008	Targeted *Cryptostylis hunteriana* searches at CHB conservation lands						
4/12/2008	Targeted *Cryptostylis hunteriana* searches at CHB conservation lands						
5/12/2008	Targeted *Cryptostylis hunteriana* searches at CHB conservation lands						
10/03/2009	Targeted Glossy Black Cockatoo and Masked Owl Surveys at Gwandalan Development Lands						
14/04/2009	Targeted Glossy Black Cockatoo and Masked Owl Surveys at Gwandalan Development Lands						
12/05/2009	Targeted Glossy Black Cockatoo and Masked Owl Surveys at Gwandalan Development Lands						
09/06/2009	Targeted Glossy Black Cockatoo and Masked Owl Surveys at Gwandalan Development Lands						
14/07/2009	Targeted Glossy Black Cockatoo and Masked Owl Surveys at Gwandalan Development Lands						
04/08/2009	Targeted Glossy Black Cockatoo and Masked Owl Surveys at Gwandalan Development Lands						

Source:
Australian Government – Geoscience Australia [http://www.ga.gov.au/geodesy/]
Daily weather observations – Newcastle Weather Station [http://www.bom.gov.au]

2.4 Limitations

Limitations associated with the EAR are presented herewith. The limitations have been taken into account throughout this assessment specifically in relation to threatened species assessments, results and conclusions.

In these instances, a precautionary approach has been adopted; as such 'assumed presence' of known and expected threatened species, populations and ecological communities has been made where relevant and scientifically justified to ensure a holistic assessment.

Seasonality

Most notably, several threatened flora species, particularly cryptic orchids, should be surveyed within their respective flowering periods. Reliance on previous surveys (Wildthing, 2003a; 2003b; 2004a; 2004b; 2004c; EcoBiological, 2006a; 2006b; and RPS HSO, 2007d) has occurred as these surveys have provided most of the cryptic orchid seasonal surveys. The survey of the Gwandalan lands for cryptic orchids has been undertaken by RPS HSO (2007a), RPS HSO in November 2007 and December 2008.

The flowering and fruiting plant species that attract some nomadic or migratory threatened species, often fruit or flower in cycles spanning a number of years. Furthermore, these resources might only be accessed in some areas during years when resources more accessible to threatened species fail. As a consequence threatened species may be absent from some areas where potential habitat exists for extended periods and this might be the case for the above-mentioned species. Again, this has been taken into account in the habitat assessment phase, although ongoing surveys, conducted during a range of seasonal periods, are designed to elucidate any potential significance the Rosegroup lands might represent for seasonal species.

Data Availability & Accuracy

- The collated threatened flora and fauna species records provided by the NPWS for the region are known to vary in accuracy and reliability. Traditionally this is due to the reliability of information provided to the NPWS for collation and/or the need to protect specific threatened species locations. For the purposes of this assessment this information has been considered to have an accuracy of ± 1km.
- Threatened flora and fauna records within the region were predominantly sourced from the DECC Atlas of Wildlife Database and a DEWR Protected Matters Search. Other sources such as Birdata and HBOC were also utilised. Limitations are known to exist with regards to these data sources and their accuracy.

Note: Data recorded by RPS HSO during the survey period, has been undertaken with a Trimble GeoXH GPS unit, which is capable of sub-metre accuracy following post processing.

Vegetation Mapping

The vegetation mapping which has been undertaken within the site (Figure 2-1) has been a collation of RPSHSO vegetation survey and previous mapping (Wildthing 2003a, 2003b,

2004a, 2004b, 2004c and EcoBiological 2006b) and aerial photograph interpretation.

Access

The survey was limited by access and size of the site; in some areas the topography or density of flora (i.e. closed heath) restricted access to some parts of the site.

Fauna

The presence of fauna within a particular area is not static over time, may be seasonal or in response to the availability of a particular resource. As such, where survey effort targeting particular threatened fauna species has not specifically met guidelines recommended by DECC, habitat assessment and prediction of the occurrence of threatened fauna species has been applied. In saying that, it is considered that the combined survey effort and datatset from all of the investigations undertaken to date provide a substantial picture of the fauna species and habitat values occurring within the site.

3 Results of Supplementary Field Investigations

3.1 Flora

A total of 347 flora species were identified during the survey period over the CHB site within the quadrats and random meander surveys. A complete list of the flora species identified is provided in Appendix B of this report.

3.1.1 Description of Vegetation Communities

A description of each community and classification into both adopted regional vegetation classification, being LHCCREMS (NPWS 2000; House 2003) and the Natural Vegetation of the Wyong Local Government Area (Bell, 2002), is provided below. Note that descriptions for the Gwandalan Development Lands have not been included within the vegetation descriptions as they were not delineated during the current survey. These were previously delineated by Wildthing (2003b).

The following 15 vegetation communities were delineated within the CHB Development Lands site as shown in Figure 3-1**Error! Reference source not found.** and listed below:

1. Munmorah Palm-Apple Dry Drainage Line Forest;
2. Coastal Plains Smooth-barked Apple Woodland;
3. Coastal Sand Wallum Heath Scrub;
4. Narrabeen Foreshore Redgum-Ironbark Forest;
5. Narrabeen Wallarah Sheltered Grassy Woodland;
6. Narrabeen Doyalson Coastal Woodland;
7. Coastal Headland Complex (Grassland & Shrubland);
8. Coastal Holocene Banksia Scrub;
9. **Coastal Sand Mahogany-Paperbark Swamp Forest (EEC Swamp SclerophyllForest);**
10. **Estuarine Swamp Oak Forest (EEC Swamp Oak Floodplain Forest);**
11. **Estuarine Mangrove-Saltmarsh Complex (EEC Saltmarsh);**
12. **Freshwater Wetland Complex (EEC Freshwater Wetlands on CoastalFloodplains);**
13. Regenerating Vegetation;
14. Weeds and Cleared Areas; and
15. Dams.

1 Munmorah Palm-Apple Dry Drainage Line Forest

This vegetation community was located within the drainage lines and gullies within the site and covers an area of approximately 9.5ha. This vegetation community is commensurate with MU 25 Munmorah Palm-Apple Dry Drainage Line Forest as described by the Natural Vegetation of the Wyong Local Government Area (Bell, 2002). This community is also commensurate with MU 39 Apple - Palm Gully Forest as described by LHCCREMS (NPWS 2000; House 2003). Structurally this community is generally of an open forest

nature, however where drainage lines converge this community can be closed due to the increased density in *Livistonia australis* (Cabbage Tree Palm). This vegetation community has some affinities with the endangered ecological community of "Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregion", but the dominance of Eucalypts and the variable canopy cover provide distinction and it is considered not to be commensurate with this EEC.

Upper Stratum – 15 to 20m with a Percent Foliage Cover (PFC) of 40 to 60%, the dominant species being *Livistonia australis* (Cabbage Tree Palm), *Angophora costata* (Smooth-barked Apple), *Eucalyptus resinifera* subsp. *resinifera* (Red Mahogany) and occasionally *Eucalyptus robusta* (Swamp Mahogany).

Mid Stratum 1 – 10 to 15m with a PFC of 40 to 70%, the dominant species being, *Callistemon salignus* (Willow Bottlebrush), *Alphitonia excelsa* (Red Ash), *Glochidion ferdinandi* (Cheese Tree), and *Allocasuarina torulosa* (Forest She-oak).

Mid Stratum 2 – 2 to 3m with a PFC to 30%, the dominant species being, *Acmena smithii* (Lilly Pilly), *Melaleuca linearifolia* (Snow-in-Summer), *Elaeocarpus reticulatus* (Blueberry Ash), *Leptospermum polygalifolium* (Lemon-scented Tea Tree), and *Melaleuca nodosa* (Ball Honeymyrtle).

Lower Stratum – to 1m with a PFC of 20 to 30%, the dominant species being *Doodia apsera* (Rasp Fern), *Schoenus melanostachys, Adianthum aethiopicum* (Common Maidenhair), *Adianthum formosum* (Giant Maidenhair), *Blechnum indicum, Gahnia clarkei* (Tall Saw Sedge), *Gahnia melanocarpa* (Black-fruit Saw-sedge), *Smilax australis* (Lawyer Vine), *Cissus hypoglauca* (Native Grape), *Morinda jasminoides* (Jasmine Morinda), *Calochlaena dubia* (False Bracken) and *Gymnostachys anceps* (Settlers Flax).

2 Coastal Plains Smooth-barked Apple Woodland

This vegetation community occupies a large area within the five portions throughout the proposed offset portions of the site and encompasses 12.36ha. This vegetation community 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 recorded within this community. The Scribbly Gum *Eucalyptus signata* also occurs sporadically throughout this vegetation community. This community has been delineated from the Narrabeen Wallarah Sheltered Grassy Woodland by the dominance of *Angophora costata* (Smooth-barked Apple) and *Corymbia gummifera* (Red Bloodwood) within the canopy.

Upper Stratum – 20 to 25m with a PFC of 40 to 50%, the dominant species being *Angophora costata* (Smooth-barked Apple), *Corymbia gummifera* (Red Bloodwood), *Eucalyptus piperita* (Sydney Peppermint), *Eucalyptus capitellata* (Brown Stringybark), and occasionally *Eucalyptus resinifera* subsp. *resinifera* (Red Mahogany).

Mid Stratum 1 – 4 to 8m with a PFC of 20 to 40%, the dominant species being *Allocasuarina littoralis* (Black She-oak), *Exocarpus cupressiformis* (Ballart Cherry), juvenile *Eucalyptus capitellata* (Brown Stringybark) and *Corymbia gummifera* (Red Bloodwood).

Mid Stratum 2 – 1 to 2m with a PFC of 10 to 30%, the dominant species being *Banksia spinulosa* var. *collina* (Hairpin Banksia), *Dillwynia retorta* (Eggs and Bacon), *Dodonea triquetra* (Common Hop Bush), *Leptospermum trinervium* (Paperbark Tea-tree), *Pultenaea villosa* and *Acacia myrtifolia* (Myrtle Wattle).

Lower Stratum – to 1m with a PFC of 20 to 60%, the dominant species being *Lepidosperma laterale, Xanthorrhoea latifolia* subsp. *latifolia* (Forest Grass Tree), *Poa labillardieri* var. *labillardieri* (Tussock Grass), *Joycea pallidea* (Silver-top Wallaby Grass), *Lomandra obliqua* (Fishbones), *Themeda australis* (Kangaroo Grass), *Entolasia stricta* (Wiry Panic), *Tetratheca juncea* (Black-eyed Susan) and *Dianella caerulea var. producta* (Blue Flax Lily).

3 Coastal Sand Wallum Heath Scrub

This vegetation community occurs in three sections in the eastern portion of the CHB site on the exposed south facing slopes on Aeolian sands. The unique presence of Grass Trees (*Xanthorrhoea resinifera*), which normally have no trunk, occurs within this community. This vegetation community encompasses approximately 6.28ha. This vegetation community is commensurate with MU 7 Coastal Sand Wallum Heath-Scrub as described by the Natural Vegetation of the Wyong Local Government Area (Bell, 2002). This vegetation community is consistent with 7a Type variant as described by Bell (2002). This community is also commensurate with MU 34a Coastal Sand Wallum Heath as described by LHCCREMS (NPWS 2000; House 2003).

Upper Stratum – to 10m with a Projected Foliage Cover (PFC) of 30 to 60%, the dominant species being *Banksia aemula* (Wallum Banksia), *Banksia serrata* (Old Man Banksia), *Leptospermum trinervium* (Paperbark Tea-tree), *Angophora costata* (Smooth-barked Apple), *Eucalyptus umbra* subsp. *umbra* (Broad-leaved Mahogany) and *Corymbia gummifera* (Red Bloodwood).

Mid Stratum – 2 to 4m with a PFC of 40 to 60%, the dominant species being *Leptospermum polygalifolium* (Lemon-scented Tea-tree), *Tetratheca thymifolia, Dillwynia retorta* (Eggs and Bacon), *Xanthorrhoea resinifera* (Tree form), *Isopogon anemonifolius* (Drumsticks), *Ricinocarpus pinifolius* (Wedding Bush), *Cassina uncata* (Bent Cassina) and *Persoonia levis* (Broad-leaved Geebung).

Lower Stratum – to 1.5m with a PFC of 40 to 60%, the dominant species being *Lomandra obliqua* (Fish Bones), *Xanthorrhoea fulva, Xanthosia pilosa* (Woolly Xanthosia), *Lomandra longifolia* (Mat Rush), *Leucopogon ericoides* (Bearded Heath), *Monotoca scoparia, Cassytha glabella* forma *glabella* (Slender Devil's Twine) and *Entolasia stricta* (Wiry Panic).

4 Narrabeen Foreshore Redgum-Ironbark Forest

This vegetation community occurs on the foreshore of Lake Macquarie, adjoining the Estuarine Swamp Oak Forest and encompasses 0.91ha. This vegetation community is commensurate with MU 24 Narrabeen Foreshore Redgum-Ironbark Forest as described by the Natural Vegetation of the Wyong Local Government Area (Bell, 2002) however; this community is not commensurate with any vegetation communities as described by LHCCREMS (NPWS 2000; House 2003). This community had severe incursions of *Lantana camara* (Lantana) and *Chrysanthemoides monilifera* subsp. *rotundata* (Bitou Bush) throughout.

Upper Stratum – to 20m with a PFC of 30% to 50%, the dominant species being *Eucalyptus tereticornis* (Forest Redgum), *Eucalyptus paniculata* subsp. *paniculata* (Grey Ironbark) and occasionally *Angophora costata* (Smooth-barked Apple).

Mid Stratum 1 – 4 to 6m with a PFC of 10 to 20%, the dominant species being *Allocasuarina littoralis* (Black She-Oak) and *Exocarpus cupressiformis* (Cherry Ballarat).

Mid Stratum 2 – 1 to 3m with a PFC of 80%, the dominant species being *Acacia longifolia* var. *longifolia* (Sydney Golden Wattle), *Bursaria spinosa, Notelaea longifolia* (Mock Olive), *Acrotriche divaricata, Chrysanthemoides monilifera* subsp. *rotundata* (Bitou Bush), *Lantana camara* (Lantana), *Dodonaea triquetra* (Common Hop Bush), *Acacia falcata* (Sickle Wattle) and *Acacia irrorata* subsp. *irrorata.*

Lower Stratum – to 1m with a PFC of 40 to 80%, the dominant species being *Imperata cylindrica* var. *major* (Blady Grass), *Oplismenus aemulus* (Basket Grass), *Hardenbergia violacea* (Native Sarsaparilla), *Pratia purpurescens* (Whiteroot), *Centella asiatica* (Swamp Pennywort) and *Cassytha pubescens* (Common Devil's Twine).

5 Narrabeen Wallarah Sheltered Grassy Woodland

This vegetation community occupies the southwestern portion of the site and encompasses 219.19ha. This vegetation community is commensurate with MU 33 – Narrabeen Wallarah Sheltered Grassy Forest as described by the Natural Vegetation of the Wyong Local Government Area (Bell, 2002). However, this vegetation community is not commensurate with any vegetation units as described by LHCCREMS (NPWS 2000; House 2003). This community was difficult to delineate due to the variable canopy layer in which no species was dominant. The presence of *Eucalyptus globoidea* (White Stringybark) and *Eucalyptus paniculata* subsp. *paniculata* (Grey Ironbark) separates this community from the Coastal Plains Smooth-barked Apple Woodland. Variations of a dominance of *Eucalyptus propinqua* (Small-fruited Grey Gum) and *Eucalyptus acmenoides* (White Mahogany) occurs within the southern drainage lines of the Offset Lands. In contrast, the ridgelines within the western portion (Crangan Bay) of the vegetation community were dominated by a combination of *Angophora costata* (Smooth-barked Apple) and *Eucalyptus signata* (Scribbly Gum).

Upper Stratum – 20 to 25m with a PFC of 30 to 60%, the dominant species being

Eucalyptus punctata (Grey Gum), *Eucalyptus paniculata* subsp. *paniculata* (Grey Ironbark), *Eucalyptus globoidea* (White Stringybark), *Allocasuarina torulosa* (Forest She-oak), *Corymbia gummifera* (Red Bloodwood), *Eucalyptus piperita* (Sydney Peppermint), *Angophora costata* (Smooth-barked Apple), *Eucalyptus signata* (Scribbly Gum), and in the moist gullies *Eucalyptus resinifera* subsp. *resinifera* (Red Mahogany).

Mid Stratum 1 – 6 to 10m with a PFC of 20%, the dominant species being *Allocasuarina torulosa* (Black She-oak) and juvenile *Eucalyptus* species.

Mid Stratum 2 – 1 to 2m with a PFC of 10 to 30%, the dominant species being *Acacia longifolia* var. *longifolia* (Sydney Golden Wattle), *Dodonaea triquetra* (Common Hop Bush), *Bursaria spinosa* (Blackthorn), *Polyscias sambucifolia* (Elderberry Panax), *Podolobium ilicifolium* (Native Holly) and *Acrotriche divaricata*.

Lower Stratum – to 1m with a PFC of 30 to 60%, the dominant species being *Xanthorrhoea macronema* (Grass Tree), *Themeda australis* (Kangaroo Grass), *Entolasia stricta* (Wiry Panic), *Pratia purpurascens* (White Root) and *Dianella caerulea* var. *producta* (Blue Flax Lily).

6 Narrabeen Doyalson Coastal Woodland

This vegetation community covers approximately 23.88ha with the CHB Site. This vegetation community is commensurate with MU 31 – Narrabeen Doyalson Coastal Woodland (including variant a) 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). This community varied considerably within the site. The portion which is within the southern most section of the site has a dense understorey of *Banksia serrata* (Old Man Banksia) in combination with *Eucalyptus haemastoma* (Scribbly Gum) and *Corymbia gummifera* (Red Bloodwood). The sections on the ridgetops have a more open woodland habitat dominated by *Eucalyptus haemastoma* (Scribbly Gum), *Angophora costata* (Smooth-barked Apple) and *Corymbia gummifera* (Red Bloodwood) with a heathy understorey.

Upper Stratum – 15 to 18m with a Projected Foliage Cover (PFC) of 20 to 30%, 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 – 5 to 15m with a PFC of 5%, the dominant species being, *Leptospermum trinervium* (Paperbark Tea-tree), *Xylomelum pyriforme* (Woody Pear) and *Banksia serrata* (Old Man Banksia).

Mid Stratum 2 – 1 to 5m with a PFC of 30 to 40%, the dominant species being, *Banksia aemula* (Wallum Banksia), *Leptospermum polygalifolium* (Lemon-scented Tea-tree), *Hakea dactyloides, Hakea bakeriana, Persoonia levis* (Broad-leaved Geebung), *Lambertia formosa* (Mountain Devil), *Ricinocarpos pinifolius* (Wedding Bush) and *Isopogon anemonifolius* (Drumsticks).

Lower Stratum – to 2m with a PFC of 70 to 80%, the dominant species being *Epacris pulchella* (NSW Coral Heath), *Ptilothrix deusta, Tetratheca thymifolia, Philotheca salisolifolia, Lomandra obliqua* (Fishbones), *Xanthorrhoea resinifera* (Forest Grass Tree), *Themeda australis* (Kangaroo Grass) and *Entolasia stricta* (Wiry Panic).

7 Coastal Headland Complex (Grassland & Shrubland)

This vegetation community encompasses the coastal headland areas and comprises of both open and closed heath structure. The community encompasses 12.94ha. This vegetation community is commensurate with MU 13 Coastal Headland Complex (Grassland and Shrubland) as described by the Natural Vegetation of the Wyong Local Government Area (Bell, 2002). Included in this vegetation community are four variants of Grassland, Shrubland, Sheltered Gully and Tall Scrub as described by Bell (2002). This community is also commensurate with MU 48 Coastal Clay Heath as described by LHCCREMS (NPWS 2000; House 2003). The portions surveyed during the current study were highly disturbed by weeds. Stunted Eucalypts occurred throughout the community which was interspersed with heath vegetation.

Upper Stratum – 4 to 10m with a Projected Foliage Cover (PFC) of 5%, scattered trees of *Corymbia gummifera* (Red Bloodwood).

Mid Stratum 2 – 2 to 4m with a PFC of 30 to 90%, the dominant species being *Westringia fruiticosa* (Coast Westringia), *Banksia spinulosa* var. *collina* (Hairpin Banksia), *Allocasuarina distyla, Leptospermum laevigatum* (Coastal Tea Tree), *Melaleuca nodosa* (Ball Everlasting), *Banksia oblongifolia*, *Acacia longifolia* var. *longifolia* (Sydney Golden Wattle) and *Lambertia formosa* (Mountain Devil).

Lower Stratum – to 1.5m with a PFC of 40 to 90%, the dominant species being *Lomandra obliqua* (Fish Bones), *Patersonia sericea* (Purple Flag Flower), *Patersonia glabrata, Austrostipa* sp*., Pultenaea elliptica, Xanthorrhoea latifolia* subsp. *latifolia* (Grass Tree), *Gonocarpus teucrioides* (Raspwort), *Ptilothrix deusta, Cassytha glabella* forma *glabella* (Slender Devil's Twine) and *Themeda australis* (Kangaroo Grass).

8 Coastal Holocene Banksia Scrub

This vegetation community occurs on the fore dunes along the coastline and on the hind dunes within the Coastal Headland Complex. This vegetation community encompasses approximately 5.44ha. The community is commensurate with MU 6 Coastal Sand Holocene Banksia Scrub within the sheltered back dunes, and with MU 5 Coastal Sand Foredune Acacia Scrub in the foredunes as described by the Natural Vegetation of the Wyong Local Government Area (Bell, 2002). This community is also commensurate with MU 50 Coastal Sand Scrub as described by LHCCREMS (NPWS 2000; House 2003). This vegetation community is highly disturbed with a high number of weeds occurring throughout.

Mid Stratum 1 – 4 to 6m with a PFC of 30 to 80%, the dominant species being *Banksia*

integrifolia subsp. *integrifolia* (Coast Banksia) and *Leptospermum laevigatum* (Coastal Tea Tree).

Upper Stratum – 1 to 2m with a PFC of 20 to 30%, the dominant species being *Chrysanthemoides monilifera* subsp. *rotundata* (Bitou Bush) *Acacia longifolia* var. *longifolia* (Sydney Golden Wattle), *Acacia longifolia* var. *sophorae* (Coastal Wattle) and *Acacia myrtifolia* (Myrtle Wattle).

Lower Stratum – to 1m with a PFC of 20 to 30%, the dominant species being *Themeda australis* (Kangaroo Grass), *Lomandra longifolia* (Mat Rush) and *Cassytha glabella* forma *glabella* (Slender Devil's Twine).

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

This vegetation community occurs in the low lying estuarine drainage lines and encompasses 11.22ha. This vegetation community 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). This community has only minor weed incursions with generally a good diversity of natives throughout.

Upper Stratum – to 20m with a Projected Foliage Cover (PFC) of 50 to 70%, the dominant species being *Eucalyptus robusta* (Swamp Mahogany), *Melaleuca quinquinervia* (Broad-leafed Paperbark), *Eucalyptus resinifera* subsp. *resinifera* (Red Mahogany) and occasionally *Livistonia australis* (Cabbage Tree Palm).

Mid Stratum 1 – 4 to 8m with a PFC of 10 to 20%, the dominant species being *Melaleuca linearifolia* (Snow-in Summer), *Melaleuca styphelioides* (Prickly-leaved Melaleuca), *Melaleuca sieberi* (Sieber's Paperbark), *Callistemon salignus* (Willow Bottlebrush) and *Glochidion ferdinandi* (Cheese Tree).

Mid Stratum 2 – 3 to 5m with a PFC of 30 to 90%, the dominant species being *Elaeocarpus reticulataus* (Blueberry Ash), *Synoum glandulosum* subsp. *glandulosum* (Scentless Rosewood), *Cryptocarya microneura* (Murrogun), *Cyathea cooperi* (Straw Treefern) and *Pittosporum undulatum* (Sweet Pittosporum).

Lower Stratum – to 1.5m with a PFC of 10 to 50%, the dominant species being *Gahnia clarkei* (Tall Saw Sedge), *Blechnum indicum* (Swamp Water Fern), *Baloskion tetraphyllum* subsp. *meiostachyum* (Tassel Cord Rush), *Empodisma minus* (Spreading Rope Rush), *Hydrocotyle peduncularis, Viola hederacea* (Native Violet), *Dioscoria transversa* (Pencil Yam), *Marsdenia suaveolens* (Scented Marsdenia), *Hemarthria uncinata* (Matt Grass), *Oplimenus aemulus* (Basket Grass) and *Smilax glyciphylla* (Native Sarsaparilla).

10 Estuarine Swamp Oak Forest (EEC – Swamp Oak Floodplain Forest)

This vegetation community occurs along the foreshore of Lake Macquarie within Crangan Bay. This vegetation community encompasses approximately 3.48 ha 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 – 5 to 12m with a PFC of 10 to 20%, the dominant species are *Casuarina glauca* (Swamp Oak) and *Eucalyptus tereticornis* (Forest Red Gum).

Mid Stratum – 1 to 5m with a PFC to 80%, the dominant species being, *Chrysanthemoides monilifera* subsp*. rotundata* (Bitou Bush) and *Avicennia marina* (Grey Mangrove).

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

11 Mangrove Estuarine – Saltmarsh Complex

This vegetation community occurs along the foreshore of Lake Macquarie within the site. This vegetation community covers approximately 3.35ha 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 – 4 to 5m 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 of 80 to 90%, the dominant species being *Stenotaphrum secundatum* (Buffalo Grass), *Juncus kraussii* subsp. *australiensis* (Sea Rush), *Baumea juncea, Sporobolus virginicus* (Salt Couch), *Tetragonia tetagonioides* (New Zealand Spinach), *Samolus repens* (Creeping Brookweed), *Atriplex prostrata* (Orache), *Suaeda uastralia* (Austral Seabite) and *Lobelia alata.*

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

This vegetation community occurs in several locations within the proposed Offset Lands all of which either adjoin or are part of the SEPP 14 wetland located to the south of the CHB site. A dam which was previously located within the south of the site has been included in this community due to the high diversity of natives located therein. This community was floristically diverse and provides habitat for a range of native flora and fauna. This vegetation community covers approximately 1.78 ha 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).

Upper Stratum – 5 to 10m with a Projected Foliage Cover (PFC) of 10 to 20%, the dominant species being *Eucalyptus robusta* (Swamp Mahogany), *Callistemon salignus* (Willow Bottlebrush), *Melaleuca styphelioides* (Prickly-leaved Melaleuca) and *Melaleuca ericifolia* (Swamp Paperbark).

Mid Stratum – 1.5 to 3m with a PFC of 30 to 40%, the dominant species being, *Melaleuca thymifolia, Gahnia clarkei* (Tall Saw Sedge).

Lower Stratum – to 1.5m with a PFC of 20 to 30%, the dominant species being *Gahnia clarkei* (Tall Saw Sedge)*, Leptocarpus tenax, Lepyrodia scariosa, Carex appressa*, *Adiantum aethiopicum* (Common Maidenhair), *Gleichenia dicarpa* (Pouched Coral Fern), *Baloskion tetraphyllum* subsp. *meiostachyum* (Tassel Cord Rush), *Blechnum indicum, Entolasia marginata* (Bordered Panic), *Persicaria hydropiper* (Water Pepper), *Hydrocotyle peduncularis,* and *Dichondra repens* (Kidney Weed).

Emergents – *Phagramities australis, Typha orientalis* (Bull Rush), *Baumea articulata* (Jointed Twig-Rush), *Eleocharis sphacelata, Juncus usitatus*, and *Philydrum lanuginosum* (Woolly Frogmouth).

13 Regenerating Vegetation

This vegetation community occurs within the previously cleared areas and edges of native vegetation. Rehabilitation of the old coal dumps is currently occurring within the CHB Development Lands. This vegetation community encompasses approximately 20.1ha. This community is not commensurate with any vegetation communities that have been described by either the Natural Vegetation of the Wyong Local Government Area (Bell, 2002) or LHCCREMS (NPWS 2000; House 2003).

Upper Stratum – 8 to 10m with a PFC of 40 to 50%, the dominant species being *Angophora costata* (Smooth-barked Apple) and *Corymbia gummifera* (Red Bloodwood).

Mid Stratum – 2 to 4m with a PFC to 60 to 80%, the dominant species being, *Acacia longifolia* var. *sophorae* (Coastal Wattle), *Acacia longifolia* var. *longifolia* (Sydney Golden Wattle), *Chrysanthemoides monilifera* subsp*. rotundata* (Bitou Bush), *Kunzea ambugia* (Tick Bush) and *Leptospermum laevigatum* (Coastal Tea Tree)*.*

Lower Stratum – to 2m with a PFC of 5 to 10%, the dominant species being *Acrotriche divaricata, Austrodanthonia linkii* (Wallaby Grass), *Epracis pulchella* (NSW Coral Heath), *Astroloma humifusum* (Cranberry Heath), *Entolasia stricta* (Wiry Panic), and *Chloris gayana* (Rhodes Grass).

14 Weeds and Cleared Areas

This vegetation community occurs within the central portion of the site and is the result of clearing for the underground mining operations. This community encompasses approximately 50.47ha and is not commensurate with any vegetation communities that have been described by either the Natural Vegetation of the Wyong Local Government Area (Bell, 2002) or LHCCREMS (NPWS 2000; House 2003). These areas are highly disturbed and have high weed incursions.

Upper Stratum – 15 to 18m with a Projected Foliage Cover (PFC) of 5%, the dominant species being *Eucalyptus punctata* (Grey Gum), *Eucalyptus robusta* (Swamp Mahogany), *Erythrina* x *sykesii* (Coral Tree) and *Ficus rubiginosa* (Port Jackson Fig).

Mid Stratum – to 2m with PFC of 20 to 30%, the dominant species being *Pteridium esculentum* (Bracken Fern), *Acacia longifolia* var. *longifolia* (Sydney Golden Wattle), *Lantana camara* (Lantana), *Cinnamomum camphora* (Camphor Laurel), *Ligustrum sinense* (Small-leaved Privet) and *Chrysanthemoides monilifera* subsp*. rotundata* (Bitou Bush).

Lower Stratum – to 1m with a PFC of 80 to 90%, the dominant species being *Pennisetum clandestinum* (Kikuyu), *Pteridium esculentum* (Bracken Fern), *Cynodon dactylon* (Common Couch), *Hydrocotyle bonariensis* (Pennywort)*, Chloris gayana* (Rhodes Grass), *Verbena bonariensis* (Purple Top), *Eragrostis tenuifolia* (Elastic Grass), *Stenotaphrum secundatum* (Buffalo Grass), *Richardia brasiliensis* (White Eye), *Andropogon virginicus* (Whisky Grass), *Hypochaeris radicata* (Flatweed), *Plantago lanceolata* (Ribwort), *Bidens pilosa* (Farmer's Friends), *Trifolium repens* (White Clover) and *Sida rhombifolia* (Paddy's Lucerne).

15 Dam

This vegetation community occurs adjoining the cleared areas within the north of the site. This community encompasses approximately 0.95ha and is not commensurate with any vegetation communities that have been described by either the Natural Vegetation of the Wyong Local Government Area (Bell, 2002) or LHCCREMS (NWPS 2000; House 2003). This community differs from the Freshwater Wetland Complex in that it is highly disturbed with weed incursions present around the edges of the dam and with very little density of native species.

Upper Stratum – 10 to 15m with a PFC of 40 to 50%, the dominant species being *Angophora costata* (Smooth-barked Apple) and *Eucalyptus signata* (Scribbly Gum).

Mid Stratum – 2 to 4m with a PFC of 30 to 40%, the dominant species being, *Acacia longifolia* var. *longifolia* (Sydney Golden Wattle), *Dodonea triquetra* (Common Hop Bush), *Pultenaea villosa*, *Pittosporum undulatum* (Sweet Pittosporum) and *Chrysanthemoides monilifera* subsp*. rotundata* (Bitou Bush).

Lower Stratum – to 1m with a PFC of 80 to 90%, the dominant species being *Pennisetum*

clandestinum (Kikuyu), *Pteridium esculentum* (Bracken Fern), *Hydrocotyle bonariensis* (Pennywort), *Imperata cylindrica* var. *major* (Blady Grass), *Hardenbergia violacea* (False Sarsaparilla), *Andropogon virginicus* (Whisky Grass), and *Hypochaeris radicata* (Flatweed).

Emergents – *Schoenoplectus validus, Phragmites australis* (Native Rush), *Typha orientalis* (Bull-rush), *Juncus subsecundus* (Finger Rush) and *Cyperus* sp. *Juncus mollis, Juncus usitatus* (Common Rush).

WARNING
No part of this plan should be used for critical design dimensions. Confirmation of critical positions should be obtained from RPS Newcastle. Note that this Vegetation Community Map depicts clearly defined boundaries between vegetation communities that are the product of individual interpretation and are not distinguished by clearly defined boundaries 'on the ground'. Therefore, this map should only be treated as an indication of approximate peripheries between delineated vegetation communities. Caution should therefore be exercised when using this data for purposes requiring high levels of accuracy. Furthermore, no account for intergrading areas between delineated vegetation communities has been made.

Legend

Site Boundary

Catherine Hill Bay Development Boundary

Vegetation Communities

- Narrabeen Wallarah Sheltered Grassy Forest
- Coastal Holocene Banksia Scrub
- Regenerating Vegetation
- Coastal Headland Complex
- Dam
- Coastal Sand Mahogany-Paperbark Swamp Forest (EEC)
- Freshwater Wetlands (EEC)
- Coastal Sand Wallum Heath-Scrub
- Coastal Plains Smooth-barked Apple Woodland
- Weeds and Cleared Areas
- Narrabeen Doyalson Coastal Woodland
- Munmorah Palm-Apple Dry Drainage Line Forest
- Estuarine Swamp Oak Forest (EEC)
- Narrabeen Foreshore Redgum-Ironbark Forest
- Estuarine Mangrove-Saltmarsh complex
- Disturbed Open Woodland
- Narrabeen Coastal Sheltered Peppermint-Apple Forest
- Established Native Garden
- Narrabeen Snappy Gum Forest
- Littoral Rainforest

Please Note: This vegetation map is a combination of RPSHSO vegetation survey and mapping by EcoBiological 2006b and Wildthing (2003a, 2003b, 2004a, 2004b).

N

0 0.5 1km

SCALE: 1: 20,000 AT A3 SIZE

TITLE: FIGURE 3-1 VEGETATION MAP

LOCATION: CATHERINE HILL BAY

DATUM: N/A
PROJECTION: MGA ZONE 56 (GDA 94)

DATE: 23/9/2010
PURPOSE: ECOLOGY

LAYOUT REF: J:\JOBS\24k\24619 - Catherine Hill Bay\Draft...\Mapinfo\Work...\Ecological Ass. Report 2010 24619 FIGURE 3-1 Vegetation Map A-A3
VERSION (PLAN BY): A A3 (NW-MD)

CLIENT: ROSE CORP PTY LTD
JOB REF: 24619

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
241 DENISON STREET BROADMEADOW PO BOX 428 HAMILTON NSW 2303
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RPS

3.1.2 Conservation Status of Vegetation Communities

Four EEC's that are listed under the *TSC Act* occur within the delineated vegetation communities extant on the site. These four communities are listed below:

- The vegetation community delineated as Estuarine Swamp Oak Forest is commensurate with 'Swamp Oak Floodplain Forest in the NSW North Coast, Sydney Basin and South East Corner Bioregions';
- The vegetation community delineated as Coastal Sand Mahogany - Paperbark Swamp Forest is commensurate with 'Swamp Sclerophyll Forest on Coastal Floodplains in the NSW North Coast, Sydney Basin and South East Corner Bioregions';
- Freshwater Wetlands is commensurate with 'Freshwater Wetlands on Coastal Floodplains in the NSW North Coast, Sydney Basin and South East corner Bioregions'; and
- The Mangrove Estuarine – Saltmarsh Complex vegetation community present on site contains small areas of saltmarsh which represents 'Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions'. Additionally, this community is protected under the *Fisheries Management Act 1994.*

3.1.3 Regionally Significant Flora Species in the Lake Macquarie LGA

No ROTAP listed species (Briggs and Leigh, 1996) were identified within the site. However, Lake Macquarie Flora and Fauna Guidelines (2001) contain a list of regionally significant flora species and seven of these were identified within the site, and are listed as follows:

- *Asplenium aethiopicum*;
- *Conospermum ericifolium*;
- *Eucalyptus robusta*;
- *Eucalyptus signata*;
- *Hakea bakeriana*;
- *Gompholobium pinnatum*; and
- *Xanthorrhoea resinifera* (Tree Form).

3.1.4 Regionally Significant Communities within the Lake Macquarie LGA

The following vegetation communities, which occur within the site, are considered to be regionally significant by Lake Macquarie Flora and Fauna Guidelines (2001) within the Lake Macquarie LGA:

- Munmorah Palm-Apple Dry Drainage Line Forest;
- Coastal Headland Complex;
- Narrabeen Doyalson Coastal Woodland;
- Coastal Holocene Banksia Scrub;

- Coastal Wallum Heath Scrub;
- **Swamp Mahogany - Paperbark Forest (Swamp Sclerophyll Forest on Coastal Floodplains - listed as EEC); and**
- **Swamp Oak Rushland Forest (Swamp Oak Floodplain Forest - listed as EEC).**

3.1.5 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:

- Coastal Headland Complex (Naturally restricted distribution and prone to weed infestation);
- Coastal Sand Holocene Banksia Scrub (Naturally restricted and prone to invasion by Bitou Bush);
- Narrabeen Foreshore Redgum-Ironbark Forest (Highly restricted distribution);
- Narrabeen Wallarah Sheltered Grassy Forest (Restricted distribution); and
- Munmorah Palm-Apple Dry Drainage Line Forest (Restricted distribution).

3.1.6 Regionally Significant Flora Species

No ROTAP listed species (Briggs and Leigh, 1996) were identified within the site. However, Bell (2002) contains a list of regionally significant flora species and 15 of these were identified within the site, and are listed as follows:

- *Asplenium aethiopicum*;
- *Astroloma humifusum*;
- *Avicennia marina* subsp. *australasica*;
- *Blechnum nudum*;
- *Bossiaea rhombifolia*;
- *Callistemon rigidus*;
- ***Cryptostylis hunteriana*** **(listed under TSC Act and EPBC Act);**
- *Cyathea australis*;
- *Melaleuca hypericifolia*;
- *Oxalis perennans*;
- *Persicaria hydropiper*;
- *Pultenaea daphnoides*;
- *Schizaea dichotoma;*
- ***Tetratheca juncea*** **(listed under TSC Act and EPBC Act); and**
- *Xylomelum pyriforme*.

3.1.7 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 5km (DECCW Wildlife Atlas 2010) of the site:

- *Angophora inopina* (Charmhaven Apple);
- *Caladenia tessellata* (Thick Lip Spider Orchid);
- *Callistemon linearifolius* (Netted Bottle Brush);
- *Cryptostylis hunteriana* (Leafless Tongue Orchid);
- *Diuris praecox* (Rough Double Tail);
- *Eucalyptus camfieldii* (Camfield's Stringybark);
- *Eucalyptus parramattensis* subsp. *decadens* (Drooping Red Gum);
- *Pultenaea maritima* (Coastal Headland Pea);
- *Rutidosis heterogama* (Heath Wrinklewort);
- *Syzygium paniculatum* (Magenta Lilly Pilly);
- *Tetratheca glandulosa*; and
- *Tetratheca juncea* (Black-eyed Susan).

Tetratheca glandulosa does not have potential habitat within the site and therefore has not been assessed further within this report.

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

- *Acacia bynoeana*;
- *Chamaesyse psammogeton* (Sand Spurge);
- *Cynanchum elegans* (White-flowered Cynanchum);
- *Dendrobium melaleucaphilum* (Spider Orchid);
- *Genoplesium insignis* (Variable Midge Orchid);
- *Grevillea parviflora* ssp *parviflora* (Little-flower Grevillea);
- *Melaleuca groveana* (Grove's Paperbark); and
- *Microtis angusii* (Angus's Onion Orchid).

3.1.8 Targeted Threatened Flora Species Survey Results

This section lists the results of the targeted threatened flora surveys. Two threatened flora species were located within the site, being *Cryptostylis hunteriana* (Leafless Tongue Orchid) and *Tetratheca juncea.* No other threatened flora species were detected within the site.

Tetratheca juncea

A total of 1,607 *Tetratheca juncea* plants were located during the targeted surveys within the site (Table 3-2 and Figure 3-2 show the distribution). A total of 369 *T. juncea* clumps would be removed as part of the proposal (189 recorded within the CHB Development Lands and 180 recorded by Wildthing (2003b) within the Gwandalan Development Lands. A summary of the *T. juncea* records within the site is presented in Table 3-1 below.

Table 3-1: *Tetratheca juncea* recorded within the site

Site	Survey	*T. juncea* clumps
CHB Development Lands	RPS HSO Nov 2007	189
Gwandalan Development Lands	Wildthing (2003b)	180
Total in Development Lands		*369*
Proposed offsets	RPS HSO Nov 2007	159
Proposed offsets	Wildthing (2003a)	55
Proposed offset	RPS July 2008	1024
Total in offsets (extreme underestimate due to low survey effort)		*1,238*
TOTAL		***1, 607***

Previous surveys undertaken by EcoBiological (2006) within the CHB Development Lands identified *T. juncea* in several more locations than were detected during the current survey (see Figure 3-3). *Tetratheca juncea* spot flowers throughout the year and November is considered to be late in the flowering season. Therefore, since some individuals are likely to have been missed, the population within CHB Development Lands may be larger than currently estimated.

A total of 1024 *Tetratheca juncea* clumps were recorded during the targeted surveys within the Offset Lands. Due to the time constraints in conducting the survey it was not possible to survey all areas identified by (Wildthing 2004) and (RPS HSO 2007) as containing suitable habitat for *T. juncea* within the conservation Offset Lands. *T. juncea* flowering season is between late August and the end of November (in dry years) and between August and January (in wet years) (NPWS 2000). The targeted survey was undertaken outside the peak flowering period for this species. At the time of the survey many *T. juncea* clumps had not yet flowered. Plants are usually sprawling and can be difficult to detect amongst other vegetation when not flowering. In view of the sporadic flowering nature of the species, the survey should be repeated 2–3 times during the flowering period (NPWS 2000).

Therefore, it is considered that the number of *T. juncea* clumps occurring within the proposed Offset Lands is considerably higher than that which was recorded during the targeted surveys outline herewith.

It is expected that the population within the Offset Lands would be quite large (estimated at 5,147) as other surveys within the Wallarah Peninsula have located populations in the thousands in similar and proximate habitats (Table 3-2). Additionally, other large 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 estates.

The work of Payne (2000) states that all sub-populations of 100 plants or more are of very high conservation significance within the south-east quadrant of Lake Macquarie in which this site occurs. However, at the time the total population of *T. juncea* was estimated to be only 10,000 (Payne, 2000). This figure given by Payne (2000) is an underestimation of the entire population throughout its range, since a conservative approach was taken due to the cryptic nature of this species and the lack of extensive survey data at the time. Further surveys since that time has increased the known numbers of this species and this is supported by the large numbers located on the Wallarah Peninsula alone.

Some of the elements of the life-cycle of *T. 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 hypothised as one of the reasons for the species decline and fragmentation (Gross *et al.,* 2003). As the population at the site is large and contains other species which utilise buzz pollination (e.g. *Hibbertia sp. and Dianella sp.*) it is considered that the habitat within 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 occurs to ensure sufficient seed is set to ensure the survival of this species. The populations located within the Offset Lands are estimated to be larger than those within the Development Lands 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 [2007c; 2007d] and Conacher Travers [2007] data combined). Table 3-2 is a breakdown of the numbers of *T. juncea* currently within lands that are dedicated to conservation or are proposed to be dedicated to conservation and have been surveyed to date. This number is expected to be an underestimation as targeted surveys within the Offset Lands were not undertaken and there are large areas of privately owned that remain unsurveyed. Thus, whilst the population within the CHB and Gwandalan Development Lands would be removed, this conservatively represents only 0.3% of the population within the Wallarah Peninsula and large areas of the known populations would be conserved within the proposed Offset Lands. Within the Wallarah Peninsula there is currently over 30,000 *T. juncea* clumps that would be conserved (RPS HSO, 2007d; 2007e; Conacher Travers, 2007; Payne, 2000). Thus the removal of 189 (0.3%) *T. juncea* clumps from the Wallarah Peninsula population is considered unlikely to have a significant effect upon the local population. 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 3-2: 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
Coal & Allied Catherine Hill Bay Proposed Offset Lands	7,057
Coal & Allied Gwandalan Proposed Offset Lands	6,591
Coal & Allied Nords Wharf Proposed Offset Lands	5,933
Rosegroup Offset Lands***	1,238
Total in Conservation Reserves at Wallarah Peninsula	**31,044**

* Data from Conacher Travers (2007)

** Data from Payne (2000)

***Data from RPSHSO (2007) and Wildthing (2003a)

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

LEGEND

- CHB Development Lands
- *Tetratheca juncea (RPSHSO 2007)*
- *Tetratheca juncea (EcoBiological 2006b)*

N

0 200 400

SCALE: 1: 5000 AT A3 SIZE

TITLE: FIGURE 3-2 TETRATHECA JUNCEA COUNTS WITHIN CHB DEVELOPMENT LANDS

LOCATION: CATHERINE HILL BAY

DATUM: N/A
PROJECTION: MGA ZONE 56 (GDA 94)

DATE: 23/9/2010
PURPOSE: ECOLOGY

J:\JOBS\24k\24619 - Catherine Hill Bay\Draft .... \Mapinfo\Work...\Ecological Ass. Report 2010
LAYOUT REF: 24619 FIGURE 3-2 TJ counts within CHB Dev Lands B-A4
VERSION (PLAN BY): B A3 (NW-MD)

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Warning:
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LEGEND

N

Site Boundary

Predicted Tetratheca juncea Extent

Tetratheca juncea Extent (RPSHSO 2007)

Tetratheca juncea extent (Wildthing 2004a)

RPS HSO July 2008

Tetratheca juncea (1024 clumps)

NOTE:
- During surveys often more than one Tetratheca juncea clump was attributed to each point. As a result, an individual point may represent between 1-22 clump(s).

- Surveys were not undertaken systematically across all of the offset lands, but were focused on areas of predicted occurrence. Not all potential habitat for the species was surveyed. Greater survey effort (systematic 10m transects) was undertaken in areas that were found to be flowering at the time of the survey.

- Surveys were undertaken outside of the peak flowering period for the species. As a result, it is expected that the offset lands will contain substantially more Tetratheca juncea than recorded during July 2008 surveys. This is particularly the case since not all potential habitat was systematically surveyed within the offset lands.

0 500 1,000m

SCALE: 1:1,400 AT A3 SIZE

TITLE: FIGURE 3-3 TETRATHECA JUNCEA OCCURRENCE WITH CHB LANDS

LOCATION: CATHERINE HILL BAY

DATUM: N/A
PROJECTION: MGA ZONE 56 (GDA 94)

DATE: 23/9/2010
PURPOSE: ECOLOGY

LAYOUT REF: J:\JOBS\24k\24619 - Catherine Hill Bay\Draft ....\Mapinfo\Work\Ecological Ass. Report 2010 24619 Figure 3-3 TJ occurence with CHB Lands A A3
VERSION (PLAN BY): A A3 (NW-MD)

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***Cryptostylis hunteriana* (Leafless Tongue Orchid)**

A total of five *Cryptostylis hunteriana* clumps containing 13 above-ground stems were recorded during the December 2008 within the Narrabeen Doyalson Coastal Woodland vegetation community within the CHB Development Lands (Figure 3-4). Several other records for this species occur within the local area. This find is significant as this species is extremely difficult to locate due to sporadic flowering (Bell, 2001). There are six locations where this species has been located in the Wyong LGA and southern Lake Macquarie LGA being Charmhaven, Wyee, Chain Valley Bay, Vales Point and Freemans Waterhole (Bell, 2001). In recent times, an individual was located within the Wallarah Peninsula, at Murrays Beach (Conacher Travers, 2004). Thus the find of a seventh population within the area is significant. The location of the species within Scribbly Gum habitat is also consistent with the habitat in which this species has been found to be growing. Other locations include Bulahdelah, Nelson Bay, Lemon Tree Passage, Ben Boyd NP, Gilbrater Range NP, Ku-ring-gai Chase NP, Pigeon House, and the south coast. Further afield it occurs in Victoria and Queensland (Bell, 2001).

A major population of this species was located at Bulahdelah within the Bulahdelah Bypass area where the largest population has been found (Parson Brinckenoff, 2004). Approximately 50% of this population is to be translocated as part of the proposal and ongoing research and monitoring will be performed to assess the success of this translocation.

In conclusion, this population is significant locally, regionally, and at both a State and Federal level, due to the low numbers of this species recorded. Very few of these populations are reserved within defined conservation reserves and it is recommended that this population be conserved within the CHB Development Lands layout.

Plate 1: *Cryptostylis hunteriana* within CHB Development Lands

A total of nine patches of *Cryptostylis hunteriana* were found within the CHB conservation area during the targeted 2-5 December 2008 Survey in the resulting in 43 flowering stems being recorded. These patches were located in the Narrabeen Doyalson Coastal Woodland (Figure 3-4).

The cryptic nature of this species makes it a very difficult to locate in the field, so it would not be unexpected that more specimens occur within suitable areas of the locality.

Cryptostylis hunteriana has a history of flowering sporadically, going for years at a time not producing any flower which makes it difficult to accurately determine potential population sizes. However, the works undertaken to date within both proposed Development Lands (one clump, 10 specimens) and within Offset Lands (nine clumps, 43 specimens) would seemingly indicate that the level of conservation of this species would be greater than the 4:1 ratio applied at an elementary level across all other facets of biodiversity assessed for this proposal.

Warning:
No part of this plan should be used for critical design dimensions. Confirmation of critical positions should be obtained from RPS Newcastle. Note that this Vegetation Community Map depicts clearly defined boundaries between vegetation communities that are the product of individual interpretation and are not distinguished by clearly defined boundaries 'on the ground'. Therefore, this map should only be treated as an indication of approximate peripheries between delineated vegetation communities. Caution should therefore be exercised when using this data for purposes requiring high levels of accuracy. Furthermore, no account for intergrading areas between delineated vegetation communities has been made.

Legend

- Site Boundary
- Cryptostylis hunteriana records 2-12-08
- Cryptostylis hunteriana records 4-12-08
- Cryptostylis hunteriana (Hamlet 6)

Vegetation Communities

- Coastal Headland Complex
- Coastal Holocene Banksia Scrub
- Coastal Plains Smooth-barked Apple Woodland
- Coastal Sand Mahogany-Paperbark Swamp Forest (EEC)
- Coastal Sand Wallum Heath-Scrub
- Dam
- Disturbed Open Woodland
- Established Native Garden
- Estuarine Mangrove-Saltmarsh complex
- Estuarine Swamp Oak Forest (EEC)
- Freshwater Wetlands (EEC)
- Littoral Rainforest
- Munmorah Palm-Apple Dry Drainage Line Forest
- Narrabeen Coastal Sheltered Peppermint-Apple Forest
- Narrabeen Doyalson Coastal Woodland
- Narrabeen Foreshore Redgum-Ironbark Forest
- Narrabeen Snappy Gum Forest
- Narrabeen Wallarah Sheltered Grassy Forest
- Regenerating Vegetation
- Weeds and Cleared Areas

N

0 400 800m

SCALE: 1:5,000 AT A3

TITLE: FIGURE 3-4 LOCATION OF CRYPTOSTYLIS HUNTERIANA RECORDS WITHIN CHB

LOCATION: CATHERINE HILL BAY

DATUM: N/A
PROJECTION: MGA ZONE 56 (GDA 94)

DATE: 23/09/2010
PURPOSE: ECOLOGY

LAYOUT REF: J:\JOBS\24k\24619 - Catherine Hill Bay\Drafting\Mapinfo\Work..\Ecological Ass. Report 2010 24619 Figure 3-4 Location of Cryptostylis hunteriana records within CHB B A3
VERSION (PLAN BY): B A3 (NW-MD)

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RPS

3.2 SEPP 14 Wetland Boundary Survey Results

Groundtruthing found that the northern SEPP 14 wetland boundary, as indicated by wetland vegetation, exists to the north of the DoP boundary (Figure 3-5). The delineation of the boundary of the SEPP 14 wetland was determined by the presence of sedges, Melaleucas or other wetland flora species. The SEPP 14 wetland extends into the southern portion of the site at CHB; however, it lies approximately 35m outside of the CHB Development Lands boundary at the closest point. Figure 3-5 indicates both the new groundtruthed wetland boundary delineated using a Trimble GEOXH GPS with post processing, and the broad-scale DoP SEPP 14 boundary.

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

LEGEND

- Site Boundary
- SEPP 14 Wetlands
- Groundtruthed SEPP 14 Boundary

N

0 500 1,000

Metres

SCALE: 1: 14000 AT A3 SIZE

TITLE:	FIGURE 3-5 SEPP14 WETLANDS	LOCATION:	CATHERINE HILL BAY	DATUM: PROJECTION:	N/A MGA ZONE 56 (GDA 94)	DATE: PURPOSE:	23/9/2010 ECOLOGY

LAYOUT REF: J:\OBS\24k\24619 - Catherine Hill Ba .... ting\Mapinfo\Work\Ecological Ass Report 2010 24619 Figure 3-5 SEPP14 Wetlands A-A4
VERSION (PLAN BY): A A3 (NW-MD)

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3.3 Fauna

The results of the threatened fauna database searches and targeted Eastern Pygmy Possum, Glossy Black Cockatoo and Masked Owl surveys are discussed below. Please refer to previous survey reports (Wildthing, 2003a; 2003b; 2004a; 2004b; 2004c; EcoBiological, 2006a; 2006b; and RPS HSO, 2007d) for details of the findings of previous investigations.

3.3.1 Habitat Description

CHB Development Lands

The majority of CHB Development Lands have been subject to high levels of disturbance associated with coal mining operations and facilities and offers little habitat to native flora and fauna. However, high quality native vegetation does occur within small areas on the fringes of the CHB Development Lands. These high quality native remnants contain a variety of shrub and groundcover that is likely to support small terrestrial mammals and reptiles. Additionally, hollow-bearing trees recorded in the south of the CHB Development Lands (Figure 3-6) provide an important resource for hollow-dependent fauna species.

Gwandalan Development Lands

Much of the Gwandalan Development Lands contain vegetation in good to high condition, which is likely to provide habitat that supports a range of fauna species. Habitats that are likely to be important include abundant hollow-bearing trees, fallen timber and logs, shrub and groundcover (shelter and foraging opportunities), canopy species (foraging opportunities), dams and riparian areas.

Offset Lands

The Offset Lands contain a range of habitats that would support a range of fauna species including intact creeklines and riparian vegetation, abundant hollow-bearing trees, variations in shrub and groundcover densities (shelter and foraging resources), canopy foraging resources.In area alone the proposed Offset Lands comprise more than 80% of the southern Lake Macquarie holdings.

3.3.2 NPWS Threatened Species Database Search Results

The results of the above search indicated that twenty-eight (28) threatened fauna species have been previously recorded within 5km (DECCW Wildlife Atlas 2010) of the site. Of these species, five have been recorded within the site (indicated by an asterisk (*). Section 4 provides an assessment of the likelihood of occurrence of these threatened species within the site based on the presence of local records, findings of previous surveys and the presence of suitable habitat.

- *Daphoenositta chrysoptera* Varied Sitella
- *Glossopsitta pusilla* Little Lorikeet
- *Calyptorhynchus lathami** Glossy Black-Cockatoo*

Lathamus discolor	Swift Parrot
Crinia tinnula	Wallum Froglet
Ixobrychus flavicollis	Black Bittern
Ephippiorhynchus asiaticus	Black-necked Stork
Pandion haliaetus	Osprey
Haematopus fuliginosus	Sooty Oystercatcher
Haematopus longirostris	Pied Oystercatcher
Charadrius mongolus	Charadrius mongolus
Sterna albifrons	Little Tern
Ptilinopus regina	Rose-crowned Fruit-Dove
Ninox connivens	Barking Owl
Ninox strenua	Powerful Owl
*Tyto novaehollandiae**	Masked Owl*
Xanthomyza phrygia	Regent Honeyeater
Dasyurus maculatus	Spotted-tailed Quoll
*Phascolarctos cinereus**	Koala*
Cercartetus nanus	Eastern Pygmy-possum
Squirrel Glider	Squirrel Glider
Pteropus poliocephalus	Grey-headed Flying-fox
Mormopterus norfolkensis	Eastern Freetail-bat
Falsistrellus tasmaniensis	Eastern False Pipistrelle
*Miniopterus australis**	Little Bentwing-bat*
*Miniopterus schreibersii oceanensis**	Eastern Bentwing-bat*
Myotis adversus	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 those oceanic species.

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
- *Tyto tenebricosa* Sooty Owl
- *Saccolaimus flaviventris* Yellow-bellied Sheathtail-bat

3.3.3 Targeted Eastern Pygmy Possum Survey Results

The Common Antechinus (*Antechinus stuartii*) was the only fauna species captured during targeted Eastern Pygmy Possum surveys (Table 3-3). No other species were recorded within the CHB Development Lands during the targeted survey.

Table 3-3: Trapping Results

Date	Trap Number	Species	Sex
13/11/07	A9	*Antechinus stuartii*	Female
13/11/07	D1	*Antechinus stuartii*	Female
14/11/07	A9	*Antechinus stuartii*	Female
14/11/07	D1	*Antechinus stuartii*	Female
15/11/07	A9	*Antechinus stuartii*	Female
16/11/07	A10	*Antechinus stuartii*	Female
16/11/07	A7	*Antechinus stuartii*	Female
16/11/07	D4	*Antechinus stuartii*	Female

Lambertia formosa was scattered within potential habitat identified by EcoBiological (2006a) and was the only Proteaceae flowering within the CHB Development Lands at the time of the survey. Other Proteaceae observed within the CHB Development Lands included *Banksia serrata*, *B. spinulosa*, *B. oblongifolia*, *B. robur* and *Hakea bakeriana*.

3.3.4 Targeted Glossy Black Cockatoo Survey Results within Gwandalan Development Land

The Glossy Black Cockatoo was recorded within the site on three occasions during the survey period. The survey records were:

- 9th June – four Glossy Black Cockatoos observed;
- 14th July – four Glossy Black Cockatoos observed; and
- 4th August – four Glossy Black Cockatoos observed.

All records were of birds flying over the north western part of the site except on one occasion when four birds landed briefly within the site and then moved on. No foraging was observed when the species was observed within the site. The species was recorded

on each occasion in the late afternoon prior to dusk and are considered likely to be the same birds. Potentially, these birds were flying from a feed site (somewhere east of the site) to their roosting site (somewhere west of the site).

Chewed cones of *A. littoralis* were recorded from the site on the 9th June 2009 survey period. This indicated that *C. lathami* had used the site at least once for foraging purposes since the previous survey period on the 12th May 2009 during which no evidence of foraging was found. No other chewed cones were found during the survey periods. There were no indications of breeding or attempted breeding during the survey period for *C. lathami*.

3.3.5 Targeted Masked Owl Survey Results within Gwandalan Development Land

The Masked Owl was recorded from the Gwandalan development site in 2003 by Wildthing Consultants. However, targeted searches on six separate occasions from March to August 2009 including spotlighting, stag watching, call playback and secondary indications searches failed to find any observations, signs or breeding evidence of *T. novaehollandiae*.

3.4 Opportunistic Observations

Three significant opportunistic observations were made during field surveys, being:

- a Powerful Owl, was recorded within the site during the 14th April and 9th June surveys after call playback;
- a White-bellied Sea-Eagle (*Haliaeetus leucogaster*) nest within the Offset Lands; and
- Wallum Froglet (*Crinia tinnula*) within the SEPP 14 Wetland to the south of the CHB Development Lands. One Wallum Froglet, listed as Vulnerable under the *TSC Act*, was recorded calling briefly from SEPP 14 wetland to the south of the CHB Development Lands during mapping of the northern SEPP 14 boundary.

The Powerful Owl, a threatened owl species listed as Vulnerable under *TSC Act 1995* was recorded within the site during the 14th April and 9th June surveys after call playback. On the 14th April an observation was made of a bird that came from outside of the site in response to call playback. The observation on the 9th June was of a bird that was potentially on the site or located very close to the site due to the early and fast response of the individual. No indications of breeding or attempted breeding were recorded during the survey period for the Powerful Owl.

The White-bellied Sea-Eagle is listed as Migratory under the *EPBC Act.* The White-bellied Sea-Eagle nest was found within a large *Angophora costata* (Smooth-barked Apple) adjacent to the west of the SEPP 14 wetland in the southern portion of the proposed Offset Lands (Figure 3-6). The nest was in current use with two to three juvenile White-bellied Sea-Eagles occupying the nest. An adult was observed landing to feed young. The nest had a large build-up of nesting material under the tree, indicating that it is likely to have been in use for multiple breeding seasons.

A Rufous Fantail (*Rhipidura rufifrons*), a species listed as Migratory under the *EPBC Act*, was recorded adjacent to Munmorah Palm-Apple Dry Drainage Line Forest within Lot 5 DP 774923 to the west of the coal dump within the Offset Lands (Figure 3-6).

3.5 Corridors and Connectivity

The site is located within a large tract of vegetation that extends from Swansea in the north, west to Summerland Point and to Toukley in the south. Two estates managed by NSW National Parks and Wildlife Service are located in close proximity to the site, Munmorah SCA and Lake Macquarie SCA. Other large holdings include land owned by Coal & Allied to the north of the Offset Lands and to the south of Gwandalan Development Lands.

The CHB Development Lands are situated in an area that is mostly disturbed and as such is not likely to sever any existing connectivity with large areas of vegetation. Some minor loss of fringing vegetation would very slightly reduce the overall fragment size. However, this reduction in size is not considered significant in a wider locality perspective.

The Development Lands at Gwandalan are part of a tract of vegetation running north to south linking Lake Macquarie SCA with vegetation to the south. Land immediately to the west of the site also provides a north-south vegetated corridor. The proposed development of the lands at Gwandalan would reduce the overall fragment size in this area and reduce the width of the existing north-south connectivity (Figure 1-1).

The proposal includes Offset Lands to be transferred to the Minister of the Environment.

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

Legend

Site Location

Fauna Species

- White-bellied Sea Eagle Nest
  Migratory EPBC Act
- Wallum Froglet
  TSC Act (V)
- Glossy Black Cockatoo
  TSC Act (V)
- Rufous Fantail
  Migratory EPBC Act

Hollow-bearing Trees

- Areas containing Hollow-bearing Trees
- Hollow-bearing Trees

N

0 500 1,000
Metres

SCALE: 1: 22000 AT A3 SIZE

TITLE: FIGURE 3-6 SIGNIFICANT FAUNA OBSERVATIONS

LOCATION: CATHERINE HILL BAY GWANDALAN

DATUM: N/A
PROJECTION: MGA ZONE 56 (GDA 94)

DATE: 24/9/2010
PURPOSE: ECOLOGY

LAYOUT REF: J:\JOBS\24k\24619 - Catherine Hill Ba .... ting\Mapinfo\Work\Ecological Ass Report 2010 24619 FIGURE 3-6 Significant Fauna Observations B-A3
VERSION (PLAN BY): A A3 (NW-MD)

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4 Threatened Species and Communities Assessment

4.1 Introduction

This section discusses the potential impacts on threatened species and endangered ecological communities listed under the *TSC Act* and/or *EPBC Act* arising from the proposal. The aim of this section is to provide an overall assessment of the significance of potential impacts arising from the proposal at CHB Development Lands and Gwandalan Development Lands and takes into consideration the proposed Offset Lands. These assessments have been developed through habitat assessment and targeted survey undertaken by RPS HSO during recent investigations in addition to information provided within previous assessments undertaken by Wildthing (2003a; 2003b; 2004a; 2004b; 2004c) and EcoBiological (2006a; 2006b).

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 site 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. Separate assessments were undertaken for the Gwandalan Development Lands, CHB Development Lands and for the Offset Lands due to the differences in the types of habitats present and level of disturbance.

4.2 Assessment of Likelihood of Occurrence of Threatened Species and Communities

The assessment of likelihood of occurrence of threatened species, populations and/or EECs was undertaken relying on habitat assessments from previous ecological survey reports (Wildthing, 2003a; 2003b; 2004a; 2004b; 2004c; EcoBiological, 2006a; 2006b; and RPS HSO, 2007) in conjunction with site visits to undertake fieldwork for this EAR.

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 4.3 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 to the Offset Lands forming part of the proposal.

Notes: *(V)* = *Vulnerable Species listed under the* Threatened Species Conservation Act 1995*.*
(E) = *Endangered Species listed under the* Threatened Species Conservation Act 1995*.*
(CE) = Critically Endangered Species listed under the Threatened Species Conservation Act 1995.
(CE*) = Critically Endangered Species listed under the Commonwealth EPBC Act 1999.
(V*) = Vulnerable Species listed under the *Commonwealth EPBC Act 1999*.
(E*) = Endangered Species listed under the *Commonwealth EPBC Act 1999*.
(M*) = Migratory Species listed under the *Commonwealth EPBC Act 1999*.
Notes: (V) = Vulnerable Species listed under the Threatened Species Conservation Act 1995.

Table 4-1: Threatened Species Assessment

Species	Habitat Description and Known Populations	Chance of Occurrence within Gwandalan Development Lands	Chance of Occurrence within CHB Development Lands	Chance of Occurrence within Offset Lands	Likely Level of Impact
PLANTS					
Acacia bynoeana Bynoe's Wattle (E, 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 southwest of the site within the Lake Macquarie State Recreation Area.	**Low – Moderate** Targeted surveys were unable to record this species within the Gwandalan Development Lands, despite a small amount of potential habitat being present (Wildthing, 2003b). However, this cryptic species is relatively difficult to locate in the field and as such its presence within the site cannot be totally discounted.	**Low – Moderate** Targeted surveys were unable to record this species within the CHB Development Lands, despite a small amount of potential habitat being present (Wildthing, 2004a). However, this cryptic species is relatively difficult to locate in the field and as such its presence within the site cannot be totally discounted.	**Moderate** Potential habitat for this species occurs within the Offset Lands. Since targeted surveys were not undertaken across the entire Offset Lands, the species cannot be discounted as occurring.	**Low** Considered unlikely to be adversely affected by the proposal due to the conservation of areas of potential habitat for this species within Offset Lands, and the lack of records within development areas subjected to several flora surveys.
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).	**Low - Moderate** Potential habitat for this species occurs within the Gwandalan Development Lands. However, the species was not recorded during flora surveys undertaken by Wildthing (2003b).	**Low - Moderate** Potential habitat for this species occurs within the CHB Development Lands. However, the species was not recorded during flora surveys undertaken by Wildthing (2004a) and EcoBiological (2006a; 2006b).	**Moderate** Potential habitat for this species occurs within the Offset Lands. Since targeted surveys were not undertaken across the entire Offset Lands, the species cannot be discounted.	**Low** The current proposal is unlikely to adversely impact upon this species, due to its absence from potential habitat within the Development Lands and the retention of potential habitat within Offset Lands to be dedicated to conservation.
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.	**Low - Moderate** Potential habitat for this species occurs in the drainage lines within the Gwandalan Development Lands. However, the species was not recorded during flora surveys undertaken by Wildthing (2003b).	**Low - Moderate** Potential habitat for this species occurs in the drainage lines within the CHB Development Lands. However, the species was not recorded during flora surveys undertaken by Wildthing (2004a) and EcoBiological (2006a; 2006b).	**Moderate** Potential habitat for this species occurs in the drainage lines within the Offset Lands. Since targeted surveys were not undertaken across the entire Offset Lands, the species cannot be discounted.	**Low** The current proposal is unlikely to adversely impact upon this species, due to its absence from potential habitat within the Development Lands and the retention of potential habitat within Offset Lands to be dedicated to conservation.
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 Conservation Area to the southwest of the site.	**Low – Moderate** Flora surveys were conducted within the flowering season for this species by RPSHSO (2007) and it was not recorded within the Gwandalan Development Lands. However, habitat assessment suggests that there is potential for this species to occur in woodland habitats with a heathy to grassy understorey of which there is a small area in the east of the Gwandalan Development Lands.	**Low – Moderate** Targeted flora surveys were conducted by Ecobiological (2006) within the flowering season for this species and it was not recorded within the CHB Development Lands.	**Moderate** No targeted searches for this species were undertaken within the Offset Lands; however, there is habitat within the Narrabeen Doyalson Coastal Woodland and Narrabeen Wallarah Sheltered Grassy Woodland.	**Low** Due to the conservation of those areas representing potential habitat for this species it is unlikely that the current proposal will adversely impact upon this species.
Chamaesyce psammogeton (E)	Perennial prostrate herb, which grows on sand dunes near the sea. Within the region records exist from Myall Lakes National Park and Wamberal Lagoon Nature Reserve.	**Low** No potential habitat (sand dunes) exists within the site for this species.	**Low – Moderate** Highly marginal habitat exists within the Coastal Headland Complex in the north of the CHB Development Lands. However, the species was not recorded during flora surveys (Wildthing, 2004a; EcoBiological, 2006a; 2006b).	**Low – Moderate** Marginal habitat exists within the Coastal Headland Complex to the north of the CHB Development Lands. However, the species was not recorded during flora surveys.	**Low** A small amount of highly marginal habitat exists within the CHB Development Lands. However, similar habitat also exists within Offset Lands which would be dedicated to conservation. This species may be indirectly impacted upon by increased residential development due to increased usage of the CHB beach outside of the site (where more suitable habitat exists) if measures to protect

Species	Habitat Description and Known Populations	Chance of Occurrence within Gwandalan Development Lands	Chance of Occurrence within CHB Development Lands	Chance of Occurrence within Offset Lands	Likely Level of Impact
					potential habitat from pedestrian traffic are not incorporated into the occupation phases of residential development.
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.	**Moderate** The relatively wide range of possible habitats that this species potentially occurs within and the ubiquitous presence of a closely related species, *C. subulata and C. erecta*, with which this species is sometimes associated, suggests that it may occur within any of the wooded habitats within the Gwandalan Development Lands, except those that are very wet or saline in nature. Targeted searches for this species failed to locate it within the Gwandalan Development Lands. However, due to the large amount of habitat within the site and the cryptic nature of this species its presence within the site cannot be discounted.	**High** This species (approximately 13 individuals) was recorded within the Narrabeen Doyalson Coastal Woodland within the CHB Development Lands.	**Moderate - High** This species was recorded within the CHB conservation area. A total of nine clumps with 43 flowering stems were located by two ecologists. The cryptic nature of this species makes it a very difficult to locate in the field, so it would not be unexpected that more specimens occur within suitable areas of the locality.	**Moderate** The areas of potential habitat which are located within the Offset Lands provide a small amount of habitat for this species. However, the majority of the Offset Lands is not optimal habitat for this species. The presence of this species within the CHB Development Lands is of notable significance. If this species and the habitat surrounding it are retained then the impact of the proposal will be minimal. In addition, a buffer area is recommended to be implemented in combination with appropriate nutrient and sediment controls to mitigate any runoff from the proposed adjoining urban development. The removal of suitable habitat within the Gwandalan Development Lands would further reduce the amount of habitat available to the species in the local area. The works undertaken to date within both proposed Development Lands (one clump, 10 specimens) and within conservation lands (nine clumps, 43 specimens) would seemingly indicate that the level of conservation of this species would be greater than the 4:1 ratio applied at an elementary level across all other facets of biodiversity assessed for this proposal.
Cynanchum elegans White-flowered Wax Plant (E, E*)	Occurs scattered along the NSW Northern Coast south to Wollongong usually in dry, littoral or subtropical rainforest and occasionally Melaleuca scrub or woodland. A climbing or twining plant species that flowers from August to May with peak flowering in November. One record within the Atlas of NSW Wildlife data occurs within the Lower Hunter Region and Central Coast at Green Point to the north of Belmont.	**Low – Moderate** The wet sclerophyll habitats, within the east of the Gwandalan Development Lands represents sub-optimal habitat for this species. However, it was not recorded during flora surveys within the development estate and there are very few records for this species within the region.	**Low - Moderate** The littoral rainforest remnants described by EcoBiological (2006) contain potential habitat for this species. However, it was not recorded during flora surveys performed by EcoBiological (2006) within the CHB Development Lands and there are very few records for this species within the region.	**Moderate** Due to its potential to occur across a wide range of wet sclerophyll habitats, the Offset Lands contain a range of opportunities for this species. Targeted surveys for the species were not undertaken within the Offset Lands.	**Low** Whilst some potential habitat for this species occurs within the development estate large areas of superior habitat for this species will be conserved within the Offset Lands.
Dendrobium melaleucaphilum Spider Orchid (E)	Epiphytic orchid growing mostly growing on *Melaleuca stypheloides*, but occasionally on rainforest tress 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 stypheloides*, 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 within the Gwandalan Development Lands (Wildthing 2003b). Nevertheless due to the occurrence of potential habitat its presence within the site cannot be totally discounted.	**Low – Moderate** Although the favoured host plant for this orchid, *Melaleuca stypheloides*, 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 within the CHB Development Lands (Wildthing, 2004a; EcoBiological, 2006a; 2006b). Nevertheless due to the occurrence of potential habitat its presence within the site cannot be totally discounted.	**Low - Moderate** Although the favoured host plant for this orchid, *Melaleuca stypheloides*, was recorded within the Offset Lands during flora surveys, there are no known records for this orchid species in the Lake Macquarie area. Nevertheless due to the occurrence of potential habitat and the lack of targeted surveys undertaken within Offset Lands, 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 the majority of the wet sclerophyll forests which represent potential habitat for conservation purposes (ie in the Offset Lands).
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 woodland locations to the south east of Lake Macquarie.	**Moderate - High** Records for this species occur to the Northeast of the Gwandalan Development Lands (Atlas of NSW Wildlife data). Onsite habitat in the vicinity is commensurate with the sites of other records in the area. The species was not recorded during targeted	**Moderate - High** Records for this species occur to the north and south of the CHB Development Lands (Atlas of NSW Wildlife data). Onsite habitat in the vicinity is commensurate with the sites of other records in the area. The species was not recorded during targeted surveys	**High** Records for this species occur to the north and south of the Offset Lands (Atlas of NSW Wildlife data). Onsite habitat in the vicinity is commensurate with the sites of other records in the area. Targeted surveys have not been performed within the Offset Lands	**Low - Moderate** Those areas representing the most suitable habitat for this species will be retained within Offset Lands that would be dedicated to conservation. It is unknown if the development proposal will removal any individuals of this species due to the cryptic

Species	Habitat Description and Known Populations	Chance of Occurrence within Gwandalan Development Lands	Chance of Occurrence within CHB Development Lands	Chance of Occurrence within Offset Lands	Likely Level of Impact
		surveys (RPS HSO 2007). However, due to the cryptic nature of this species (i.e. does not flower every year) the presence of this species within the Gwandalan Development Lands cannot be discounted.	within the CHB Development Lands by EcoBiological (2006a) within the flowering period. However, due to the cryptic nature of this species (ie does not flower every year) the presence of this species within the CHB Development Lands cannot be discounted.	for this species. However, due to the presence of potential habitat within the Offset Lands and the lack of targeted surveys undertaken within the Offset Lands, the presence of this species within the Offset Lands cannot be discounted, and is predicted as likely.	nature of this orchid. However, it is unlikely to be adversely affected by the current proposal as there are vast tracts of potential habitat for this species to be retained within the Offset Lands.
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.	**Low - Moderate** Potential habitat for this species exists within the Narrabeen Snappy Gum Forest vegetation community. 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. No individuals of this species were detected within the Gwandalan Development Lands (Wildthing, 2003b); 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** Potential habitat for this species exists within the Narrabeen Doyalson Coastal Woodland vegetation community. 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. No individuals of this species were detected within the CHB Development Lands; 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 totally discounted.	**Moderate** Records for this species occur within Lot 6 DP 771923 adjoining the Pacific Highway (Atlas of NSW Wildlife data). Onsite habitat in the vicinity is commensurate with the sites of other records in the area. During flora surveys by Wildthing (2003a; 2004c) within the Offset Lands, this species was not detected. Local status of this species is not clear, due to widespread presence of *Eucalyptus capitellata* within the Offset Lands, a species to which *E. camfieldii* is very closely aligned. Due to the abundance of potential habitat within the Offset Lands, the lack of targeted surveys across the entire Offset Lands and its known occurrence within the locality, the likelihood of it occurring within the Offset Lands cannot be discounted.	**Low** Whilst some potential habitat may be removed as part of the development proposal similar habitat will be reserved within the Offset Lands.
Eucalyptus parramattensis ssp. *decadens* Drooping Red Gum (V, V*)*	Red Gum species that grows in dry sclerophyll woodland on sandy soils, often in low damp sites. This species occurs almost exclusively in association with the Aeolian sand communities of Tomago and Kurri Kurri and ecotonal areas, but a small disjunct stand of stunted individuals have been recently recorded within a south-facing slope within the Coastal Headland Complex to the north of the CHB Development Lands (RPS HSO *pers. obs*).	**Low** Whilst the species has been recorded near CHB, no potential habitat for this species is present within the Gwandalan Development Lands and it was not recorded during flora surveys by Wildthing (2003b).	**Low** Whilst this species has been recorded on a south-facing slope within the Coastal Headland Complex to the north of the CHB Development Lands, it was not recorded within the CHB Development Lands by Wildthing (2004a) or EcoBiological (2006a; 2006b) during their flora surveys.	**Low** Whilst the species has been recorded near CHB, no potential habitat for this species (coastal headland complex/heath) occurs within the Offset Lands.	**Low** This species was not detected within the Development Lands at CHB but potential habitat is present both within the Coastal Headland Complex, with large areas of potential habitat on the headland to the east of the CHB Development Lands. Therefore, it is unlikely that this species will be affected by the 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 Conservation Area to the south of the site.	**Low – Moderate** Habitat for this species exists within the Narrabeen Snappy Gum Forest vegetation community within the site. No individuals were detected during targeted surveys within the flowering period (RPSHSO, 2007). However, due to the noted occurrence of this species in the local area and its cryptic nature, its presence within the site cannot be totally discounted.	**Low – Moderate** Habitat for this species exists within the Narrabeen Doyalson Coastal Woodland vegetation community within the CHB Development Lands. No individuals were detected during targeted surveys within the flowering period by EcoBiological (2006a). However, due to the noted occurrence of this species in the local area and its cryptic nature, its presence within the site cannot be totally discounted.	**Low – Moderate** A small area of potentially suitable habitat occurs in the south of the Offset Lands within the Narrabeen Doyalson Coastal Woodland. Since no targeted surveys for the species were undertaken within the Offset Lands, the presence of the species cannot be totally discounted.	**Low** Those areas representing the best potential habitat opportunities for this species would be conserved within the Offset Lands.
Grevillea parviflora subsp. *parviflora (V, V*)*	Occurs in light, clayey soils in woodlands. Most plants appear capable of suckering from a rootstock. Relatively widespread within the Cessnock LGA, and occurs within Werakata National Park. Other populations known from the North Cooranbong area. Much confusion surrounds the taxonomy of this species and other similar *Grevillea* taxa (S. Bell *pers. comm.*), and a NPWS-funded study of the species is currently in progress.	**Low – Moderate** Potential habitat for this species occurs throughout the dry sclerophyll areas, particularly in the Narrabeen Coastal Sheltered Apple-Peppermint Forest. However, the species was not recorded during flora surveys undertaken by Wildthing (2003b).	**Low – Moderate** Potential habitat for this species occurs throughout the dry sclerophyll areas, particularly in the Narrabeen Wallarah Sheltered Grassy Forest. However, the species was not recorded within the CHB Development Lands during flora surveys by Wildthing (2004a) and EcoBiological (2006a; 2006b).	**Moderate** Potential habitat for this species occurs throughout the dry sclerophyll areas, particularly in the Narrabeen Wallarah Sheltered Grassy Forest. Since targeted surveys within the entire Offset Lands were not undertaken, the presence of the species cannot be discounted.	**Low** Those areas representing the best potential habitat opportunities for this species would be conserved within the Offset Lands.
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	**Low – Moderate** Habitat for this species exists within the Narrabeen Snappy Gum Forest vegetation community within the Gwandalan	**Low – Moderate** Habitat for this species exists within the Narrabeen Doyalson Coastal Woodland vegetation community within the CHB	**Low – Moderate** A small area of potentially suitable habitat occurs in the south of Offset Lands within the Narrabeen Doyalson Coastal Woodland.	**Low** Whilst some habitat may be removed as part of the development proposal similar habitat will be reserved within the Offset Lands.

Species	Habitat Description and Known Populations	Chance of Occurrence within Gwandalan Development Lands	Chance of Occurrence within CHB Development Lands	Chance of Occurrence within Offset Lands	Likely Level of Impact
	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 Conservation area, which occurs to the south of Gwandalan.	Development Lands. However, the species was not recorded during targeted surveys within the flowering period (RPSHSO, 2007). Due to the noted occurrence of this species in the local area and its cryptic nature, its presence within the site cannot be entirely discounted.	Development Lands. However, the species was not recorded during targeted surveys undertaken within the flowering period (EcoBiological, 2006a). Due to the noted occurrence of this species in the local area and its cryptic nature, its presence within the site cannot be entirely discounted.	Since targeted surveys within the entire Offset Lands were not undertaken, the presence of the species cannot be discounted.	
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 Gwandalan Development Lands by Wildthing (2003b). Therefore it is considered unlikely to exist within the Gwandalan Development Lands.	**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 CHB Development Lands by Wildthing (2004a) and EcoBiological (2006a; 2006b). Therefore it is considered unlikely to exist within the CHB Development Lands.	**Low – Moderate** The closest records for this species occur to the west of Lake Macquarie. However, suitable habitat exists within riparian areas of the Offset Lands and since targeted surveys were not undertaken across the entire Offset Lands, the presence of the species cannot be totally discounted.	**Low** It is unlikely that the current proposal will represent a threat to this species due to the low chance of it occurring within the site.
Melaleuca groveana Grove's Paperbark (V)	Restricted to exposed heath and heath woodland, mainly at high altitudes in coastal and sub-coastal districts. Hunter Region records exist from the Tomaree and Yengo National Parks (Atlas of NSW Wildlife data).	**Low** There is no exposed habitat for this species within the Gwandalan Development Lands. Therefore, it is considered unlikely to exist within the site.	**Low – Moderate** The most likely habitat onsite occurs within heathlands and stunted woodland in the northwest of the CHB Development Lands. However, there are no local records for this species, the nearest coastal records occurring on the Tomaree Peninsula (Port Stephens) and the species was not recorded during flora surveys conducted by Wildthing (2004a) or EcoBiological (2006a) within the CHB Development Lands.	**Low** No heathland or exposed woodland habitat was found to exist within the Offset Lands.	**Low** It is unlikely that the current proposal will represent a threat to this species due to the low chance of it occurring within the site and the lack of records from flora surveys.
Pultenaea maritima Coast Headland Pea (V)	Appendix 1. A prostrate shrub species with foliage similar to *P. villosa* of which it was previously considered a subspecies. Occurring on headlands between Newcastle and Byron Bay.	**Low** No headland habitat for this species is present within the Gwandalan Development Lands.	**Low – Moderate** Suitable habitat exists within exposed headlands (Coastal Headland Complex) within the north-east of the CHB Development Lands. However, the species was not recorded during previous flora surveys by Wildthing (2004a) and EcoBiological (2006a; 2006b).	**Low – Moderate** There are opportunities for this species to occur in Coastal Headland Complex in the north-east of the Offset Lands. However, the species was not recorded during flora surveys in the area.	**Low** Whilst a small area of potential habitat will be removed as part of the development proposal, potential habitat for this species will be conserved within the Offset Lands.
Rutidosis heterogama (V, V*)	Small Asteraceous herb occurring in the Hunter Region growing in disturbed areas and adjacent parcels of bushland within the Cessnock LGA. This species is also noted as occurring within coastal heathland habitats between Wyong and Evans Head on sandy substrates or moist areas within open forest.	**Low** No habitat for this species is present within the Gwandalan site.	**Low - Moderate** There is opportunity for this species to occur within heathland and stunted woodland habitats in the east of the CHB Development Lands and coastal records for this species occur to the north of the site. However, targeted surveys did not detect this species within the CHB Development Lands (Wildthing, 2004a; EcoBiological 2006a; 2006b).	**Low - Moderate** There is opportunity for this species to occur within heathland and stunted woodland habitats in the northeast of the Offset Lands and coastal records for this species occur to the north of the site.	**Low** Whilst a small area of potential habitat will be removed as part of the development proposal, potential habitat for this species will be conserved within the Offset Lands.
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).	**High** (natural??) Three individuals were recorded within the Established Native Garden vegetation community within the Gwandalan Development Lands by Wildthing (2004a). Wildthing (2004a) concluded that they were likely to have been planted and represented little ecological constraints.	**Low – Moderate** Potential habitat for this species occurs within the drainage flats and associated mesic vegetation assemblages of mid to lower slope drainage lines in the west of the site. However, this species was not recorded within the CHB Development Lands during flora surveys undertaken by Wildthing (2004a) and EcoBiological (2006a; 2006b).	**Moderate – High** Potential habitat for this species occurs within the drainage flats and associated mesic vegetation assemblages of mid to lower slope drainage lines within the Offset Lands. Due to the presence of local records and lack of targeted surveys across the entire Offset Lands, the species has potential to occur within the Offset Lands.	**Low** The three individuals to be removed as a result of the proposal within Gwandalan Development Lands are considered likely to have been planted and are of little ecological significance. Additionally, areas representing the best potential habitat opportunities for this species will be conserved within the Offset Lands. Therefore it is considered unlikely to be affected by the proposal.
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	**High** This species was recorded throughout the site by Wildthing (2003b) during its flowering season. A population of this species (over 180) was recorded throughout the Narrabeen Snappy Gum Forest and the	**High** This species was recorded throughout the CHB Development Lands by Wildthing (2003a) and EcoBiological (2006b) during its flowering season. A population of this species (159) was recorded by RPS HSO	**High** This species was recorded at a number of sites throughout the Offset Lands. A total of 1024 *Tetratheca juncea* clumps were recorded during the targeted surveys within	**Low - Moderate** Although a small portion of the current population within the Gwandalan and CHB Development Lands would be removed, a large portion would be retained within the Offset Lands. The population count of 1024

Species	Habitat Description and Known Populations	Chance of Occurrence within Gwandalan Development Lands	Chance of Occurrence within CHB Development Lands	Chance of Occurrence within Offset Lands	Likely Level of Impact
	records exist from the local area including several records from the northern slopes of the site (Atlas of NSW Wildlife data).	Narrabeen Coastal Sheltered Peppermint-Apple Forest within the Gwandalan Development Lands. The distribution of the species was spread throughout the Gwandalan Development Lands.	(2007). These individuals were recorded within the Narrabeen Doyalson Coastal Woodland, Coastal Plains Smooth-barked Apple Woodland and the Narrabeen Wallarah Sheltered Grassy Forest within the site.	the Offset Lands. Due to the time constraints in conducting the survey it was not possible to survey all areas identified by (Wildthing 2004) and (RPS HSO 2007) as containing suitable habitat for *T. juncea* within the conservation Offset Lands. Therefore it is considered that the number of *T. juncea* clumps occurring within the Offset Lands is considerably higher than that which was recorded during the targeted surveys outline herewith.	clumps within the Offset Lands is expected to be hugely under estimated and it is expected that the population count is to be closer to 5,147. In addition, large populations are currently reserved within Offset Lands within the Wallarah Peninsula (approx 30,000). As such, conservativeluy the amount to be removed by the proposal represents 0.3% of the population within the Wallarah Peninsula. Therefore, it is unlikely that the current proposal will place the local population of this species at a greater risk of extinction. The proposed offset areas for conservation will ensure long term protection for large numbers of this species.
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 / Port Stephens (Atlas of NSW Wildlife data).	**Low - Moderate** Marginal habitat present within the site in Swamp Sclerophyll vegetation assemblages. However, the species was not recorded by Wildthing (2003b) during surveys.	**Low - Moderate** Marginal habitat present within the CHB Development Lands immediately adjacent to SEPP 14 wetland; however, the species was not recorded during targeted surveys (EcoBiological, 2006a) undertaken in appropriate conditions where the species was recorded calling at a known site elsewhere (EcoBiological, 2006a).	**High** Suitable habitat was found within wetland areas in the south-west portion of the Offset Lands (Wildthing, 2003a). Additionally, the species was recorded within SEPP 14 wetland in Munmorah SCA to the south of CHB Development Lands during recent field investigations by RPS HSO.	**Low -Moderate** *CHB Development Lands* Potential indirect impacts are alteration to hydrology, water quality and erosion and sedimentation. However, provided the recommended SEPP 14 wetland buffers are adopted, in conjunction with adequate stormwater controls, these potential indirect impacts would be minimised. *Gwandalan Development Lands* Provided recommendations to retain riparian areas and carefully manage stormwater within the Gwandalan Development Lands are adopted, potential habitat at this site would be retained.
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 woodland or open forest habitats associated with the site.	**Low - Moderate** Due to its generalist habitat requirements, this species could potentially exist in any of the woodland or open forest habitats associated with the site.	**Low - Moderate** Due to its generalist habitat requirements, this species could potentially exist in any of the woodland or open forest habitats associated with the site.	**Low** The portion of potential habitat to be removed as a result of the proposal (CHB and Gwandalan Development Lands) is a small portion of the habitat available within the entire site (including Offset Lands). Additionally, potential habitats within the Offset Lands would be dedicated to conservation as estates managed by DECC.
Hoplocephalus stephensii Stephen's Banded Snake (V)	A nocturnal and partially arboreal snake which 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 woodland or open forest habitats associated with the site.	**Low - Moderate** Due to its generalist habitat requirements, this species could potentially exist in any of the woodland or open forest habitats associated with the site.	**Low - Moderate** Due to its generalist habitat requirements, this species could potentially exist in any of the woodland or open forest habitats associated with the site.	**Low** The portion of potential habitat to be removed as a result of the proposal (CHB and Gwandalan Development Lands) is a small portion of the habitat available within the entire site (including Offset Lands). Additionally, potential habitats within the Offset Lands would be dedicated to conservation as estates managed by DECC.
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 - Moderate** Marginal habitat exists within the dams within the Gwandalan Development Lands. However, the species was not recorded during field surveys (Wildthing, 2003b).	**Low – Moderate** Wetland habitats within the site are commensurate with potential habitat for this species. However, this species was not recorded within the site during targeted fauna surveys encompassing potential habitat during appropriate seasonal and weather conditions (EcoBiological, 2006a).	**Low - Moderate** Small ponds within creeks and drainage lines are likely to provide some marginal habitat for the species.	**Low** The occurrence of this species within the site is relatively unlikely; however, habitats within which this species might potentially occur would be retained within Offset Lands. Additionally, it is likely that the proposed residential development would require sediment retention ponds that could be landscaped to provide habitat for the species.
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	**Low** This frog is not likely to occur within the site, given the apparent specificity of habitat to	**Low** This frog is not likely to occur within the site, given the apparent specificity of habitat to	**Low** This frog is not likely to occur within the site, given the apparent specificity of habitat to	**Low** Considered unlikely to be affected by the proposal.

Species	Habitat Description and Known Populations	Chance of Occurrence within Gwandalan Development Lands	Chance of Occurrence within CHB Development Lands	Chance of Occurrence within Offset Lands	Likely Level of Impact
	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.	sandstone–based creeks within the high country to the west of Lake Macquarie.	sandstone–based creeks within the high country to the west of Lake Macquarie.	sandstone–based creeks within the high country to the west of Lake Macquarie.	
Mixophyes balbus Southern Barred Frog (E, V*)	A relatively large and muscular frog, growing to about 8 cm in length. Southern 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** The site does not offer suitable stream habitat for this species which is known to prefer foothills and escarpment areas well to the west of the site in the Watagan Mountains.	**Low** The site does not offer suitable stream habitat for this species which is known to prefer foothills and escarpment areas well to the west of the site in the Watagan Mountains.	**Low** Despite the presence of moderately suitable habitat within the lower drainage slopes of the site, there are no records for this species in the vicinity of the site and this species is 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** The site does not offer suitable stream habitat for this species which is known to prefer foothills and escarpment areas well to the west of the site in the Watagan Mountains.	**Low** The site does not offer suitable stream habitat for this species which is known to prefer foothills and escarpment areas well to the west of the site in the Watagan Mountains.	**Low** Despite the presence of moderately suitable habitat within the lower drainage slopes of the site, there are no records for this species in the vicinity of the site and 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** 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** 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 – 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 – 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** The portion of potential habitat to be removed as a result of the proposal (CHB and Gwandalan Development Lands) is a small portion of the habitat available within the entire site (including Offset Lands). Additionally, potential habitats within the Offset Lands would be dedicated to conservation as estates managed by DECC.
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	**Low - Moderate** The species is known to forage within Lake Macquarie locally and suitable nesting	**Low - Moderate** An Osprey record occurs to the south of the site, but this species is more suited to closed	**Moderate** The species is known to forage within Lake Macquarie locally and suitable nesting	**Low** The portion of potential habitat to be removed as a result of the proposal (CHB

Species	Habitat Description and Known Populations	Chance of Occurrence within Gwandalan Development Lands	Chance of Occurrence within CHB Development Lands	Chance of Occurrence within Offset Lands	Likely Level of Impact
	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 south of the site.	habitat within large trees is present within the site. However, the species, or nesting evidence was not recorded during previous surveys (Wildthing, 2003b) or during recent site visits (RPS HSO, 2007 and present report).	or protected estuarine waters than open beach habitats as occur on the eastern side of the site. Pairs are known from southern Lake Macquarie, which is more suited to their hunting technique, but are more likely to nest in forest adjacent to the lake than to fly over to the site's forests for nesting purposes. This species was not recorded during fauna surveys, however it would not be considered unusual to see an occasional individual over the site.	habitat within large trees is present within the site. Particularly suitable sites exist on the shores of Lake Macquarie at Crangan Bay. However, the species, or nesting evidence was not recorded during previous surveys (Wildthing, 2003a), nor by RPS Ecologists whilst undertaking vegetation mapping.	and Gwandalan Development Lands) is a small, marginal portion of the habitat available within the entire site (including Offset Lands). Additionally, more suitable habitats within which this species potentially occurs within the site at Crangan Bay would be retained within the Offset Lands that would be dedicated to conservation as estates managed by DECC.
Charadrius mongolus Lesser Sand Plover (V, M*)	When in Australia, this migratory species inhabits sheltered bays, harbours and estuaries with large intertidal sandflats or mudflats. Prey includes molluscs, worms, crustaceans and insects.	**Low** This species may fly over the site; however, the site does not offer suitable estuarine or coastal habitats and the species is considered unlikely to utilise the site.	**Low** This species may fly over the site; however, the site does not offer suitable estuarine or coastal habitats and the species is considered unlikely to utilise the site.	**Low** This species may fly over the site; however, the site does not offer suitable estuarine or coastal habitats and the species is considered unlikely to utilise the site.	**Low** This species forages, roosts and nests on within sheltered estuarine habitats. These habitats are located outside of the proposed development areas. As such the species is considered unlikely to be impacted by the proposal.
Haematopus fuliginosus Sooty Oystercatcher (V)	Marine, usually rock shoreline, high rocky islets, boulders below cliffs, wave-cut platforms and reefs. Also inhabits sandy beaches and coves between rocky headlands (Morcombe, 2000). Also occurs within closed estuarine habitats where rocky substrates are present (e.g. Hunter Estuary).	**Low** This species may fly over the site and has been recorded nearby. However, the site does not offer suitable estuarine or coastal habitats and the species is considered unlikely to utilise the site.	**Low** This species may fly over the site and has been recorded flying between the rocky headlands at the north and south of CHB by RPS Ecologists. However, the site does not offer suitable estuarine or coastal habitats and the species is considered unlikely to utilise the site.	**Low** This species may fly over the site and has been recorded flying between the rocky headlands at the north and south of CHB by RPS Ecologists. However, the site does not offer suitable estuarine or coastal habitats and the species is considered unlikely to utilise the site.	**Low** This species forages, roosts and nests on rocky shoreline habitats. These habitats are located outside of the proposed development areas. As such the species is considered unlikely to be impacted by the proposal.
Haematopus longirostris Pied Oystercatcher (V)	This species prefers undisturbed sandy shell-grit or pebble beaches, sandspits and sandbars, tidal mudflats and estuaries, coastal islands. Occasionally rocky reefs, shores rock-stacks, brackish or saline wetlands. Also grassy paddocks, golf-courses or parks near coast. Forages for molluscs, crustaceans, polychaetes, ascidians, echinoderms and small fish, probes for worms in short wet grass.	**Low** This species may fly over the site and has been recorded nearby. However, the site does not offer suitable sandy beach habitat and the species is considered unlikely to utilise the site.	**Low** This species may fly over the site and has been recorded on the beach of CHB by RPS Ecologists. However, the site does not offer suitable sandy beach habitat and the species is considered unlikely to utilise the site.	**Low** This species may fly over the site and has been recorded on the beach of CHB by RPS Ecologists. However, the site does not offer suitable sandy beach habitat and the species is considered unlikely to utilise the site.	**Low** This species forages and nests on sand beaches and inlets and sometimes roosts on rocky shorelines. These habitats are located outside of the proposed development areas. As such the species is considered unlikely to be impacted by the proposal.
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.	**Low** Essentially an estuarine and riparian species, there is limited opportunity for this species within the site.	**Low** Essentially an estuarine and riparian species and although the SEPP 14 wetland to the south contains suitable habitat, there is limited opportunity for this species within the CHB Development Lands.	**Moderate** The western boundary of the Offset Lands on the shore of Lake Macquarie offers suitable habitat for this species. Additionally, the SEPP 14 wetland to the south of the CHB Development Lands would provide habitat for this species.	**Low** Potential habitat is located within the Offset Lands that would be dedicated to conservation and as such the species is considered unlikely to be affected by the proposal. Further suitable habitat occurs within brackish ponds in Munmorah SCA to the south of the site.
Ephippiorhynchus asiaticus Black-necked Stork (E)	Inhabits swamps associated with river systems and large permanent pools but sometimes appears on the coast or in estuaries. It has also been recorded on farm dams and sewage treatment ponds.	**Low-Moderate** Marginal habitat within farm dams onsite; however, the species is not considered likely to occur on more than an occasional basis.	**Low-Moderate** Marginal habitat present within the dams onsite and although the SEPP 14 wetland to the south contains suitable habitat, the species is not considered likely to occur within the CHB Development Lands on more than an occasional basis.	**Moderate** The western boundary of the Offset Lands on the shore of Lake Macquarie offers suitable habitat for this species. Additionally, the SEPP 14 wetland to the south of the CHB Development Lands would provide habitat for this species.	**Low** Potential habitat is located within the Offset Lands that would be dedicated to conservation and as such the species is considered unlikely to be affected by the proposal. Further suitable habitat occurs within brackish ponds in Munmorah SCA to the south of the site.
Sterna albifrons Little Tern (E)	Migratory bird from eastern Asia, which occurs in sheltered coastal environments.	**Low** This species may fly over the site; however, the site does not offer suitable estuarine or coastal habitats and the species is considered unlikely to utilise the site.	**Low** This species may fly over the site; however, the site does not offer suitable estuarine or coastal habitats and the species is considered unlikely to utilise the site.	**Low** This species may fly over the site; however, the site does not offer suitable estuarine or coastal habitats and the species is considered unlikely to utilise the site.	**Low** This species forages over the ocean, roosts and nests on sandy protected habitats. These habitats are located outside of the proposed development areas. As such the species is considered unlikely to be impacted by the proposal.
Daphoenositta chrysoptera *Varied sittella (V)*	Is a small 'treecreeper' like bird that covers the majority of Australia.	**Moderate**	**Moderate**	**Moderate**	**Low**

Species	Habitat Description and Known Populations	Chance of Occurrence within Gwandalan Development Lands	Chance of Occurrence within CHB Development Lands	Chance of Occurrence within Offset Lands	Likely Level of Impact
	Habitat across the varying races is similar, although they can be found in a wide range of habitats. Open eucalypt forests and woodlands are the preferred habitat, but this species may also be found in mallee, coastal tea-tree scrubs, inland acacia communities, golf courses orchards and scrubby gardens. The nest of D. chrysoptera (Varied Sittella) consists of deep cup of bark which is well camouflaged with spiders web and lichen. They favour the use of tree species for nesting such as Eucalypts, paperbarks, she-oaks and tea-trees.	Habitat within the site is considered suitable for both foraging and roosting and records occur within the locality. Extensive areas of foraging and nesting habitat for this species will be retained as offset areas. This species has been recorded within the region.	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 foraging and nesting habitat for this species will be retained as offset areas. This species has been recorded within the region.	Habitat within the site is considered suitable for both foraging and roosting and records occur within the locality.	Whilst some potential habitat may be removed as part of the development proposal similar habitat will be reserved within the Offset Lands.
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. meliodora* (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.	**Moderate** Habitat within the site is considered suitable for both foraging and roosting and records occur within the locality. Extensive areas of foraging and nesting habitat for this species will be retained as offset areas. This species has been recorded within the region.	**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 foraging and nesting habitat for this species will be retained as offset areas. This speces has been recorded within the region.	**Low – Moderate** Habitat within the site is considered suitable for both foraging and roosting and records occur within the locality.	**Low** Whilst some potential habitat may be removed as part of the development proposal similar habitat will be reserved within the Offset Lands.
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 (RPS HSO Ecologists pers. obs.) and this species is known to feed on the fruit of *Eucalyptus signata*, which is present within the site. Therefore its use of the site on at least an intermittent basis cannot be discounted.	**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 (RPS HSO Ecologists pers. obs.) and this species is known to feed on the fruit of *Eucalyptus signata*, which is present within the site. Therefore its use of the site on at least an intermittent basis cannot be discounted.	**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 (RPS HSO Ecologists 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** The portion of potential habitat to be removed as a result of the proposal (CHB and Gwandalan Development Lands) is a small portion of the habitat available within the entire site (including Offset Lands). Additionally, potential habitats within the Offset Lands would be dedicated to conservation.
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 west of the site.	**High** The species was recorded by RPS HSO (2007) and during recent field investigations within the Gwandalan Development Lands. Additionally, suitable nesting/breeding hollows are abundant within trees within the Gwandalan Development Lands.	**Moderate** Suitable foraging habitat for the species has been mapped within the CHB Development Lands by EcoBiological (2006a). However, the species was not recorded during previous investigations (EcoBiological 2006a; Wildthing, 2004a; 2004c).	**High** Recorded during previous investigations (Wildthing, 2003a) and suitable foraging habitat for the species exists within stands of *Allocasuarina*. Additionally, suitable nesting/breeding hollows are abundant within trees within the Offset Lands.	**Low - Moderate** *CHB Development Lands* The portion of potential foraging and nesting habitat to be removed as a result of the proposal within CHB Development Lands is a small portion of the habitat available within the entire site (including Offset Lands). Additionally, potential foraging and nesting habitats within the Offset Lands would be dedicated to conservation. **Moderate** *Gwandalan Development Lands* The proposal would remove known foraging and potential breeding habitat for the Glossy Black-Cockatoo within the Gwandalan Development Lands. Abundant foraging and roosting habitat is present within Offset

Species	Habitat Description and Known Populations	Chance of Occurrence within Gwandalan Development Lands	Chance of Occurrence within CHB Development Lands	Chance of Occurrence within Offset Lands	Likely Level of Impact
					Lands to the south. No nesting / breeding of this species within the Gwandalan Development Land was recorded during the targeted surveys for this species.
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 within the Gwandalan Development Lands for this species exists in the form of winter-flowering *E. robusta*. Therefore its seasonal presence within the site on at least an intermittent basis cannot be discounted.	**Low-Moderate** Potential foraging habitat for this species was found to occur to the west of the CHB Development Lands (Wildthing, 2004a) and to the south within Munmorah SCA. However, no *E. robusta*, a key foraging species exists within the Development Lands. As such, whilst the species may utilise adjacent areas, little favoured habitat is present within the CHB Development Lands.	**Moderate** Potential foraging habitat for this species was found to occur within Coastal Sand Mahogany-Paperbark Swamp Forest and Narrabeen Foreshore Red Gum-Ironbark Forest vegetation communities within the Offset Lands.	**Low-Moderate** The portion of potential habitat to be removed as a result of the proposal (CHB and Gwandalan Development Lands) is a small portion of the habitat available within the entire site (including Offset Lands). Furthermore, potential habitats within the Offset Lands would be dedicated to conservation as estates managed by DECC. Additionally, provided recommendations to retain the riparian areas within the Gwandalan Development Lands are adopted, important foraging habitat at this site (*Eucalyptus robusta*) would also be retained.
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* (RPS Ecologist 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 and Nord's Wharf to the west (Atlas of NSW Wildlife data).	**Moderate** 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, the presence of this species within the site on at least an intermittent basis would not be unexpected.	**Low - Moderate** Potential foraging habitat for this species was found to occur to the west of the CHB Development Lands (Wildthing, 2004a) and to the south within Munmorah SCA. However, no *E. robusta*, a key foraging species exists within the Development Lands. As such, whilst the species may utilise adjacent areas, little favoured habitat is present within the CHB Development Lands.	**Moderate – High** Due to the occurrence of records within the vicinity of the site, its high mobility and the presence of potential foraging habitat for this species within the Coastal Sand Mahogany-Paperbark Swamp Forest and Narrabeen Foreshore Red Gum-Ironbark Forest vegetation communities within the Offset Land, it is likely that this species occurs within the site on at least an intermittent basis.	**Low-Moderate** The portion of potential habitat to be removed as a result of the proposal (CHB and Gwandalan Development Lands) is a small portion of the habitat available within the entire site (including Offset Lands). Furthermore, potential habitats within the Offset Lands would be dedicated to conservation as estates managed by DECC. Additionally, provided recommendations to retain the riparian areas within the Gwandalan Development Lands are adopted, important foraging habitat at this site (*Eucalyptus robusta*) would also be retained.
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 HSO ecologists pers. obs.).	**High** Suitable foraging habitat including prey species recorded within the site and habitat assessment noted hollows of sufficient size to represent potential breeding sites for this species. The species was not recorded within the site during previous surveys (Wildthing, 2003b). However, the species was recorded within the site during the 14th April and 9th June surveys after call playback. On the 14th April an observation was made of a bird that came from outside of the site in response to call playback. The observation on the 9th June was of a bird that was potentially on the site or located very close to the site due to the early and fast response of the individual. No indications of breeding or attempted breeding were recorded during the survey period for the species.	**Moderate** Suitable foraging habitat recorded within the site. However, no trees containing hollows suitable for the species (large vertical hollows in large mature trees) were recorded within the CHB Development Lands. Additionally, the species was not recorded within the site during previous surveys (Wildthing, 2004a; 2004c)	**Moderate - High** Suitable foraging habitat including prey species recorded within the site and habitat assessment noted hollows of sufficient size to represent potential breeding sites for this species. The species was not recorded within the site during previous surveys (Wildthing, 2003a); however, not all Offset Lands have been surveyed in detail for Powerful Owl. Recorded to the north of the site by RPS HSO (2007d).	**Low - Moderate** The portion of potential habitat to be removed as a result of the proposal (CHB and Gwandalan Development Lands) is a small portion of the habitat available within the entire site (including Offset Lands). Additionally, those areas containing the highest quality foraging habitat and nesting habitat for this species are proposed as Offset Lands to be conserved.
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	**High** The species was recorded during previous surveys (Wildthing, 2003b) and there are a number of local records for this species. Additionally, 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. Numerous	**Moderate - High** Since there are a number of local records (including in adjacent Offset Lands) it is considered likely that the site represents part of the home range of individuals of this species. A small number of hollows of sufficient size to represent potential breeding sites for this species were noted during habitat assessment.	**High** The species was recorded during previous surveys (Wildthing, 2003a) and there are a number of local records for this species. Additionally, 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. Numerous	**Low - Moderate** *CHB Development Lands* The portion of potential foraging and nesting habitat to be removed as a result of the proposal within CHB Development Lands is a small portion of the habitat available within the entire site (including Offset Lands). Additionally, potential foraging and nesting habitats within the Offset Lands would be

Species	Habitat Description and Known Populations	Chance of Occurrence within Gwandalan Development Lands	Chance of Occurrence within CHB Development Lands	Chance of Occurrence within Offset Lands	Likely Level of Impact
	(HBOC records; RPS HSO ecologists pers. obs.). Local records for this species occur on Point Wollstonecraft, several elsewhere on the Wallarah Peninsula and within the site near the northern and southern boundaries.	hollows of sufficient size to represent potential breeding sites for this species were noted during habitat assessment and hollows beraing tree survey. However, targeted searches on six separate occasions from March to August 2009 including spotlighting, stag watching, call playback and secondary indications searches failed to find any observations, signs or breeding evidence of T. novaehollandiae.		hollows of sufficient size to represent potential breeding sites for this species were noted during previous habitat assessment.	dedicated to conservation. **Moderate** *Gwandalan Development Lands* The proposal would remove known foraging and potential breeding habitat for the MaskedOwl within the Gwandalan Development Lands. Abundant foraging and roosting habitat is present within Offset Lands to the south.
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 HSO ecologist pers. obs.).	**Low** Despite the presence of mesic vegetation assemblages within the forested drainage lines of the site, these communities cannot be classified as wet sclerophyll and are not considered to be of sufficient extent or structural complexity to support this species.	**Low** Despite the presence of mesic vegetation assemblages within the forested drainage lines of the site, these communities cannot be classified as wet sclerophyll and are not considered to be of sufficient extent or structural complexity to support this species.	**Low - Moderate** Suitable habitat exists within gullies along drainage lines in the west of the Offset Lands within the Narrabeen Wallarah Sheltered Grassy Forest vegetation community and Munmorah Palm-Apple Dry Drainage Line Forest. However, few local records exist of the species.	**Low** The current proposal is unlikely to impact upon this species due to a lack of suitable habitat within the CHB or Gwandalan Development Lands. Suitable habitat within Offset Lands would be dedicated to conservation as estates managed by DECC.
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 – Moderate** 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 relatively unlikely to occur within the site.	**Low – Moderate** 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 relatively unlikely to occur within the site.	**Low – Moderate** 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 relatively unlikely to occur within the site.	**Low** Considered unlikely to be resident within the proposed Development Lands at CHB and Gwandalan. Additionally, suitable habitat within Offset Lands would be dedicated to conservation.
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 and connectivity with large tracts of vegetation, due to the levels of ongoing disturbance within the site.	**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.	**Moderate** Suitable habitat connected with large areas of habitat is present within the site and may support the species. The species was not recorded during previous investigations (Wildthing, 2003a); however, not all Offset Lands have been surveyed in detail for Spotted-tailed Quoll.	**Low** Considered unlikely to be resident within the proposed Development Lands at CHB and Gwandalan. Additionally, suitable habitat within Offset Lands would be dedicated to conservation.
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 and habitat is marginal at best. Additionally, the species was not recorded within the site during surveys which included call playback for the Powerful Owl, which is known to trigger territorial responses from the Yellow-bellied Glider (Wildthing, 2003b).	**Low** No coastal records occur for this species in the vicinity of the site and habitat is marginal at best. Additionally, the species was not recorded within the site during surveys which included call playback for the Powerful Owl, which is known to trigger territorial responses from the Yellow-bellied Glider (Wildthing, 2004a).	**Low - Moderate** No coastal records occur for this species in the vicinity of the site. However, tall wet forest within gullies in the Narrabeen Wallarah Sheltered Grassy Forest vegetation community, offers marginal foraging and denning habitat for the species. Surveys for Yellow-bellied Glider were not undertaken within this portion of offset habitat.	**Low** The current proposal is unlikely to impact upon this species due to a lack of suitable habitat within the Development Lands. Additionally, potential habitat within Offset Lands would be dedicated to conservation.
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.	**Moderate** Suitable foraging and denning habitat exists within the site. However, the species was	**Moderate** Suitable foraging and denning habitat exists within the site. However, the species was	**Moderate - High** Suitable foraging and denning habitat exists within the offsets land. A record for this	**Low** The portion of potential habitat to be removed as a result of the proposal (CHB

Species	Habitat Description and Known Populations	Chance of Occurrence within Gwandalan Development Lands	Chance of Occurrence within CHB Development Lands	Chance of Occurrence within Offset Lands	Likely Level of Impact
	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 to the west of the site.	not recorded within the site during fauna surveys, although the closely related Sugar Glider (*Petaurus breviceps*) was recorded (Wildthing, 2004a).	not recorded within the site during fauna surveys, including targeted trapping surveys (Wildthing, 2003b).	species exists in the west of the Offset Lands (NPWS Atlas of Wildlife data). However, this species was not recorded within the site during fauna surveys, although the closely related Sugar Glider (*Petaurus breviceps*) was recorded.	and Gwandalan Development Lands) is a small portion of the habitat available within the entire site (including Offset Lands). Additionally, the species was not recorded within the Development Lands during targeted surveys and suitable habitat within Offset Lands would be dedicated to conservation.
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** Schedule 2 feed trees occur within the Gwandalan Development Lands and Koala records occur within the local area (Atlas of NSW Wildlife data). However, no evidence of Koalas was observed during previous fauna surveys that included scat searches and spotlighting (Wildthing 2003b).	**Low – Moderate** Schedule 2 feed trees occur within the CHB Development Lands and records for Koalas occur within Offset Lands to the west of the site from 1996 (Atlas of NSW Wildlife data). However, no evidence of Koalas was observed during previous fauna surveys that included scat searches and spotlighting (Wildthing 2004a).	**Moderate** Suitable habitat exists within Offset Lands, particularly the combination of (Narrabeen Wallarah Sheltered Grassy Forest, Narrabeen Doyalson Coastal Woodland, Narrabeen Foreshore Redgum-Ironbark Forest, Coastal Sand Mahogany-Paperbark Swamp Forest). Records for Koalas occur within the west of the Offset Lands from 1996 (Atlas of NSW Wildlife data). No evidence of Koalas was observed during previous fauna surveys that included scat searches and spotlighting (Wildthing, 2003a). However, all Offset Lands were not surveyed for Koala presence.	**Low** The portion of potential habitat to be removed as a result of the proposal (CHB and Gwandalan Development Lands) is a small portion of the habitat available within the entire site (including Offset Lands). Furthermore, habitats within the Offset Lands are considered to contain habitat of higher quality than that to be removed as a result of the proposal. Additionally, provided recommendations to retain the riparian areas within the Gwandalan Development Lands are adopted, important foraging habitat at this site (*Eucalyptus robusta*) would also be retained.
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** Marginal habitat exists within the Gwandalan Development Lands, with occurrences of *Banksia spinulosa* and *Lambertia formosa* offering some limited foraging resources. The lack of overall foraging diversity is likely to preclude the species.	**Moderate** Potential habitat occurs within the CHB Development Lands. However, the species was not recorded during targeted trapping surveys.	**Low - Moderate** Marginal habitat exists within Scribbly Gum woodland in the Offset Lands, with occurrences of *Banksia spinulosa* and *Lambertia formosa* offering some limited foraging resources. The lack of overall foraging diversity is likely to preclude the species.	**Low - Moderate** Suitable habitat for the species would be removed as a result of the proposal. However, the species was not recorded during targeted surveys. Known habitat is protected to the south within Munmorah SCA. Marginal habitat within offset areas would be conserved.
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.	**Moderate - High** Suitable foraging habitat exists within flowering myrtaceous tree species and fruiting ornamental tree species. However, the species was not recorded during previous surveys (Wildthing, 2003b).	**Moderate - High** Suitable foraging habitat exists within flowering myrtaceous tree species. However, the species was not recorded during previous surveys (Wildthing, 2004a).	**Moderate - High** Suitable foraging habitat exists within flowering myrtaceous tree species. Suitable camp/roosting sites were identified within the drainage lines by Wildthing (2004a) and during vegetation mapping. However, the species was not recorded during previous surveys (Wildthing, 2004a).	**Low - Moderate** The portion of potential habitat to be removed as a result of the proposal (CHB and Gwandalan Development Lands) is a small portion of the habitat available within the entire site (including Offset Lands). Furthermore, suitable habitat within Offset Lands would be dedicated to conservation. Additionally, provided recommendations to retain the riparian areas within the Gwandalan Development Lands are adopted, important foraging habitat at this site (*Eucalyptus robusta*) would also be retained.
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.	**High** This species is likely to use the site regularly as part of its foraging range and was recorded during previous surveys (Wildthing, 2003b). No potential roosting habitat is knownt within the Gwandalan Development Lands.	**High** This species is likely to use the site regularly as part of its foraging range and was recorded during previous surveys (Wildthing, 2004a). No potential roosting habitat is known within the CHB Development Lands.	**High** This species is likely to use the site regularly as part of its foraging range and was recorded during fieldwork. Potential cave-roosting habitat may occur within rock outcrops within the Offset Lands.	**Low - Moderate** Although it is likely that a small amount of foraging habitat for this species will be modified during the process of development, large areas containing foraging habitat within Offset Lands would be dedicated to conservation. Potential roosting habitat within the site would not be affected by 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	**High** This species is likely to use the site regularly	**High** This species is likely to use the site regularly	**High** This species is likely to use the site regularly	**Low - Moderate** Although it is likely that a small amount of

Species	Habitat Description and Known Populations	Chance of Occurrence within Gwandalan Development Lands	Chance of Occurrence within CHB Development Lands	Chance of Occurrence within Offset Lands	Likely Level of Impact
	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).	as part of its foraging range and was recorded during previous surveys (Wildthing, 2003b). No potential roosting habitat is known within the Gwandalan Development Lands.	as part of its foraging range and was recorded during previous surveys (Wildthing, 2004a). No potential roosting habitat is known within the CHB Development Lands.	as part of its foraging range and was recorded during fieldwork. Potential cave-roosting habitat may occur within rock outcrops within the Offset Lands.	foraging habitat for this species will be modified during the process of development, large areas containing foraging habitat within Offset Lands. Potential roosting habitat within the site would not be affected by 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** This species is potentially likely to use the site as part of its foraging range, and may use the numerous hollows within the site for roosting and breeding habitat.	**Moderate** This species is potentially likely to use the site as part of its foraging range, and may use the hollow-bearing trees within the site for roosting/breeding habitat.	**Moderate** This species is potneitally likely to use the site as part of its foraging range, and may use the abundant hollows within the site for roosting/breeding habitat.	**Low - Moderate** Although it is likely that a relatively small amount of foraging habitat for this species will be modified during the process of development, large areas containing foraging habitat within Offset Lands would be dedicated to conservation. Potential roosting/breeding habitat within the numerous hollow-bearing trees would be removed within the Gwandalan Development Lands.
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 LGAs (Atlas of NSW Wildlife data).	**Moderate** Due to its mobility and the occurrence of other records in near coastal districts to the south it is potentially likely that this species uses the site on at least an intermittent basis. Potential roosting habitat for this species occurs within the numerous hollow-bearing trees within the Gwandalan Development Lands.	**Moderate** Due to its mobility and the occurrence of other records in near coastal districts to the south it is potentially likely that this species uses the site on at least an intermittent basis. Potential roosting habitat for this species occurs within the small amount of hollows within the south-east of the CHB Development Lands.	**Moderate** Due to its mobility and the occurrence of other records in near coastal districts to the south it is potentially likely that this species uses the site on at least an intermittent basis. Potential roosting habitat for this species occurs within the abundant hollows across the Offset Lands.	**Low - Moderate** Although it is likely that a relatively small amount of foraging habitat for this species will be modified during the process of development, large areas containing foraging habitat within Offset Lands would be dedicated to conservatio. Potential roosting/breeding habitat within the numerous hollow-bearing trees would be removed within the Gwandalan Development Lands.
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 fro this species occurs on Pulbah Island to the northwest (Atlas of NSW Wildlife data).	**Moderate** Due to its mobility and the occurrence of records within the locality it is potentially likely that this species uses the site on at least an intermittent basis. Potential roosting habitat for this species occurs within the site.	**Moderate** Due to its mobility and the occurrence of records within the locality it is potentially likely that this species uses the site on at least an intermittent basis. Potential roosting habitat for this species occurs within the site.	**Moderate** Due to its mobility and the occurrence of records within the locality it is potentially 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 relatively small amount of foraging habitat for this species will be modified during the process of development, large areas containing foraging habitat within Offset Lands would be dedicated to conservation. Potential roosting/breeding habitat within the numerous hollow-bearing trees would be removed within the Gwandalan Development Lands.
Chalinolobus dwyeri Large-eared Pied Bat (V)	This species forages in tall open forests, including dry forests and the edges of rainforest. It roosts in mine shafts and similar structures. Hunter Region records for this species are largely confined to the Watagan Mountains well to the west of the site (Atlas of NSW Wildlife data).	**Low - Moderate** Marginal foraging habitat exists within the site. However, due to the absence of records from within the local area it is unlikely that this species would occur within the site.	**Low - Moderate** Marginal foraging habitat exists within the site. However, due to the absence of records from within the local area it is unlikely that this species would occur within the site.	**Low - Moderate** Marginal foraging habitat exists within the site. However, due to the absence of records from within the local area it is unlikely that this species would occur within the site.	**Low** Although this species is considered unlikely to occur within the site, abundant potential foraging habitat within Offset Lands would be dedicated to conservation as estates managed by DECC
Myotis adversus Large-footed Myotis (V)	Usually found near bodies of water, including estuaries, lakes, reservoirs, rivers and large streams, often in close proximity to their roost site. Roosts in colonies of between a dozen and several hundred individuals in caves, mines and disused railway tunnels. Local records for this species occur at Vales Point and Lake Munmorah (Atlas of NSW Wildlife data).	**Moderate** This species has been recorded within the locality of the site and there are foraging opportunities within the various dams in the site and adjacent Lake Macquarie. No known cave-roosting sites occur within the site for this species.	**Moderate** This species has been recorded within the locality of the site and there are foraging opportunities within the various dams in the site. No known cave-roosting sites occur within the site for this species.	**Moderate** This species has been recorded within the locality of the site and there are foraging opportunities within the adjacent Lake Macquarie. No known cave-roosting sites occur within the site for this species.	**Low - Moderate** The portion of potential habitat to be removed as a result of the proposal (CHB and Gwandalan Development Lands) is a small portion of the habitat available within the entire site (including Offset Lands). Furthermore, suitable habitat within Offset Lands adjacent to Lake Macquarie would be dedicated to conservation.
Scoteanax rueppellii Greater Broad-nosed Bat (V)	Forages in moister gullies and wet sclerophyll forests as well as in lightly wooded areas and open spaces / ecotones. This species roosts in tree hollows and is relatively widespread within the Lower Hunter Region and extends to a local record at the southern end of Ruttleys Road (Atlas of NSW	**Moderate** Due to its mobility and the occurrence of records within the locality it is potentially likely that this species uses the site on at least an intermittent basis. Potential roosting habitat for this species occurs within the site.	**Moderate** Due to its mobility and the occurrence of records within the locality it is potentially likely that this species uses the site on at least an intermittent basis. Potential roosting habitat for this species occurs within the site.	**Moderate** Due to its mobility and the occurrence of records within the locality it is potentially 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 relatively small amount of foraging habitat for this species will be modified during the process of development, large areas containing foraging habitat within Offset Lands would be dedicated to conservation. Potential roosting/breeding habitat within the

Species	Habitat Description and Known Populations	Chance of Occurrence within Gwandalan Development Lands	Chance of Occurrence within CHB Development Lands	Chance of Occurrence within Offset Lands	Likely Level of Impact
	Wildlife data).				numerous hollow-bearing trees would be removed within the Gwandalan Development Lands.
Vespadelus troughtoni Eastern Cave Bat (V)	A cave dweller, known from wet sclerophyll forest and tropical woodlands from the coast and Dividing Range to the drier forests of the semi-arid zone. It has been found roosting in small groups in sandstone overhangs, in mine tunnels and occasionally in buildings. In all situations, the roost sites are frequently in reasonably well-lit areas. The distribution of this species is largely to the north of the Hunter (Strahan 1995), with one record at Windermere Park in south-western Lake Macquarie (Atlas of NSW Wildlife data).	**Low** Considered unlikely to occur within the site on more than a rare occasion.	**Low** Considered unlikely to occur within the site on more than a rare occasion.	**Low** Considered unlikely to occur within the site on more than a rare occasion.	**Low** Although this species is unlikely to occur within the site, abundant potential foraging habitat within Offset Lands would be dedicated to conservation.
ENDANGERED ECOLOGICAL COMMUNITIES					
Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bio-regions	Associated with periodic or semi-permanent inundation by freshwater, although there may be minor saline influence in some wetlands. They typically occur on silts, muds or humic loams in depressions, flats, drainage lines, backswamps, lagoons and lakes associated with coastal floodplains. Wetlands or parts of wetlands that lack standing water most of the time are usually dominated by dense grassland or sedgeland vegetation, often forming a turf less than 0.5 metre tall and dominated by amphibious plants including *Paspalum distichum*, *Leersia hexandra* and *Carex appressa*. Wetlands or parts of wetlands subject to regular inundation and drying may include large emergent sedges over 1 metre tall, such as *Baumea articulata, Eleocharis equisetina* and *Lepironia articulata*. Correlates with LHCCREMS Map Unit (MU) 46 – 'Freshwater Wetland Complex'.	**Low** The vegetation communities mapped within the site are not considered to be representative of this EEC. Whilst there are several man made dams within the site, these are not commensurate with this EEC.	**Low** The vegetation communities mapped within the site are not considered to be sufficiently representative of this EEC. The artificial dams do provide some species which are representative of this community but these dams are highly degraded with weed infestation and sediment runoff.	**High** This community occurs in three locations to the south and south east of the site. These areas are all part of the SEPP 14 wetland which is located to the south of the site within the Munmorah State Conservation Area. The dam within the south west of the site is also part of this community as it contains a good diversity of native flora species and is considered to be commensurate with this EEC. The exception being the dam in the south eastern corner of the site where this dam contains a wide variety of native species and fringes the SEPP 14 wetland located within Munmorah State Conservation Area. The area of this EEC within the site is 1.78ha.	**Low - Moderate** Those areas where this community occurs within the site will be retained as Offset Lands within the current proposal. Therefore it is unlikely that this community will be directly impacted upon by the current proposal. However, indirect threats to the long-term integrity of this community may potentially exist without appropriate sediment and water management control measures incorporated into planning and construction phases of the development.
Littoral Rainforest	Littoral rainforest occurs on both sand dunes and on soils derived from underlying rocks. Littoral Rainforest is a closed forest in structure, and the species composition is strongly influenced by the close proximity to the ocean. The floristic composition consists of predominantly rainforest species with evergreen mesic or coriaceous leaves. Several species have compound leaves, and vines may be a major component of the canopy. Littoral Rainforest comprises the *Cupaniopsis anacardioides – Acmena* spp. alliance of Floyd (1990). This alliance as described by Floyd includes five sub-alliances – *Syzygium leuhmannii – Acmena hemilampra, Cupaniopsis anacardioides, Lophostemon confertus, Drypetes – Sarcomelicope – Cassine – Podocarpus* and *Acmena smithii – Ficus - Livistona – Podocarpus.* While the canopy is dominated by rainforest species, scattered emergent individuals of sclerophyll species, such as *Angophora costata*, *Banksia integrifolia, Eucalyptus botryoides* and *E. tereticornis*	**Low** The vegetation communities mapped within the site are not considered to be representative of this EEC.	**High** EcoBiological (2006b) delineated a vegetation community which appeared to be commensurate with Littoral Rainforest EEC within the CHB Development Lands. Whilst this community was described as highly degraded it has components which are similar to this community. The rainforest was not mapped completely and it is difficult to determine the exact area of the community. Further survey and anaylsis of this community is recommended to determine the exact extent and species composition.	**Low** The vegetation communities mapped within the site are not considered to be representative of this EEC.	**Moderate - High** The area to be removed as a result of the proposal within the CHB Development Lands is considered to be degraded (EcoBiological, 2006b). However, since the vegetation community has not been accurately delineated and mapped, it is difficult to determine the extent or magnitude of potential impacts arising from the proposal. It is likely that this community extends to the south within Munmorah SCA.

Species	Habitat Description and Known Populations	Chance of Occurrence within Gwandalan Development Lands	Chance of Occurrence within CHB Development Lands	Chance of Occurrence within Offset Lands	Likely Level of Impact
	occur in many stands.				
Themeda Grassland on seacliffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner bioregions	Community occurring on sandstone, old sand dunes and basalt, which is characterised by *Themeda australis* (Kangaroo Grass). *T. australis* within the community is sometimes limited to only a few metres square, but on some substrates, such as old sand dunes the community can be relatively extensive in size. *T. australis* within the community is often stunted and prostrate as are the shrubs and trees occurring within the community. In the Lower Hunter and Central Coast regions this community occurs on coastal landforms with *Pimelea linifolia*, *Westringia fruticosa*, and *Banksia integrifolia* the most commonly associated species. Aerial interpertation has revealed that habitat for this community does occur on the headland to the east of the CHB Development Lands.	**Low** The vegetation communities mapped by Widlthing within the site are not considered to be representative of this EEC.	**Low** The vegetation communities mapped within the site are not considered to be representative of this EEC.	**Low** The vegetation communities mapped within the site are not considered to be representative of this EEC.	**Low** This community was not identified as occurring within the site.
Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bio-regions	This community is associated with periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains, typically occurring on grey-black clay-loams and sandy loams. Usually occurring below 20 m altitude. Within the site this community correlates with LHCCREMS MU 40 'Swamp Oak – Rushland Forest'.	**Low** The vegetation communities mapped within the site are not considered to be representative of this EEC.	**Low** The vegetation communities mapped within the site are not considered to be representative of this EEC.	**High** This community occurs within the west of the site on the shore of Lake Macquarie. The area of this EEC within the site is 5.266ha.	**Low** Those areas where this community occurs within the site will be retained as Offset Lands within the current proposal. Therefore it is unlikely that this community will be impacted upon by the current proposal.
Coastal Saltmarsh in the North Coast Bioregion	Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner occurs in the intertidal zone on the shores of estuaries and lagoons, including when they are intermittently closed along the NSW coast. Classified by the Lower Hunter Central Coast Regional Biodiversity Conservation Strategy (LHCCREMS) as Map Unit (MU) 47a.	**Low** The vegetation communities mapped within the site are not considered to be representative of this EEC.	**Low** The vegetation communities mapped within the site are not considered to be representative of this EEC.	**High** This community occurs in small patches within the Mangrove-Estuarine Saltmarsh Vegetation community.	**Low** This community was not identified as occurring within the Development Lands. Therefore it is unlikely that this community will be impacted upon by the current proposal.
Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bio-regions	The community is associated with humic clay or sandy loams on waterlogged or episodically flooded alluvial flats and drainage lines within coastal floodplains. It is generally characterised by an open to dense canopy of Eucalypts and / or Paperbarks. Canopy heights generally vary from 8m to 25m depending on species composition. In the Hunter Region the canopy often contains *Eucalyptus robusta* and / or *Melaleuca quinquinervia* although other species, such as *Casuarina glauca*, *Eucalyptus resinifera* subsp. *hemilampra* and *Livistona australis* may be present. Within the site this community correlates with LHCCREMS MU 37 'Swamp Mahogany - Paperbark Forest'.	**High** During recent targeted *Cryptostylis hunteriana* surveys (RPS HSO, 2007), the drainage line within the site was observed to contain species representative of Swamp Sclerophyll Forest, despite previous surveys mapping this area as Narrabeen Coastal Sheltered Peppermint Forest (Wildthing, 2003b). This EEC was not listed until 2004 and therefore this vegetation community was not detected at the time of that survey. The area of this EEC within the site is 1.198ha.	**Low** The vegetation communities mapped within the site are not considered to be representative of this EEC.	**High** This community occurs within four areas of this site. Two are located adjoining the Estuarine Swamp Oak Forest adjacent to Lake Macquaire. The third portion is located in the drainage line to the west of the Pacific Highway and the final section is located within a drainage line in the north east of the site. The area of this EEC within the site is 11.22ha.	**Moderate** A small area of this EEC may be removed as part of the development proposal at Gwandalan (1.198ha), with over 11.22ha to be retained within the Offset Lands at CHB. The retained areas in the vicinity of the proposed development may be the subject of indirect threats such as urban runoff, there appropriate sediment and water management control measures are recommended to be incorporated into planning and construction phases of the development. Appropriate landscaping associated with development may help reduce impacts of incremental loss of *E. robusta*.

4.3 Assessment of Significant Species / Communities

As per the assessment carried out within Table 4-1, the following species / communities listed under *TSC Act* and/or *EPBC Act* have been deemed appropriate to be applied further detailed assessment due to projected potential levels of impacts (greater than low level) likely to result from the proposal.

Flora

- Cryptostylis hunteriana — Leafless Tongue Orchid
- Diuris praecox — Newcastle Doubletail
- Tetratheca juncea — Black-eyed Susan

Endangered Ecological Communities

- Freshwater Wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bio-regions
- Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner bioregions
- Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions

Fauna

- *Crinia tinnula* — Wallum Froglet
- *Calyptorhynchus lathami* — Glossy Black-Cockatoo
- *Xanthomyza phrygia* — Regent Honeyeater
- *Lathamus discolor* — Swift Parrot
- *Ninox strenua* — Powerful Owl
- *Tyto novaehollandiae* — Masked Owl
- *Cercartetus nanus* — Eastern Pygmy Possum
- *Pteropus poliocephalus* — Grey-headed Flying-fox
- *Miniopterus schreibersii* — Eastern Bentwing-bat
- *Miniopterus australis* — Little Bentwing-bat
- *Mormopterus norfolkensis* — Eastern Freetail-bat
- *Saccolaimus flaviventris* — Yellow-bellied Sheathtail-bat
- *Falsistrellus tasmaniensis* — Eastern False Pipistrelle
- *Myotis adversus* — Large-footed Myotis
- *Scoteanax rueppellii* — Greater Broad-nosed Bat

Migratory fauna listed under EPBC Act

- *Xanthomyza phrygia* Regent Honeyeater
- *Haliaeetus leucogaster* White-bellied Sea-Eagle

4.3.1 Threatened Flora

Cryptostylis hunteriana

Cryptostylis hunteriana was identified whilst performing targeted parallel transect searches for *T. juncea* within the Narrabeen Doyalson Coastal Woodland within the northern portion of CHB Development Lands (Hamlet 6). Five patches containing 13 aboveground stems were identified. This orchid appears naturally rare, and difficult to locate with only seven populations being discovered within the Lake Macquarie and Wyong LGAs. One of the conditions of the approval under the EPBC Act for the proposal requires that a management plan is prepared for *Cryptostylis hunteriana* within this area (attached as Appendix A). This will provide protection for this species untl such time that removal is necessary and research can be undertaken on this species.

Cryptostylis hunteriana was also recorded within the conservation area. A total of 43 flowering stems were located by two ecologists. The cryptic nature of this species makes it a very difficult to locate in the field, so it would not be unexpected that more specimens occur within suitable areas of the locality.

Cryptostylis hunteriana has a history of flowering sporadically, going for years at a time not producing any flower which makes it difficult to accurately determine potential population sizes. However, the works undertaken to date within both proposed Development Lands (one clump, 10 specimens) and within conservation lands (nine clumps, 43 specimens) would seemingly indicate that the level of conservation of this species would be greater than the 4:1 ratio applied at an elementary level across all other facets of biodiversity assessed for this proposal.

Diuris praecox

Diuris praecox was not recorded within the CHB or Gwandalan Development Lands; however, suitable habitat is present. The proposal would represent an incremental loss of suitable *D. praecox* habitat within the local area. However, a large portion of suitable D. praecox habitat exists within the Offset Lands that would be dedicated to conservation. Due to the proposed conservation of a large portion of *D. praecox* habitat within the Offset Lands, the proposed development at CHB and Gwandalan is not considered likely to have a significant impact on the species.

Tetratheca juncea

A total of 1,607 *Tetratheca juncea* plants were located during the targeted surveys within the site (Figure 3-3 and Figure 3-4 show the distribution). A total of 369 *T. juncea* clumps would be removed as part of the proposal (189 recorded within the CHB Development Lands and 180 recorded by Wildthing (2003b) within the Gwandalan Development Lands. It must be noted that EcoBiological (2006a) found this species in other areas of the CHB Development Lands and these could not be relocated during surveys by RPS HSO (November 2007) as they had probably finished flowering. Thus the population estimate

of 189 individuals within the CHB Development Lands would be a slight underestimation of the actual population.

Whilst 369 *T. juncea* clumps would be removed as a result of the proposal within Gwandalan and CHB Development Lands, a large population would be conserved within the proposed Offset Lands population count of 1,024 that is considered an under estimate of the population count that is expected to be 5,147. Additionally, much larger populations are currently conserved within Wallarah National Park to the north of the site (over 9,900 individuals) and further populations located by RPS HSO (2007) within Coal & Allied lands at Gwandalan and Nords Wharf area which would be conserved in conservation reserves the number conserved is likely to increase. Thus, in the Wallarah Peninsula the total number of *T. juncea* totals over 49,000. Of these over 30,000 are to be conserved in conservation reserves. Such a large number of known plants protected in several disjunct but proximate conservation areas bode well for the long term security of the species within the locality. Therefore, as the large numbers of *T. juncea* and the majority of the habitat will be conserved it is considered unlikely that any impact will be significant in regards to the long term viability of the Wallarah population.

4.3.2 Endangered Ecological Communities

The EEC's which are present within the site are listed below. Only a very small amount of one EEC would be affected by the proposal. Additionally, any long-term discernable impacts are considered likely to be quite minimal. The impacts upon extant EEC's within the Development Lands are summarised below.

Freshwater Wetlands on Coastal Floodplains

CHB Development Lands

This EEC occurs within the Offset Lands. This community abuts and becomes part of the SEPP 14 wetland which occurs to the south of the CHB Development Lands. If nutrient and sediment control measures are put in place to mitigate runoff, particularly during the construction phase, then this would minimise any adverse impacts from the development and thus a significant impact would be unlikely to result. Therefore, it is considered unlikely that the development proposal at CHB Development Lands would have a significant impact upon this EEC.

Littoral Rainforest

EcoBiological (2006b) identified Littoral Rainforest EEC within an area of approximately 3.9ha within the CHB Development Lands. The community was found to be significantly degraded by weeds and surrounded by scrub (EcoBiological 2006b). Littoral Rainforest was not mapped as a separate vegetation community by EcoBiological (2006b), but was found to occur within the eastern portion of Narrabeen Wallarah-Sheltered Grassy Forest. Further Littoral Rainforest exists to the south in the locality of Frazer Park within Munmorah SCA.

The Littoral Rainforest within the CHB Development Lands is likely to occupy less than 3.9ha and is a disturbed representation of the community within the local area. As such, the removal of Littoral Rainforest within the CHB Development Lands is considered to be

a small, disturbed portion of the community that exists within conservation reserves to the south.

Swamp Sclerophyll Forest (includes both Swamp Mahogany – Paperbark Forest and Riparian Melaleuca Swamp Woodland communities)

An area of this EEC is proposed to be removed within the Gwandalan Development Lands. Approximately 1.198ha (9.6%) of the community would be removed as part of the proposal and approximately 11.22ha (90.4%) would be conserved within the Offset Lands at both CHB and to the west of the Pacific Highway at Crangan Bay. Given that the majority of this EEC (90%) will be reserved within the Offset Lands, it is considered highly unlikely that removal of such a small area of this EEC would significantly compromise the viability of the local stand. Some portions of this vegetation community adjoin the Development Lands. If nutrient and sediment control measures are put in place to mitigate runoff, prior to and during the construction phase, then this would minimise any potential adverse impacts from the development would be avoided.

4.3.3 Threatened Fauna

Wallum Froglet

CHB Development Lands

The Wallum Froglet was recorded within SEPP 14 wetland in Munmorah SCA to the immediate south of the CHB Development Lands. Limited habitat exists for the Wallum Froglet within the CHB Development Lands immediately adjacent to SEPP 14 wetlands. The key potential impacts on the Wallum Froglet resulting from the proposal are confined to indirect impacts such as sedimentation, alteration in hydrology and drainage channel profiles associated with stormwater runoff from the proposed residential development.

The combination of potential water derived impacts is likely to represent the Key Threatening Process (KTP) “Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands”. Therefore, sediment and water management strategies will need to be incorporated into the planning, construction and occupation phases of the proposed development estate to ensure that potential impacts to downstream wetland habitats are prevented.

The proposal at CHB Development Lands is not considered likely to isolate Wallum Froglet since connectivity is maintained from the SEPP 14 wetland to the west following suitable habitat in drainage lines. Furthermore, the majority of CHB Development Lands are in a highly disturbed condition on the upper slopes and are not likely to be utilised by the species.

Gwandalan Development Lands

Although this species was not recorded within the Gwandalan Development Lands, there is some potential for it to exist within the Swamp Sclerophyll Forest vegetation community. Providing recommendations to retain riparian vegetation within the Gwandalan Development Lands are adopted, potential Wallum Froglet habitat would be retained and potential impacts would be limited to indirect impacts. The potential indirect impacts likely to result from the proposal include sedimentation, alteration in hydrology and drainage channel profiles associated with stormwater runoff from the proposed residential

development.

The combination of potential water derived impacts is likely to represent the Key Threatening Process (KTP) “Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands”. Therefore, sediment and water management strategies will need to be incorporated into the planning, construction and occupation phases of the proposed development estate to ensure that potential impacts to downslope riparian habitats are prevented.

The proposal at Gwandalan Development Lands is not considered likely to isolate Wallum Froglet provided riparian areas are retained since connectivity would exist along drainage lines.

Glossy Black-Cockatoo

CHB Development Lands

The Glossy Black-Cockatoo was not recorded within the CHB Development Lands; however, potential Glossy Black-Cockatoo foraging habitat exists within the north-east and south of the CHB Development Lands, as mapped by EcoBiological (2006a). Additionally, hollow-bearing trees recorded within the south of the CHB Development Lands contain a small number of hollows of a suitable size for Glossy Black-Cockatoo nesting.

Whilst direct impacts associated within the CHB Development Lands include removal of potential foraging habitat and a small amount of potential nesting habitat, this is considered to be a small, disturbed portion of the foraging and nesting habitat available within Offset Lands that would be dedicated to conservation.

Potential indirect impacts on the Glossy Black-Cockatoo are considered to be limited to minor predation by domestic animals resulting from the proposal within the CHB Development Lands. However, the implementation of responsible pet ownership would reduce this potential impact on the Glossy Black-Cockatoo.

The proposal at CHB Development Lands is not considered likely to isolate Glossy Black-Cockatoo since the species is highly mobile and capable of travelling long distances.

Gwandalan Development Lands

Known foraging habitat for the Glossy Black Cockatoo exists within the Gwandalan Development Lands as indicated by the presence of a large number of chewed *Allocasuarina* cones, characteristic of the species. Additionally, the numerous hollow-bearing trees observed within the Gwandalan Development Lands contain hollows of a suitable size to support Glossy Black-Cockatoo nesting/breeding. Although, there were no indications of breeding or attempted breeding during the targeted survey period March – August 2009 for the species.

The Coastal Plains Smooth-barked Apple Woodland and Narrabeen Wallarah Sheltered Grassy Forest contain *Allocasuarina littoralis* and *A. torulosa* throughout the Offset Lands and represent potential Glossy Black-Cockatoo foraging habitat. Abundant hollows that

may be used for Glossy Black-Cockatoo breeding also exist within the Offset Lands proposed to be dedicated to conservation.

Direct impacts associated with the Gwandalan Development Lands include the removal of known Glossy Black-Cockatoo foraging habitat (Narrabeen Snappy Gum Forest and Narrabeen Coastal Sheltered Peppermint-Apple Forest) that contains abundant hollows that may potentially support breeding.

Potential indirect impacts on the Glossy Black Cockatoo are considered to be limited to minor predation by domestic animals resulting from the proposal within the Gwandalan Development Lands. However, the implementation of responsible pet ownership would reduce this potential impact on the Glossy Black-Cockatoo.

The proposal at Gwandalan Development Lands is not considered likely to isolate Glossy Black-Cockatoo since the species is highly mobile and capable of travelling long distances.

Regent Honeyeater

This species does not occur in the Central Coast and Lower Hunter Region on a continuous basis, as its stronghold is the western slopes of the Great Dividing Range. Nevertheless, Regent Honeyeaters are recorded in Swamp Sclerophyll vegetation communities and associated woodlands on an intermittent seasonal basis in the Lake Macquarie LGA when resources in the west or Lower Hunter are scarce.

CHB Development Lands

Little potential habitat for the Regent Honeyeater exists within the CHB Development Lands due to the absence of the key foraging species *Eucalyptus robusta*. Adjacent areas within Offset Lands that would be dedicated to conservation and Munmorah SCA contain areas of *E. robusta* that may be used by the Regent Honeyeater on an intermittent basis.

As such the potential impacts associated with the CHB Development Lands are considered likely to be limited to indirect impacts on forage species (*E. robusta*) such as sedimentation, alteration in hydrology and drainage channel profiles associated with stormwater runoff from the proposed residential development.

The combination of potential water derived impacts is likely to represent the Key Threatening Process (KTP) “Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands”. Therefore, sediment and water management strategies will need to be incorporated into the planning, construction and occupation phases of the proposed development estate to ensure that potential impacts to downstream wetland habitats are prevented.

The proposal at CHB Development Lands is not considered likely to isolate Regent Honeyeater since the species is highly mobile and capable of travelling long distances.

Gwandalan Development Lands

Potential foraging habitat for this species, in the form of *Eucalyptus robusta*, occurs within the Swamp Sclerophyll vegetation community and to a lesser extent *E. tereticornis*. Providing recommendations to retain riparian vegetation within the Gwandalan Development Lands are adopted, potential Regent Honeyeater habitat would be retained and potential impacts would be limited to indirect impacts. The potential indirect impacts likely to result from the proposal include sedimentation, alteration in hydrology and drainage channel profiles associated with stormwater runoff from the proposed residential development.

The combination of potential water derived impacts is likely to represent the Key Threatening Process (KTP) "Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands". Therefore, sediment and water management strategies will need to be incorporated into the planning, construction and occupation phases of the proposed development estate to ensure that potential impacts to downstream wetland habitats are prevented.

The proposal at Gwandalan Development Lands is not considered likely to isolate Regent Honeyeater since the species is highly mobile and capable of travelling long distances.

Swift Parrot

This species does not occur in the Central Coast and Lower Hunter Region on a continuous basis, as it only moves into South-eastern Australia during the winter months and spends the summer in Tasmania. Local records for this species occur at Nord's Wharf and on the Gwandalan peninsula.

CHB Development Lands

Little potential habitat for the Swift Parrot exists within the CHB Development Lands due to the absence of the key foraging species *Eucalyptus robusta*. Adjacent areas within Offset Lands that would be dedicated to conservation and Munmorah SCA contain areas of *E. robusta* that may be used by the Swift Parrot on an intermittent basis.

As such the potential impacts associated with the CHB Development Lands are considered likely to be limited to indirect impacts on forage species (*E. robusta* and *E. tereticornis*) such as sedimentation, alteration in hydrology and drainage channel profiles associated with stormwater runoff from the proposed residential development.

The combination of potential water derived impacts is likely to represent the Key Threatening Process (KTP) "Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands". Therefore, sediment and water management strategies will need to be incorporated into the planning, construction and occupation phases of the proposed development estate to ensure that potential impacts to downstream wetland habitats are prevented.

The proposal at CHB Development Lands is not considered likely to isolate Swift Parrot since the species is highly mobile and capable of travelling long distances.

Gwandalan Development Lands

Potential foraging habitat exists for this species, in the form of *Eucalyptus robusta* within the Swamp Sclerophyll vegetation community and *E. tereticornis* on the shores of Lake Macquarie within the Open Woodland vegetation community mapped by Wildthing (2003b). Providing recommendations to retain riparian vegetation within the Gwandalan Development Lands are adopted, potential Swift Parrot habitat would be retained and potential impacts would be limited to indirect impacts. The potential indirect impacts likely to result from the proposal include impacts on forage species such as sedimentation, alteration in hydrology and drainage channel profiles associated with stormwater runoff from the proposed residential development.

The combination of potential water derived impacts is likely to represent the Key Threatening Process (KTP) "Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands". Therefore, sediment and water management strategies will need to be incorporated into the planning, construction and occupation phases of the proposed development estate to ensure that potential impacts to downstream wetland habitats are prevented.

The proposal at Gwandalan Development Lands is not considered likely to isolate Swift Parrot since the species is highly mobile and capable of travelling long distances.

Powerful Owl

CHB Development Lands

Potential foraging habitat exists within the lesser disturbed areas of the CHB Development Lands. However, the species was not recorded during previous investigations (Wildthing, 2004a). No hollow-bearing trees containing hollows of a suitable size for Powerful Owl were recorded within the CHB Development Lands.

Direct impacts associated with the proposal at CHB Development Lands are limited to the removal/modification of potential foraging habitat which includes vegetated areas and edges of vegetation. This area of foraging habitat to be removed as a result of the proposal is a small portion of the foraging habitat available to the species within Offset Lands that would be dedicated to conservation as estates managed by DECCW. Indirect impacts on the Powerful Owl are considered to only be a minor reduction in prey availability (possums and gliders) due to removal of foraging and shelter habitat for these species.

The proposal at CHB Development Lands is not considered likely to isolate Powerful Owl since the species is highly mobile and capable of travelling long distances.

Gwandalan Development Lands

Potential foraging habitat exists within the Gwandalan Development Lands. The Powerful Owl was recorded within the site during the 14th April and 9th June surveys after call playback. On the 14th April an observation was made of a bird that came from outside of the site in response to call playback. The observation on the 9th June was of a bird that was potentially on the site or located very close to the site due to the early and fast response of the individual. No indications of breeding or attempted breeding were

recorded during the survey period for *N. strenua*. A number of hollow-bearing trees containing hollows that appeared to be of a suitable size for Powerful Owl were observed within the Gwandalan Development Lands.

Direct impacts associated with the proposal at Gwandalan Development Lands are the removal/modification of 26ha of potential foraging habitat that contains a number of potential roost trees. To avoid any potential impact on roosting / nesting birds, consideration should be given to targeted surveys for this species prior to any proposed vegetation clearance activities.

A large portion (294ha) of foraging habitat available to the species exists within Offset Lands and would be dedicated to conservation. Indirect impacts on the Powerful Owl are considered to only be a minor reduction in prey availability (possums and gliders) due to removal of foraging and shelter habitat for these species.

The proposal at Gwandalan Development Lands is not considered likely to isolate Powerful Owl since the species is highly mobile and capable of travelling long distances.

Masked Owl

CHB Development Lands

The Masked Owl was not recorded within the CHB Development Lands; however, it was recorded within adjacent Offset Lands and the species is considered likely to forage within vegetated areas and edges within the CHB Development Lands. A small number of hollow-bearing trees containing hollows that appeared to be of a suitable size for Masked Owl were observed within the south of the CHB Development Lands. Direct impacts associated with the CHB Development Lands include a small reduction in the amount of foraging and potential nesting habitat.

The Offset Lands contain known Masked Owl foraging habitat and abundant hollow-bearing trees that may be used for nesting/breeding. The proposed CHB Development Lands are considered to be a small portion of the habitat available to the Masked Owl within Offset Lands that would be dedicated to conservation.

Indirect impacts on the Masked Owl are considered to only be a minor reduction in prey availability (small terrestrial mammals) due to removal of foraging and shelter habitat for these prey species.

The proposal at CHB Development Lands is not considered likely to isolate Masked Owl since the species is mobile and capable of travelling through surrounding vegetation.

Gwandalan Development Lands

The Masked Owl was recorded within the Gwandalan Development Lands during previous investigations by Wildthing (2003b). The Gwandalan Development Lands also contain abundant hollows that would be potentially suitable for roosting/nesting of Masked Owl. However, targeted searches on six separate occasions from March to August 2009 including spotlighting, stag watching, call playback and secondary indications searches failed to find any observations, signs or breeding evidence of the species.

Direct impacts associated with the development at Gwandalan include removal/modification of 26ha of known foraging and potential breeding habitat for the Masked Owl. To avoid any potential impact on roosting / nesting birds, consideration should be given to targeted surveys for this species prior to any proposed vegetation clearance activities. Suitable breeding habitat would be retained within Offset Lands located further to the south.

Indirect impacts on the Masked Owl are considered to be a reduction in prey availability (mainly small- to medium-sized terrestrial mammals) due to removal of foraging and shelter habitat for these prey species.

The proposal at Gwandalan Development Lands is not considered likely to isolate Masked Owl since the species is mobile and capable of travelling through surrounding vegetation.

Eastern Pygmy Possum

CHB Development Lands

The Eastern Pygmy Possum was not recorded within the CHB Development Lands during targeted surveys; however, potential habitat exists within heathland containing a range of foraging resources (Proteaceae). Additionally, the species has been recorded within Munmorah SCA to the south (NPWS Atlas of NSW Wildlife data). Approximately 3-4ha of potential Eastern Pygmy Possum habitat exists within the CHB Development Lands.

Direct impacts associated with the CHB Development Lands consist of the removal of an estimated 3-4ha of potential habitat for the species. However, should the recommended SEPP 14 wetland buffer be implemented a large portion of Eastern Pygmy Possum habitat would also be retained.

The Offset Lands were found to contain limited habitat for the Eastern Pygmy Possum, with small patches of *Banksia spinulosa* and *Lambertia formosa* providing the only habitat. Munmorah SCA is considered likely to contain most of the habitat for the Eastern Pygmy Possum in the local area.

Gwandalan Development Lands

As found within the Offset Lands, limited habitat for the Eastern Pygmy Possum exists with small patches of *Banksia spinulosa* and *Lambertia formosa* providing the main foraging resource. Munmorah SCA is considered likely to contain most of the habitat for the Eastern Pygmy Possum in the local area, with small areas also occurring within the CHB Development Lands.

As such few impacts on the Eastern Pygmy Possum are considered likely to occur as a result of the proposal at the Gwandalan Development Lands.

Grey-headed Flying Fox

CHB Development Lands

Potential foraging habitat for the Grey-headed Flying Fox exists within the CHB Development Lands due to the presence of flowering myrtaceous tree species. No camps

or potential camp sites for the Grey-headed Flying Fox occur within the CHB Development Lands and as such are unlikely to be impacted by the proposal. Direct impacts associated with the proposed CHB Development Lands are limited to the removal of foraging habitat which includes vegetated areas of the size (less than half the CHB Development Lands), which is a small portion of the habitat available within Offset Lands (294 ha) that would be dedicated to conservation. Furthermore, the Grey-headed Flying Fox is known to forage within residential areas among ornamental trees and shrubs.

Potential indirect impacts arising from the proposal at CHB Development Lands are expected to be limited to a slight increase in mortality that may result from barbed-wire injury and netting of fruit trees. However, these impacts may be mitigated by sensitive construction fencing and responsible gardening by residents.

The proposal at CHB Development Lands is not considered likely to isolate Grey-headed Flying Fox since the species is highly mobile and capable of travelling long distances.

Gwandalan Development Lands

Potential foraging habitat for the Grey-headed Flying Fox exists within the Gwandalan Development Lands due to the presence of flowering myrtaceous tree species and ornamental tree species. No camps or potential camp sites for the Grey-headed Flying Fox occur within the Gwandalan Development Lands and as such are unlikely to be impacted by the proposal. Direct impacts associated with the proposed CHB Development Lands are limited to the removal of 26ha of foraging habitat, which is a small portion of the habitat available within Offset Lands (294ha) that would be dedicated to conservation. Furthermore, the Grey-headed Flying Fox is known to forage within residential areas among ornamental trees and shrubs.

Potential indirect impacts arising from the proposal at Gwandalan Development Lands are expected to be limited to a slight increase in mortality that may result from barbed-wire injury and netting of fruit trees. However, these impacts may be mitigated by sensitive construction fencing and responsible gardening by residents.

The proposal at Gwandalan Development Lands is not considered likely to isolate Grey-headed Flying Fox since the species is highly mobile and capable of travelling long distances.

Eastern Bentwing-Bat

CHB Development Lands

The proposal would result in the removal/modification of up to 60ha of foraging habitat for the Eastern Bentwing Bat within the CHB Development Lands. No potential cave roost habitat was recorded within the CHB Development Lands and as such breeding habitat would not be affected by the proposal. The portion of foraging habitat to be removed/modified as a result of the proposal is considered to be a small portion of that which is present within the Offset Lands (approximately 294ha) that would be dedicated to conservation. No indirect impacts on the Eastern Bentwing Bat are expected to occur as a result of the proposal at CHB Development Lands.

The Eastern Bentwing Bat is a highly mobile species capable of travelling long distances and as such is not considered likely to be isolated by the proposal at CHB Development Lands.

Gwandalan Development Lands
The proposal would result in the removal/modification of up to 26ha of foraging habitat for the Eastern Bentwing Bat within the Gwandalan Development Lands. No potential cave roost habitat was recorded within the Gwandalan Development Lands and as such breeding habitat would not be affected by the proposal. The portion of foraging habitat to be removed/modified as a result of the proposal is considered to be a small portion of that which is present within the Offset Lands (approximately 294 ha) that would be dedicated to conservation. No indirect impacts on the Eastern Bentwing Bat are expected to occur as a result of the proposal at Gwandalan Development Lands.

The Eastern Bentwing Bat is a highly mobile species capable of travelling long distances and as such is not considered likely to be isolated by the proposal at Gwandalan Development Lands.

Little Bentwing-Bat
CHB Development Lands
The proposal would result in the removal/modification of up to 60ha of foraging habitat for the Little Bentwing Bat within the CHB Development Lands. No potential cave roost habitat was recorded within the CHB Development Lands and as such breeding habitat would not be affected by the proposal. The portion of foraging habitat to be removed/modified as a result of the proposal is considered to be a small portion of that which is present within the Offset Lands (approximately 294 ha) that would be dedicated to conservation. No indirect impacts on the Little Bentwing Bat are expected to occur as a result of the proposal at CHB Development Lands.

The Little Bentwing Bat is a highly mobile species capable of travelling long distances and as such is not considered likely to be isolated by the proposal at CHB Development Lands.

Gwandalan Development Lands
The proposal would result in the removal/modification of up to 26ha of foraging habitat for the Little Bentwing Bat within the Gwandalan Development Lands. No potential cave roost habitat was recorded within the Gwandalan Development Lands and as such breeding habitat would not be affected by the proposal. The portion of foraging habitat to be removed/modified as a result of the proposal is considered to be a small portion of that which is present within the Offset Lands (approximately 294ha) that would be dedicated to conservation. No indirect impacts on the Little Bentwing Bat are expected to occur as a result of the proposal at Gwandalan Development Lands.

The Little Bentwing Bat is a highly mobile species capable of travelling long distances and as such is not considered likely to be isolated by the proposal at Gwandalan Development Lands.

Eastern Freetail-Bat

CHB Development Lands

The proposal would result in the removal/modification of up to 60ha of foraging habitat for the Eastern Freetail Bat within the CHB Development Lands. In addition, a small number of hollow-bearing trees that may be utilised for roosting/breeding by the Eastern Freetail Bat. The portion of foraging and roosting habitat to be removed / modified as a result of the proposal is considered to be a small portion of that which is present within the Offset Lands (approximately 294ha) that would be dedicated to conservation. No indirect impacts on the Eastern Freetail Bat are expected to occur as a result of the proposal at CHB Development Lands.

The Eastern Freetail Bat is a highly mobile species capable of travelling long distances and as such is not considered likely to be isolated by the proposal at CHB Development Lands.

Gwandalan Development Lands

The proposal would result in the removal/modification of up to 26ha of foraging habitat for the Eastern Freetail Bat within the Gwandalan Development Lands. In addition, the abundant hollow-bearing trees present onsite may be utilised for roosting/breeding by the Eastern Freetail Bat. The portion of foraging and roosting habitat to be removed/modified as a result of the proposal is considered to be a small portion of that which is present within the Offset Lands (approximately 294ha) that would be dedicated to conservation. No indirect impacts on the Eastern Freetail Bat are expected to occur as a result of the proposal at Gwandalan Development Lands.

The Eastern Freetail Bat is a highly mobile species capable of travelling long distances and as such is not considered likely to be isolated by the proposal at Gwandalan Development Lands.

Yellow-bellied Sheathtail-Bat

This species was not recorded during the survey but is known to occur in the Central Coast Region within a range of woodland habitats. Due to its mobility and occurrence in the near-coastal districts to the south, it is likely that this species uses the site on at least an intermittent basis.

CHB Development Lands

The proposal would result in the removal/modification of up to 60ha of foraging habitat for the Yellow-bellied Sheathtailed Bat within the CHB Development Lands. In addition, a small number of hollow-bearing trees that may be utilised for roosting/breeding by the Yellow-bellied Sheathtailed Bat. The portion of foraging and roosting habitat to be removed/modified as a result of the proposal is considered to be a small portion of that which is present within the Offset Lands (approximately 294ha) that would be dedicated to conservation. No indirect impacts on the Yellow-bellied Sheathtailed Bat are expected to occur as a result of the proposal at CHB Development Lands.

The Yellow-bellied Sheathtailed Bat is a highly mobile species capable of travelling long distances and as such is not considered likely to be isolated by the proposal at CHB

Development Lands.

Gwandalan Development Lands
The proposal would result in the removal/modification of up to 26ha of foraging habitat for the Yellow-bellied Sheathtailed Bat within the Gwandalan Development Lands. In addition, the abundant hollow-bearing trees present onsite may be utilised for roosting/breeding by the Yellow-bellied Sheathtailed Bat. The portion of foraging and roosting habitat to be removed/modified as a result of the proposal is considered to be a small portion of that which is present within the Offset Lands (approximately 294ha) that would be dedicated to conservation. No indirect impacts on the Yellow-bellied Sheathtailed Bat are expected to occur as a result of the proposal at Gwandalan Development Lands.

The Yellow-bellied Sheathtailed Bat is a highly mobile species capable of travelling long distances and as such is not considered likely to be isolated by the proposal at Gwandalan Development Lands.

Eastern False Pipistrelle
This species was not recorded during the survey but a record from Pulbah Island in Lake Macquarie strongly suggests that it is likely to uses the site on at least an intermittent basis.

CHB Development Lands
The proposal would result in the removal/modification of up to 60ha of foraging habitat for the Eastern False Pipstrelle within the CHB Development Lands. In addition, a small number of hollow-bearing trees that may be utilised for roosting/breeding by the Eastern False Pipstrelle. The portion of foraging and roosting habitat to be removed/modified as a result of the proposal is considered to be a small portion of that which is present within the Offset Lands (approximately 294ha) that would be dedicated to conservation. No indirect impacts on the Eastern False Pipstrelle are expected to occur as a result of the proposal at CHB Development Lands.

The Eastern False Pipstrelle is a highly mobile species capable of travelling long distances and as such is not considered likely to be isolated by the proposal at CHB Development Lands.

Gwandalan Development Lands
The proposal would result in the removal/modification of up to 26ha of foraging habitat for the Eastern False Pipstrelle within the Gwandalan Development Lands. In addition, the abundant hollow-bearing trees present onsite may be utilised for roosting/breeding by the Eastern False Pipstrelle. The portion of foraging and roosting habitat to be removed/modified as a result of the proposal is considered to be a small portion of that which is present within the Offset Lands (approximately 294ha) that would be dedicated to conservation. No indirect impacts on the Eastern False Pipstrelle are expected to occur as a result of the proposal at Gwandalan Development Lands.

The Eastern False Pipstrelle is a highly mobile species capable of travelling long distances and as such is not considered likely to be isolated by the proposal at

Gwandalan Development Lands.

Large-footed Myotis

CHB Development Lands

Foraging habitat for the Large-footed Myotis exists within dams that contain open water within the CHB Development Lands. No cave roosting habitat was recorded within the CHB Development Lands and as such breeding habitat for the Large-footed Myotis would not be affected.

The proposal would result in the removal/modification of foraging habitat for the Large-footed Myotis within the CHB Development Lands. The portion of foraging habitat to be removed/modified as a result of the proposal is considered to be a small portion of that which is present within the Offset Lands (294ha) that would be dedicated to conservation.
Potential indirect impacts on the Large-footed Myotis that may occur as a result of the proposal are related to potential impacts on the SEPP 14 wetland to the south of the CHB Development Lands. A reduction in the quality of these wetland areas, particularly open ponds to the south of the CHB Development Lands may impact on the prey abundance and availability for the Large-footed Myotis.

The Large-footed Myotis is a highly mobile species capable of travelling long distances and as such is not considered likely to be isolated by the proposal at CHB Development Lands.

Gwandalan Development Lands

Foraging habitat for the Large-footed Myotis exists within dams that contain open water within the Gwandalan Development Lands. No cave roosting habitat was recorded within the Gwandalan Development Lands and as such breeding habitat for the Large-footed Myotis would not be affected.

The proposal would result in the removal/modification of four dams that represent foraging habitat for the Large-footed Myotis within the Gwandalan Development Lands. The portion of foraging habitat to be removed/modified as a result of the proposal (four dams) is considered to be a small portion of that which is present within the Offset Lands that would be dedicated to conservation.

No indirect impacts on the Large-footed Myotis are expected to occur as a result of the proposal at Gwandalan Development Lands.

The Large-footed Myotis is a highly mobile species capable of travelling long distances and as such is not considered likely to be isolated by the proposal at CHB Development Lands.

Greater Broad-nosed Bat

This species was not recorded during the survey but a record from Pulbah Island in Lake Macquarie strongly suggests that it is likely to uses the site on at least an intermittent basis.

CHB Development Lands

The proposal would result in the removal/modification of up to 60ha of foraging habitat for the Greater Broad-nosed Bat within the CHB Development Lands. In addition, a small number of hollow-bearing trees that may be utilised for roosting/breeding by the Greater Broad-nosed Bat. The portion of foraging and roosting habitat to be removed/modified as a result of the proposal is considered to be a small portion of that which is present within the Offset Lands (294ha) that would be dedicated to conservation as estates. No indirect impacts on the Greater Broad-nosed Bat are expected to occur as a result of the proposal at CHB Development Lands.

The Greater Broad-nosed Bat is a highly mobile species capable of travelling long distances and as such is not considered likely to be isolated by the proposal at CHB Development Lands.

Gwandalan Development Lands

The proposal would result in the removal/modification of up to 26ha of foraging habitat (approximately 294 ha) that would be dedicated to conservation. No indirect impacts on the Greater Broad-nosed Bat are expected to occur as a result of the proposal at Gwandalan Development Lands.

The Greater Broad-nosed Bat is a highly mobile species capable of travelling long distances and as such is not considered likely to be isolated by the proposal at Gwandalan Development Lands.

4.3.4 Migratory Species Listed under EPBC Act

A White-bellied Sea-Eagle nest, including two to three juvenile birds, was recorded within the Offset Lands. While these lands are not proposed to be developed. However, potential impacts may arise resulting from the publicisation of the location of the nest including disturbance of breeding and abandonment of nest.

DECCW should consider classifying the location of the White-bellied Sea-Eagle nest as sensitive to ensure ongoing protection, including looking at ways of limiting access into the area.

4.4 Key Threatening Process (KTP)

A Key Threatening Process (KTP) is defined in the *TSC Act (1995)* as a process that threatens, or could threaten, the survival or evolutionary development of species, populations or ecological communities. Something can be a threat if it:

- *adversely affects two or more threatened species, populations or ecological communities; or*
- *could cause species, populations or ecological communities that are not currently threatened to become threatened.*

Key Threatening Processes are listed in Schedule 3 of the *TSC Act 1995*. Those

potentially applicable to the proposal are as follows:

1. Loss of Hollow-bearing trees;
2. Clearing of native vegetation;
3. Human-caused climate change;
4. Infection of native plants by *Phytophthora cinnimomi*;
5. Invasion of native plant communities by exotic perennial grasses;
6. Removal of dead wood and dead trees;
7. Predation by the Feral Cat;
8. Alternation to the natural flow regimes of rivers and streams and their floodplains and wetlands;
9. Invasion of Native Plant Communities by Bitou and Boneseed;
10. Exotic Vines and Scramblers; and
11. *Lantana camara.*

1. Loss of Hollow-bearing Trees

The proposed development would require the removal of 26ha of vegetation containing hollow-bearing trees within Gwandalan Development Lands and a small portion within CHB Development Lands. As such, the proposal is considered as contributing to the Key Threatening Process "Removal of Hollow-bearing Trees.

CHB Development Lands

A small number of hollow-bearing trees were observed within the south of the CHB Development Lands and would cumulatively contribute to this KTP. However, the dedication of Offset Lands to conservation would protect significant numbers of hollow-bearing trees observed and the fauna they support.

Gwandalan Development Lands

The Gwandalan Development Lands contain numerous hollow-bearing trees with a variety of hollow sizes. A total of 607 mature and/or hollow-bearing trees were recorded and mapped within the Gwandalan Development Lands. A total of 124 mature and/or hollow-bearing trees will be retained within the eastern portion of the site outside of the proposed development footprint.

A total of 211 of the mature trees recorded had a DBH of 50-60cm, 126 trees were recorded to have a DBH of 61-80cm, 243 trees were recorded to have DBH of 81-100cm and 27 trees were recorded to have a DBH of greater than 100cm.

A total of 402 hollow-bearing trees containing a total of 541 hollows were recorded within the site. The total number of hollows recorded within each hollow size-class is as follows:

- 275 were 2-10cm;
- 192 were 11-20cm; and
- 24 hollows were greater than 20cm diameter.

A range of fauna species may utilise hollows within the Gwandalan Development Lands including a range of woodland birds, owl species, mammals such as possums and gliders,

reptiles and frogs. Threatened fauna species that potentially utilise hollows within the Gwandalan Development Lands include:

- Forest Owls including Masked Owl (*Tyto novaehollandiae*), which was recorded within the Gwandalan Development Lands, and Powerful Owl *(Ninox strenua);*
- Glossy Black-Cockatoo *(Calyptorhynchus lathami),* which has been confirmed as foraging on the site;
- Threatened hollow-roosting microchiropteran bat species such as East Coast Freetail Bat (*Mormopterus norfolkensis*), Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*), Eastern False Pipstrelle (*Falsistrellus tasmaniensis*) and Greater Broad-nosed Bat (*Scoteanax rueppellii*); and
- Squirrel Glider (*Petaurus norfolcensis*), of which potential habitat exists on site.

Hollow-bearing trees to be removed as a result of the proposal contain numerous hollows of a size to potentially support Masked Owl, which has been recorded onsite. However, targeted searches on six separate occasions from March to August 2009 including spotlighting, stag watching, call playback and secondary indications searches failed to find any observations, signs or breeding evidence of Masked Owl.

Microchiropteran bats are unlikely to be significantly impacted upon, due to their mobility and the presence of abundant hollow-bearing trees throughout lands to be conserved within Offset Lands. Potential habitat for Squirrel Glider exists within Gwandalan Development Lands; however, the species was not recorded during targeted surveys. Additionally, large portions of potential Squirrel Glider habitat would be dedicated to conservation.

Conclusion

The Offset Lands were found to contain numerous hollow-bearing trees of various sizes that potentially support the threatened fauna species of concern (Masked Owl, microchiropteran bat species and Squirrel Glider) in addition to many others.

It is considered that proposal is likely to represent a cumulative impact, with regard to this KTP, particularly for the Gwandalan Development Lands. However, the greater abundance of similar and greater quality habitat within the proposed Offset Lands that would be secured for conservation would provide long term protection of hollow-bearing trees in the local area.

2. Clearing of Native Vegetation

The proposed development will require the removal of native vegetation and as such is considered to contribute to the Key Threatening Process “Clearing of Native Vegetation”.

CHB Development Lands

Most of the CHB Development Lands have been historically disturbed resulting in a landscape of artificial surfaces, bare ground, grassland, regrowth and small areas of remnant native vegetation. The vegetation communities recorded within the CHB Development Lands were:

- Coastal Sand Wallum Heath-Scrub;

- Narrabeen Wallarah Sheltered Grassy Forest;
- Coastal Headland Complex (Grassland & Shrubland);
- Coastal Holocene Banksia Scrub; and
- Regenerating Vegetation.

More than half of the CHB Development Lands are vegetated and would be removed or modified as a result of the proposal. As such the proposal at CHB Development Lands would cumulatively contribute to this KTP; however, this is considered to be a minor contribution considering the large amount of high quality native vegetation within the Offset Lands to be dedicated to conservation.

Gwandalan Development Lands
Whilst some portions of the Gwandalan Development Lands have been subject to some development such as residences, facilities and grazing, a large portion of high quality native vegetation is also present. Vegetation communities recorded within the Gwandalan Development Lands include Open Woodland (which has a parkland-type structure with a cleared understorey); Narrabeen Snappy Gum Forest; Coastal Sand Mahogany-Paperbark Swamp Forest and Narrabeen Coastal Sheltered Peppermint-Apple Forest.
Less than 26ha of vegetation would be removed as a result of the proposal within the Gwandalan Development Lands. As such the proposal at Gwandalan Development Lands would contribute to this KTP.

Conclusion
Approximately 294ha of native vegetation within the proposed Offset Lands would be dedicated to conservation. It is considered that proposal is likely to represent a cumulative impact, with regard to this KTP, particularly for the Gwandalan Development Lands. The greater abundance of similar and greater quality habitat within Offset Lands that would be secured for conservation would provide long term protection of vegetation in the local area.

3. Human caused climate change
The proposal is likely to contribute to the Key Threatening Process "Human Caused Climate Change" as a result of clearing vegetation. It is considered that clearing and modification of the landscape would constitute only a minor incremental increase in the effects of this KTP. Thus the extent to which the proposal could contribute to this process is considered unlikely to be significant.

4. Infection of native plants by Phytophthora cinnamomi
Phytophora cinnomomi is a water mould (like a fungus) that attacks the roots of susceptible plants, in many cases killing the plants. In some native plant communities, epidemic disease can develop causing death of large numbers of plants.

P.cinnamomi may spread with the movement of infected soil or plant material by people, animals and may be transported by percolating through the soil, in creeks or storm runoff. People can also transport the fungus to new areas on dirt adhering to vehicles, items they are carrying or footwear.

Humans have the capacity to spread the fungus long distances and across barriers which sets us apart from the natural mechanisms which normally spread this water mould. Therefore, not a lot can be done to control the natural spread of the water mould or to destroy it, in native plant communities. Due to the use of heavy machinery that will be used for construction of the development estate there is opportunity for the KTP "Infection of native plants by *Phytophthora cinnamomi*: The transportation of *Phytophthora cinnamomi* from other areas may occur by the movement of soils attached to earth moving machinery. Precautionary measures such as clearing of machinery prior to clearing can help to limit the potential for this KTP to occur, and should be addressed in Environment Management Plans generated for site construction activities.

5. Invasion of native plant communities by exotic perennial grasses

There is opportunity for the KTP "Invasion of native plant communities by exotic perennial grasses" to occur within the site due to the removal of vegetation and the exposing of underlying soils. For the most part, this KTP already occurs within much of the CHB Development Lands due to their predominantly cleared and disturbed nature and to a lesser extent within Gwandalan Development Lands due to pasture and lawn maintenance. It is expected that those measures employed to reduce potential sediment and erosional impacts to surrounding areas will contribute to minimising the potential for this KTP to impact upon surrounding Offset Lands.

6. Removal of dead wood and dead trees

During the clearing of vegetation within the site a number of dead trees and fallen timber are likely to be removed and this may represent opportunity for the KTP "Removal of dead trees and dead wood".

Most of the CHB Development Lands have been highly disturbed as a result of previous mining activities and provide little dead trees or fallen timber resources. However, small areas of high quality native vegetation do contain a very small number of dead standing trees and a small amount of fallen timber.

Much of the Gwandalan Development Lands contain high quality native vegetation in good condition (Narrabeen Snappy Gum Forest and Narrabeen Coastal Sheltered Peppermint-Apple Forest). Within these vegetation communities dead trees and fallen timber are a relatively common occurrence and would require removal as part of the proposal within Gwandalan Development Lands. The Open Woodland vegetation community has a well maintained understorey with little fallen timber remaining on the ground and few dead trees.

The Offset Lands were found to contain numerous dead trees and fallen timber and would be dedicated to conservation as estates managed by DECCW.

It is considered that the proposal is likely to represent a cumulative impact, with regard to this KTP, particularly for the Gwandalan Development Lands. However, the greater abundance of similar and greater quality habitat within Offset Lands that would be secured for conservation would provide long term protection of dead trees and dead wood in the

local area.

7. Predation by Feral Cats

The increase of residential development within the area has the potential to increase opportunities for the KTP "Predation by feral cats". This KTP is unlikely to significantly impact upon local wildlife provided responsible pet ownership is adopted.

8. Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands

The displacement of natural vegetation communities within residential development is likely to increase the opportunity for the KTP "Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands". This is due to increased water flows and runoff potentials as a consequence of water falling upon manmade surfaces.
Of greatest risk with regard to this KTP are the SEPP 14 wetland to the south of CHB Development Lands, Swamp Sclerophyll Forest within Gwandalan Development Lands and threatened fauna associated with these communities such as Wallum Froglet.

Strict measures need to be implemented to minimise the potential impacts on SEPP 14 wetland that are likely to be associated with the proposal at CHB Development Lands as discussed in Section 4.6 of this report. In addition, impact to these threatened entities would be prevented by the implementation of sediment and water management plans during the planning and construction phases of development and suitable stormwater runoff treatment and control, coupled with adequate riparian vegetation retention.

9. Invasion of Native Plant Communities by Bitou and Boneseed

This species is currently well established along the Coastal heath vegetation communities and it occurs sporadically throughout the dry sclerophyll forests within the CHB Development Lands, Gwandalan Development Lands and Offset Lands. There is a chance that this plant may spread at the edges of the development due to the removal of the canopy layer and exposing of underlying soils which contain high number of seeds. It is recommended that a weed management program be undertaken targeting this species to ensure that the development proposal does not increase the area of occupancy. It is recommended that any topsoil which is removed from the vicinity of any Bitou plants not be used for any of the landscaping areas and be disposed of according to guidelines set out by Council. It is expected that those measures employed to reduce potential sediment and erosional impacts to surrounding areas will contribute to minimising the potential for this KTP.

10. Exotic Vines and Scramblers

Two species of exotic vines which have been listed within this KTP are present within the site namely, *Ipomoea cairica* (Mile a minute) and *Asparagus aethiopicus* (Asparagus Fern). The two species occur within the EEC of Swamp Sclerophyll Forest on Coastal Floodplains (Swamp Mahogany Paperbark Forest) within the Offset Lands. The densities of these species are low. *Ipomoea cairica* occurs with other weeds such as Lantana and Bitou and it is recommended that weeding be undertaken to prevent the further spreading and thus exacerbation of this KTP.

11. Lantana camara

There is a small opportunity for *Lantana camara* to establish, due to the removal of canopy vegetation and the exposing of underlying soils. This exotic plant species already occurs within the site in relatively high densities in some areas. It is likely that the development will considerably reduce the incidence of Lantana within the development estate. Nevertheless there will still be opportunities for this KTP at the edges of the development without appropriate management. It is expected that those measures employed to reduce potential sediment and erosional impacts to surrounding areas will contribute to minimising the potential for this KTP.

4.5 SEPP 44 (Koala Habitat Protection)

SEPP 44 - Koala Habitat Protection aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline.

4.5.1 First Consideration – Is the Land 'Potential Koala Habitat'?

Schedule 2 of State Environmental Planning Policy (SEPP) No. 44 – 'Koala Habitat Protection' lists 10 tree species that are considered indicators of 'Potential Koala Habitat'. The presence of any of the species listed on a site proposed for development triggers the requirement for an assessment for 'Potential Koala Habitat'. SEPP 44 defines potential Koala Habitat as:

> *"areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component".*

The site was found to contain potential Koala habitat as defined by SEPP 44 due to the following Schedule 2 species compositions at greater than 15% of the total number of trees:

- **CHB Development Lands** - EcoBiological (2006b) identified two species listed under Schedule 2 of SEPP 44, namely *Eucalyptus haemastoma* (Broad-leaved Scribbly Gum) and *E. punctata* (Grey Gum).
- **Gwandalan Development Lands** - Wildthing (2003b) identified three species listed under Schedule 2 of SEPP 44, namely *Eucalyptus haemastoma* (Broad-leaved Scribbly Gum), *E. tereticornis* (Forest Red Gum) and *E. robusta* (Swamp Mahogany). The most commonly occurring species within the Gwandalan Development Lands is *Eucalyptus haemastoma*.
- **Offset Lands** - The Offset Lands were found to contain areas with a range of Koala feed trees listed under Schedule 2 of SEPP 44 from *E. propinqua* (Small Fruited Grey Gum) within gullies of Narrabeen Wallarah Sheltered Grassy Forest, *E. robusta* within Swamp Sclerophyll Forest communities, *E. tereticornis* on the foreshore of Lake Macquarie, to *E. haemastoma* (Broad-leaved Scribbly Gum) and *E. punctata* (Grey Gum) in more elevated areas.

4.5.2 Second Consideration – Is the Land 'Core Koala Habitat'?

Searches were made for any secondary indications of Koalas on the site including scats, scratches on tree trunks, scent markings on tree trunks, tracks in the soil and audible noises including territorial or mating calls, fighting and movement in the trees during previous investigations (Wildthing 2003a; 2003b; 2004a; 2004b; 2004c). Searches for direct observations of Koalas were also conducted during nocturnal surveys. Whilst both the CHB and Gwandalan Development Lands were searched for the presence of Koala (Wildthing, 2004a; 2003b), not all of the Offset Lands were searched for Koala, particularly the north-west area adjacent to Crangan Bay. No animals were noted within the Development Lands and no secondary evidence of the presence of Koalas was found. However, a Koala record exists within the Offset Lands from 1996.

Records of Koala within 10 km of the site are summarised in Table 4-2 below.

Table 4-2: Locations of Koala Records within 10km of the Site

Year	Location description
1949, 1971, 1974, 1975	Pulbah Island in Lake Macquarie
1951	North of Swansea
1986	Wangi Point
1996	Southwest of Vales Point
1996	Along Pacific Highway within Offset Lands
2003	Approximately 500m to the southwest of Offset Lands
2003	Approximately 1.5 km to the south of Offset Lands, immediately to the south of Lake Macquarie SCA
2003	Approximately 1.5 km to the south of Offset Lands, immediately to the south of Lake Macquarie SCA
2003	Approximately 1.5 km to the south of Offset Lands, immediately to the south of Lake Macquarie SCA

The presence of a Koala record (see Table 4-2) and extensive areas containing a range of Schedule 2 Koala feed trees within the Offset Lands (particularly the western portion) indicates that a local Koala population may occur within these lands. Searches within all Offset Lands for Koala were not undertaken and as such the presence of core Koala habitat in these lands cannot be reliably determined.

No evidence of Koala was found during targeted searches within the CHB and Gwandalan Development Lands. Recent records of Koala exist within the local area; however, the absence of any Koala evidence indicates that the species is likely to occur only on a very rare occasion, at best.

In conclusion given that no direct evidence of secondary indication of Koala presence was

observed within the CHB or Gwandalan Development Lands during any of the previous investigations (Wildthing 2003a; 2003b; 2004a; 2004b; 2004c) it is considered unlikely that the site represents core Koala habitat as defined by SEPP 44.

4.6 SEPP 14 (Coastal Wetlands)

The close proximity of the SEPP 14 wetland to the CHB Development Lands (approximately 35m at the closest point) is of potential concern. Part of the proposal within the CHB Development Lands is located upslope of the SEPP 14 and as such it has the potential to influence the sensitive receiving environment of the wetland. Due to the low-lying nature and complex hyrdology of wetlands, even potential impacts that may occur near the downstream outlet may also potentially impact on the remainder of the wetland upstream. Such examples include pollutant dispersal, erosion and sedimentation, and resultant impacts on habitats, vegetation and micro-ecological niches.

Potential impacts on the wetland as a result of the proposal at CHB Development Lands include:

- Alteration in the amount and type of flow entering the wetland and potential subsequent impacts on wetland and heath vegetation;
- Addition of pollutants to the wetland from construction machinery, residential vehicle traffic and stormwater;
- Erosion and sedimentation within the wetland resulting from construction in upslope areas;
- Removal of wetland vegetation; and
- Invasion of weeds through vegetation clearance and residential landuse.

Strict measures will need to be implemented to minimise the potential impacts on SEPP 14 wetland that are likely to be associated with the proposal at CHB Development Lands. A riparian buffer may be implemented that aim to protect the integrity of the SEPP 14 wetland such as:

- A primary riparian buffer of 50 m from wetland vegetation, where no land uses are permitted that significantly detract from the potential of the buffer to achieve the goal of wetland protection. This buffer would consist predominantly of existing fringing vegetation.

Where this buffer is unable to be adequately implemented within the proposed development design, additional control measures should be investigated in consultation with experienced wetland hydrologists and engineers to ensure that potential impacts on the SEPP 14 wetland are minimised. This is particularly the case in the section where the wetland boundary is located 35m from the CHB Development Lands.

Other general recommendations to minimise potential impacts on the SEPP 14 wetland include:

- Where feasible, roads should enclose the residential development to avoid

encroachment of residences into surrounding bushland;

- A weed management and monitoring plan should be developed and implemented to minimise the potential for the invasion of aquatic and terrestrial weed species into the SEPP 14 wetland and buffer zones; and
- Stormwater treatment as appropriate should be undertaken to minimise potential impacts on the SEPP 14 wetland.

4.7 Key Thresholds Assessment (Part 3A)

As required by the Draft *Guidelines for Threatened Species Assessment* for Part 3A applications (DEC / DPI 2005), the following assessment of Key Thresholds (four in total) is provided for the proposed CHB and Gwandalan Development Lands.

1. Whether or not the proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts will maintain or improve biodiversity values.

It is considered that the information presented within this document, and in particular the proposal that includes the proposed offset areas for the site, is likely to result in maintained biodiversity values within the region and improved long-term conservation of these values.

2. Whether or not the proposal is likely to reduce the long-term viability of a local population of the species, population or ecological community.

The habitats utilised by the threatened species, populations and ecological communities considered likely to occur or that were recorded within the Development Lands are well represented in the proposed Offset Lands that would be dedicated to conservation.

One clump, 10 specimens of *Cryptostylis hunteriana* (listed as Vulnerable under *TSC Act* and *EPBC Act*) was found within the CHB Development Lands. *Cryptostylis hunteriana* was also recorded within the Offset Lands. A total of 43 flowering stems were located by two ecologists within the Offest Lands. The cryptic nature of this species makes it a very difficult to locate in the field, so it would not be unexpected that more specimens occur within suitable areas of the locality.

Cryptostylis hunteriana has a history of flowering sporadically, going for years at a time not producing any flower which makes it difficult to accurately determine potential population sizes. However, the works undertaken to date within both proposed Development Lands (one clump, 10 specimens) and within conservation lands (nine clumps, 43 specimens) would seemingly indicate that the level of conservation of this species would be greater than the 4:1 ratio applied at an elementary level across all other facets of biodiversity assessed for this proposal.

A small number of *Tetratheca juncea* plants (369) would be removed as part of the current development proposal within CHB and Gwandalan Development Lands. There were at least 1,024 individuals identified within the Offset Lands, with this number expected to be highly conservative due to the high number of this species found in the lands surrounding

the site and it is estimated that the count be closer to 5, 147. It is estimated that 49,000 individuals occur within the Wallarah Peninsula and local area. Of these over 30,000 are to be reserved within existing and proposed conservation reserves. Therefore, it is considered that the removal of 0.3% of the population within the local area would not reduce the long term viability of the local population of this species.

3. Whether or not the proposal is likely to accelerate the extinction of the species, population or ecological community or place it at risk of extinction.

The habitats utilised by the threatened species, populations and ecological communities considered likely to occur or that were recorded within the Development Lands are well represented in the proposed Offset Lands that would be dedicated to conservation.

Cryptostylis hunteriana was recorded within the conservation area. A total of 43 flowering stems were located by two ecologists. The cryptic nature of this species makes it a very difficult to locate in the field, so it would not be unexpected that more specimens occur within suitable areas of the locality.

Cryptostylis hunteriana has a history of flowering sporadically, going for years at a time not producing any flower which makes it difficult to accurately determine potential population sizes. However, the works undertaken to date within both proposed Development Lands (one clump, 10 specimens) and within opposed offset area (nine clumps, 43 specimens) would seemingly indicate that the level of conservation of this species would be greater than the 4:1 ratio applied at an elementary level across all other facets of biodiversity assessed for this proposal.

The removal of a small population of *Tetratheca juncea* by the proposal is unlikely to place the local population at risk of extinction due to the large numbers which are to be conserved within conservation reserves within the locality (approximately 30,000).

4. Whether or not the proposal will adversely affect critical habitat.

There is no declared “Critical Habitat” within the site locality, and as such the proposal will not adversely affect any such habitat.

5 Recommendations

The following recommendations have been outlined to ensure that the ecological impact of the proposal is minimised as far as possible:

- The EPBC approval requires as a condition that a management plan be implemented for the *Cryptostylis hunteriana* individuals that were identified within Hamlet 6 of the CHB Development Lands. This management plan is to be implemented for the protection of the species prior to any works commencing and prior to the removal of these species located in Hamlet 6.
- Protection and minimisation of disturbance to White-bellied Sea-eagle nest occurring in the Offset Lands in consultation with DECCW.
- Strict management of stormwater runoff via WSUD from both CHB and Gwandalan Development Lands must occur to minimise potential impacts on EECs, SEPP 14 wetlands and known Wallum Froglet habitat.
- Implement the following SEPP 14 buffers:
  - A primary riparian buffer of 50 m from wetland vegetation, where no land uses are permitted that significantly detract from the potential of the buffer to achieve the goal of wetland protection. This buffer would consist predominantly of existing fringing vegetation.
  - Where these buffers are unable to be implemented within the proposed development design, additional control measures should be investigated in consultation with experienced wetland hydrologists and engineers to ensure that potential impacts on the SEPP 14 wetland are minimised.
- A weed management and monitoring plan for the CHB Development Lands should be developed and implemented to minimise the potential for the invasion of aquatic and terrestrial weed species into the SEPP 14 wetland and buffer zones. The weed management and monitoring plan for CHB Development Lands should be developed to ensure consistency with management strategies undertaken for the adjacent Munmorah SCA and Offset Lands;
- The management of the development and conservation land interface is critical to ensure that no direct or indirect impacts occur in the short and long term on dedicated Offset Lands. As such, appropriate management plans should be prepared and implemented within the CHB and Gwandalan Development Lands;
- The minimum amount of clearing should take place as a general objective of the project, particularly within those areas that currently contain identified native vegetation communities. These areas have been described within this report. This is especially important within those areas identified as containing vegetation consistent with EEC's.
- Mature and / or hollow-bearing trees should be retained wherever feasible and with regards to public safety within the development framework, particularly within Gwandalan Development Lands where there are no offsets immediately adjacent to the site.
- Pre-clearance surveys should be conducted within the development areas during the

period before construction commencement in order to identify any breeding or nesting activities by native fauna within wooded areas. No breeding attempts or active nests should be disrupted as far as is practical during the course of the project.

- During the construction phase, for any tree removal within forested areas, and in particular where hollow-bearing trees may be removed, all works should be supervised by an ecologist to recover any native fauna that are potentially displaced. Furthermore, where such risks occur, site-specific ecological advice should be sought to minimise impacts during the entire process. A clearing protocol should be adopted for the removal of trees containing suitable habitat hollows as follows (this is considered as a guideline, variations on the methods employed may be required to accommodate site specific factors):
  - » All hollow bearing trees are to be flagged by an ecologist prior to the commencement of works on site.
  - » Underscrubbing of the entire site should be carried out by a 4x4 tractor with a slashing deck, this will minimise the establishment of degradation processes and leave a layer of mulch to aid in soil retention in the event of adverse weather. At this time felling of non habitat trees can take place, however a matrix of trees *must* be maintained to allow animal movement into the designated refuge area.
  - » After a period of two weeks, clearing of habitat trees should commence. Clearing must be carried out moving from the fringe of the matrix towards the refuge area. Trees should be 'soft felled' and inspected immediately by an ecologist for displaced fauna. All trees must be left for a minimum of two nights prior to being moved to a stockpile, to allow resident fauna to vacate tree hollows.

Note: Clearing should ideally take place outside of the main breeding seasons of resident fauna, preferably during late Autumn and Winter.

- Species selection for future landscaping works and seed stock for revegetation should be limited to locally occurring native species to maintain local genetic diversity. This should include *Eucalyptus robusta* and other regionally significant species.
- Appropriate vegetation, habitat and bushfire management plans should be included under an overarching Environmental Management Plan for the Gwandalan and CHB sites.
- Where possible, earthworks (and certainly all works in the vicinity of drainage lines) should be undertaken during appropriate (i.e. dry) weather conditions. This will ensure that any potential erosion events will be intercepted and that no downstream impacts occur within any of the drainage lines. This will help to maintain existing habitat characteristics for native fauna in those areas, including those for threatened species.
- Nutrient and sediment control devices should be erected pre-clearing and post-construction works in sensitive areas where degradation processes may be triggered such as areas adjacent to watercourses until suitable rehabilitation has occurred to maintain surface integrity. Furthermore, stockpiles should be subject to individual sediment and nutrient control devices.
- Where possible, landscape sediment retention ponds with fringing wetland vegetation (eg *Typha* sp.) to provide habitat for species such as Green and Golden Bell Frog.

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Appendix A

EPBC Approval

Australian Government

Department of the Environment, Water, Heritage and the Arts

APPROVAL

Rose Property Group Pty Ltd Catherine Hill Bay and Gwandalan Residential Development
EPBC 2007/3411

This decision is made under Section 133 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Proposed action

person to whom the approval is granted	Rose Property Group Pty Ltd ACN: 123 982 141
proposed action	To develop approximately 60 ha at Montefiore Street, Catherine Hill Bay and approximately 18 ha at Kanagara Drive, Gwandalan for residential, retail and commercial purposes as outlined in the referral documentation dated 4 April 2007 and in the Preferred Project Report dated 6 December 2007.

Approval decision

relevant controlling provisions	The approval has effect for: • Listed threatened species and communities (sections 18 & 18A)
conditions of approval	This approval is subject to the conditions specified below.
expiry date of approval	This approval has effect until 2039

Person authorised to make decision

name and position	Peter Garrett Minister for the Environment, Heritage and the Arts
signature	
date of decision	27.2.09

Conditions attached to the approval

1. The person proposing to take the action must undertake the action generally as described in the final *Catherine Hill Bay and Gwandalan Concept Plan*, prepared for Rose Property Group Pty Ltd and dated December 2008, subject to the conditions contained within this approval and in accordance with the plan of subdivision at Annexure 1, including the dedication of Lots 104, 105 and 107 as conservation areas.

2. Prior to any works commencing the person proposing to take the action must prepare and have approved by the Minister a management plan which must make provision for:

    a) the removal of *Cryptostylis hunteriana* individuals from Hamlet 6 for the purposes of research; and
    b) the provision of funding of no less than $15,000, by the person proposing to take the action, to facilitate the research referenced in this Condition.

    The approved management plan must be implemented.

3. In order to minimise potential future impacts on *C. hunteriana* located in Hamlet 6 of Moonee Hamlets, prior to any works commencing and prior to the removal of the *C. hunteriana* individuals located in Hamlet 6 in accordance with Condition 2, the person proposing to take the action must prepare and have approved by the Minister a *C. hunteriana* management plan which must identify measures that will be taken to:

    a) ensure that nutrient and sediment control measures are put in place to avoid any run off from Hamlet 6 or 7 having an adverse impact on the Narrabeen Doyalson Coastal Woodland, mapped as Cryptostylis hunteriana habitat at Annexure 2 and the *C. hunteriana* individuals located in Hamlet 6;
    b) manage weeds to ensure that the Narrabeen Doyalson Coastal Woodland and the *C. hunteriana* individuals located in Hamlet 6 will not be subject to weed invasion and that weeds already present in the area will be actively managed;
    c) ensure that if any controlled burning is to be undertaken during the *C. hunteriana* flowering period within the Narrabeen Doyalson Coastal Woodland mapped at Annexure 1, pre burning surveys will be undertaken for *C. hunteriana* in that area and if any *C.hunteriana* are detected, no burning will take place during that flowering period;
    d) protect the *C. hunteriana* which occur in the area from uncontrolled burning in the Narrabeen Doyalson Coastal Woodland; and
    e) ensure that public access to Hamlet 6 is actively managed to reduce the risks posed to the area through increased human access including, but not limited to illegal collection of *C. hunteriana*, trampling, and rubbish dumping.

    The approved C. hunteriana management plan must be implemented.

4. In order to minimise the potential impacts on the *Environment Protection and Biodiversity Conservation Act 1999* listed threatened species that are known to or likely to occur in the development areas and their suitable habitat, prior to any works commencing the person proposing to take the action must prepare and implement an environmental management plan that:

    a) identifies the measures to be taken to minimise the amount of clearing in areas defined as native vegetation communities;
    b) provides details of species of local provenance to be used for future landscape works and seed stock for revegetation; and
    c) identifies the measures to be taken to protect drainage lines during construction and nutrient and sediment control.

    The final version of the plan is to be provided to the Department prior to works commencing.

5. In order to minimise the potential impacts on the *Environment Protection and Biodiversity Conservation Act 1999* listed threatened species and their suitable habitat that is known to or likely to occur in the conservation lands, prior to any works commencing a management and monitoring plan must be in place that addresses the following management issues in the conservation areas:

    a) pedestrian access arrangements;
    b) edge effects due to disturbance of adjacent areas;
    c) sediment and erosion control measures;
    d) water quality and quantity;
    e) domestic animals; and
    f) spread of exotic and invasive species.

    This management plan is to identify monitoring and mitigation measures which ameliorate impacts on adjoining conservation areas.

    The final version of the plan must be implemented and provided to the Department prior to works commencing.

6. In order to minimise the potential impacts on the *Environment Protection and Biodiversity Conservation Act 1999* listed threatened species and suitable habitat that is known to, or likely to occur in the conservation lands and/or the marine environment, prior to any works commencing, the person proposing to take the action must prepare Stormwater Management Plans which ensure that stormwater discharged from the Catherine Hill Bay development site meets the objective reductions set out in the October 2007 draft *Managing Urban Stormwater: environmental targets, Department of Environment and Climate Change NSW*, and that the stormwater discharged from the Gwandalan site meets the objective reductions set out in the October 2007 draft *Managing Urban Stormwater: environmental targets, Department of Environment and Climate Change NSW*, the 2008 Wyong Water Sensitive Urban Design Development Control Plan (DCP No. 97) and the July 1999 Wyong Shire Council Urban Stormwater Quality Management Plan for the Tuggerah Lakes and Coastal Catchments.

    The plan must be implemented and the final version provided to the Department prior to works commencing.

7. Within 10 days of commencement of the action, the person taking the action must advise the Department of the actual date of commencement.

8. If, at any time after three years from the date of this approval, the Minister notifies the person taking the action in writing that the Minister is not satisfied that there has been **substantial commencement*** of the action, the action must not thereafter be commenced without the written agreement of the Minister.

***Substantial commencement** for this action is defined as the commencement of any works.

9. Upon the direction of the Minister, the person taking the action must ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the Minister. The independent auditor must be approved by the Minister prior to the commencement of the audit. Audit criteria must be agreed to by the Minister and the audit report must address the criteria to the satisfaction of the Minister.

10. If the person taking the action wishes to carry out any activity otherwise than in accordance with the plans, reports or strategies referred to in the conditions of this approval, the person taking the action must submit for the Minister's approval a revised version of any such plan, report or strategy. If the Minister approves such a revised plan, report or strategy, that plan, report or strategy must be implemented in place of the plan, report or strategy originally approved.

11. If the Minister believes that it is necessary or desirable for the better protection of listed threatened species and ecological communities to do so, the Minister may request that the person taking the action make specified revisions to the plans, reports or strategies approved pursuant to the conditions of this approval and submit the revised plan, report or strategy for the Minister's approval. The person taking the action must comply with any such request. The revised approved plan, report or strategy must be implemented.

12. Within three months of every 12 month anniversary after the commencement of the action, the person taking the action must provide a report to the Department addressing compliance with each of the Conditions of this approval over the previous 12 months. These reports must be provided to the Department each year for ten years after the commencement of the action.

13. The person taking the action must maintain accurate records substantiating all activities associated with or relevant to the above conditions of approval, and make them available upon request to the Department. Such records may be subject to audit by the Department, and used to verify compliance with the conditions of approval. Summaries of audits will be posted on the Department's website. The results of audits may also be publicised through the general media.

Definitions:

Commencement of the action: commencement of any works.

Conservation areas: includes Lots 104, 105 and 107 as identified in the plan of subdivision at Annexure 1, and Point Wolstoncroft State Recreation Area north of the Gwandalan site and Munmorah State Conservation Area to the south of the Catherine Hill Bay site.

Controlled burning: a fire planned and executed to achieve management goals. All other fires are considered uncontrolled burning.

Cryptostylis hunteriana flowering period: 1 August through to the end of February.

Department: the Australian Government Department responsible for the *Environment Protection and Biodiversity Conservation Act 1999.*

Minister: The Minister responsible for the *Environment Protection and Biodiversity Conservation Act 1999.*

Native vegetation communities: are those described in Part 3 and mapped in figure 3.1 of the Ecological Assessment Report which forms Annexure C to the Catherine Hill Bay and Gwandalan Preferred Project Report for Concept Plan MP 06 0330 dated 6 December 2007.

Works- includes any preparatory works required to be undertaken including clearing vegetation, the erection of any onsite temporary structures and the use of heavy equipment for the purpose of breaking the ground for buildings or infrastructure. Works excludes any activity required to be undertaken to fulfil the requirements of conditions 2, 3, 4, 5, and 6 above.

Appendix B

Flora Species List

Flora Species List

The following list includes all species of vascular plants observed on site during fieldwork. It should be noted that such a list cannot be considered comprehensive, but rather indicative of the flora present on the site. It can take many years of flora surveys to record all of the plant species occurring within any area, especially plant species that are only apparent in some seasons such as Orchids.

A number of species cannot always be accurately identified during a brief survey, generally due to a lack of suitable flowering and/or fruiting material. Any such species are identified as accurately as possible, and are indicated in the list as indicated:

- specimens that could only be identified to genus level are indicated by the generic name followed by the abbreviation "sp.", indicating an unidentified species of that genus;
- specimens for which identification of the genus was uncertain are indicated by a question mark ("?") placed in front of the generic, which is followed by the abbreviation "sp." and;
- specimens that could be accurately identified to genus level, but could be identified to species level with only a degree of certainty are indicated by a ("?") placed in front of the epithet.

Authorities for the scientific names are not provided in the list. These follow the references outlined below.

Harden, G. (ed) (2000). *Flora of New South Wales, Volume 1*. Revised edition. UNSW, Kensington, NSW.
Harden, G. (ed) (2002). *Flora of New South Wales, Volume 2*. Revised edition. UNSW, Kensington, NSW.
Harden, G. (ed) (1992). *Flora of New South Wales, Volume 3.* UNSW, Kensington, NSW.
Harden, G. (ed) (1993). *Flora of New South Wales, Volume 4*. UNSW, Kensington, NSW.
Names of families and higher taxa follow a modified Cronquist System (1981).

Introduced species are indicated by an asterisk "*".

Threatened species listed under the *Threatened Species Conservation Act 1995* (TSC Act) or the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and / or Rare or Threatened Australian Plant (ROTAP) listed species are indicated in bold font and marked as:

(V) = Vulnerable Species listed under the TSC Act
(E) = Endangered Species listed under the TSC Act
(EE) = Species listed under the Commonwealth EPBC Act as Endangered
(EV) = Species listed under the Commonwealth EPBC Act as Vulnerable
(R) = ROTAP as per Briggs and Leigh (1996)

The following standard abbreviations are used to indicate subspecific taxa:

ssp. - subspecies
var.- variety
agg. aggregate
× - hybrid between the two indicated species

	Community Represented
1	Munmorah Palm-Apple Dry Drainage Line Forest
2	Coastal Plains Smooth-barked Apple Woodland
3	Coastal Sand Wallum Heath-Scrub
4	Narrabeen Foreshore Redgum-Ironbark Forest
5	Narrabeen Wallarah Sheltered Grassy Forest
6	Narrabeen Doyalson Coastal Woodland
7	Coastal Headland Complex (Grassland & Shrubland)
8	Coastal Holocene Banksia Scrub
9	**Coastal Sand Mahogany-Paperbark Swamp Forest (EEC Swamp Scerlophyll Forest)**
10	**Estuarine Swamp Oak Forest (EEC Swamp Oak Floodplain Forest)**
11	Estuarine Mangrove-Saltmarsh Complex
12	**Freshwater Wetlands (EEC – Freshwater Wetlands on Coastal Floodplains)**
13	Regenerating Vegetation
14	Weeds and Cleared Areas
15	Dams

Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLASS LYCOPSIDA (CLUB MOSSES)																
SELLAGINELLACEAE																
Selaginella uliginosa	Club Moss					X							X			
CLASS FILICOPSIDA (FERNS)																
ADIANTACEAE																
Adiantum aethiopicum	Common Maidenhair Fern	X				X				X						
Adiantum hispidulum	Rough Maidenhair Fern	X				X				X						
Adiantum formosum	Giant Maidenhair Fern	X								X						
BLECHNACEAE																
Blechnum nudum	-	X				X				X						
Doodia aspera	Rasp Fern	X				X				X						
DENNSTAEDTIACEAE																

Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Pteridium esculentum	Bracken Fern			X	X	X	X			X						
DICKSONIACEAE																
Calochlaena dubia	False Bracken Fern									X			X			
GLEICHENIACEAE																
Gleichenia dicarpa	Pouched Coral Fern	X								X			X			
LINDSAEACEAE																
Lindsaea linearis	Screw Fern					X		X		X			X			
Lindsaea microphylla	Lacy Wedge-fern									X			X			
POLYPODIACEAE																
Platycerium bifurcatum ssp. *bifurcatum*	Elk Horn									X						
SCHIZACEAE																
Schizaea dichotoma	Branched Comb Fern						X									
SINOPTERIDACEAE																
Pellaea falcata	Sickle Fern	X				X				X						
Pellaea paradoxa		X								X						
CLASS CYCADOPSIDA (CYCADS)																
ZAMIACEAE																
Macrozamia communis	Burrawang						X									
CLASS CONIFEROPSIDA (CONIFERS)																
PINACEAE																
**Pinus radiata*	Radiata Pine														X	
CLASS MAGNOLIOPSIDA (FLOWERING PLANTS)																
SUBCLASS MAGNOLIIDAE (Dicotyledons)																

Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ACANTHACEAE																
Brunoniella australis	Blue Trumpet				X	X		X		X						
Pseuderanthemum variabile	Pastel Flower					X										
AIZOACEAE																
Tetragonia tetragonioides	Warrigal Cabbage										X					
APIACEAE																
Centella asiatica	Swamp Pennywort	X			X	X				X						X
**Ciclospermum leptophyllum*	Slender Celery													X		
**Hydrocotyle bonariensis*	Kurnell Curse								X		X					X
Hydrocotyle peduncularis					X	X				X						X
Xanthosia pilosa	Wooly Xanthosia			X			X									
APOCYNACEAE																
Parsonsia straminea var. *straminea*	Monkey Rope	X			X	X				X	X					
ARALIACEAE																
Polyscias sambucifolia	Elderberry Panax					X										
ASCLEPIADACEAE																
**Gomphocarpus fruticosus*	Narrow-leaf Cotton Bush													X	X	
Marsdenia rostrata	Common Milk Vine	X								X						
Marsdenia suaveolens	Sweet-scented Doubah	X			X											
ASTERACEAE																
**Ageratina adenophora*	Crofton Weed	X												X	X	
**Aster subulatus*	Wild Aster													X	X	
**Bidens pilosa*	Cobbler's Pegs								X					X	X	
Brachycome angustifolia ssp. *angustifolia*						X		X								
**Chrysanthemoides monilifera* ssp. *rotundata*	Bitou Bush	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
**Cirsium vulgare*	Spear Thistle								X					X	X	
**Conyza albida*	Tall Fleabane				X									X	X	
**Conyza bonariensis*	Flaxleaf Fleabane													X	X	
**Coreopsis lanceolata*														X	X	

Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
**Gnaphalium americanum*	Cudweed													X	X	
**Gnaphalium sphaericatum*	Cudweed													X	X	
**Hypochoeris radicata*	Cat's Ear													X	X	
Lagenifera stipitata			X			X										
**Senecio madagascariensis*	Fireweed													X	X	
**Soliva sessilis*	Bindi													X	X	
**Taraxacum officinale*	Dandelion													X	X	
Vernonia cinerea						X								X		
AVICENNIACEAE																
Avicenia marina var. *australasica*	Grey Mangrove										X	X				
BIGNONIACEAE																
Pandorea pandorana	Wonga Wonga Vine	X			X	X				X						
CARYOPHYLLACEAE																
**Cerastium holosteoides*	Mouse-ear Chickweed													X		
**Stellaria media*	Chickweed													X		
CASUARINACEAE																
Allocasuarina distyla																
Allocasuarina littoralis	Black She-oak		X			X								X		
Allocasuarina torulosa	Forest Oak				X	X										
Casuarina glauca	Swamp She-oak				X					X	X					
CELASTRACEAE																
Maytenus silvestris					X											
CHENOPODIACEAE																
**Atriplex hastata*	Orache										X					
Suaeda australis	Austral Seablite										X					
CLUSIACEAE																
Hypericum gramineum	St Johns Wort							X								
CONOLVULACEAE																
Convolvulus erubescens	Australian Bindweed	X			X											
Dichondra repens	Kidney Weed	X			X	X				X	X					

Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
**Ipomoea cairica*	Mile-a-minute													X	X	
CUNONIACEAE																
Ceratopetalum gummiferum	NSW Christmas Bush												X			
DILLENIACEAE																
Hibbertia aspera	Rough Guinea Flower		X			X		X		X						
Hibbertia dentata	Twining Guinea Flower					X										
Hibbertia empertifolia			X	X												
Hibbertia pedunculata				X												
Hibbertia scandens	Golden Guinea Flower									X						
DROSERACEAE																
Drosera peltata	Sundew						X						X			
ELAEOCARPACEAE																
Elaeocarpus reticulatus	Blueberry Ash					X				X						
EPACRIDACEAE																
Acrotriche divaricata								X						X		
Astroloma humifusum	Cranberry Heath													X		
Epacris microphylla	Coral Heath							X								
Epacris pulchella	NSW Coral Heath		X											X		
Leucopogon ericoides	Bearded Heath			X												
Leucopogon juniperinus	Bearded Heath			X												
Leucopogon lanceolatus	Lance Beard-heath					X				X						
EUPHORBIACEAE																
Breynia oblongifolia	Breynia	X			X	X				X						
Glochidion ferdinandi	Cheese Tree	X			X					X				X		
Omalanthus populifolius	Bleeding Heart															
Phyllanthus hirtellus	Thyme Spurge	X	X													
Poranthera microphylla	Small Poranthera			X	X		X									
Ricinocarpus pinifolius	Wedding Bush			X			X									
FABOIDEAE																
Bossiaea heterophylla	Variable Bossiaea						X									
Bossiaea stephensonii							X	X								

Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Daviesia ulicifolia	Gorse Bitter-pea					X										
Desmodium rhytidophyllum						X	X									
Desmodium varians						X	X									
Dillwynia retorta	Heathy Parrot Pea		X	X			X									
Glycine clandestina	Love Creeper	X	X		X	X										
Glycine microphylla	Love Creeper					X										
Glycine tabacina	Love Creeper					X										
Gompholobium latifolium	Broad-leaf Wedge-pea						X									
Gompholobium pinnatum	Pinnate Wedge Pea						X									
Hardenbergia violacea	False Sarsaparilla						X							X		
Jacksonia scoparia	Dogwood					X										
Mirbelia rubifolia																
Podolobium ilicifolium	Native Holly		X			X										
Pultenaea daphnoides						X		X								
Pultenaea ellipitica								X								
Pultenaea paleacea			X					X		X						
Pultenaea retusa			X							X						
Pultenea villosa		X				X				X						
**Trifolium repens*	White Clover															
**Trifolium dubium*	Yellow Suckling Clover															
**Vicia sativa*	Common Vetch															
GENTIANACEAE																
**Centaurium tenuiflorum*	Common Centaury							X								
GERANIACEAE																
Geranium homeanum	Cranesbill															
GOODENIACEAE																
Dampiera stricta							X	X		X			X			
Goodenia heterophylla	Variable-leaved Goodenia		X	X		X				X						
Goodenia ovata	Hop Goodenia									X	X					
Goodenia paniculata	Swamp Goodenia									X						
Goodenia rotundifolia																
HALORAGACEAE																
Gonocarpus micranthus ssp.										X						

Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ramosissimus																
Gonocarpus tetragynus	Poverty Raspwort							X		X						
Gonocarpus teucrioides	Germander Raspwort	X		X			X			X						
HAMAMELIDACEAE																
**Liquidambar formosana*	Chinese Liquidambar														X	
LAMIACEAE																
Plectranthus parviflorus					X					X						
LAURACEAE																
Cassytha glabella forma *glabella*	Slender Devil's Twine							X								
Cassytha pubescens	Common Devil's Twine				X			X		X	X					
**Cinnamomum camphora*	Camphor Laurel														X	
Cryptocarya microneura	Murrogun	X								X						
LOBELIACEAE																
Pratia purpurascens	White Root	X	X		X	X				X						
Lobelia alata	Angled Lobelia										X					
Lobelia gibbosa								X								
LORANTHACEAE																
Muellerina eucalyptoides	Mistletoe					X										
MALVACEAE																
**Modiola caroliniana*	Red-flowered Mallow													X		
**Sida rhombifolia*	Paddy's Lucerne													X		
MELIACEAE																
Synoum glandulosum	Scentless Rosewood					X				X						
MENISPERMACEAE																
Sarcopetalum harveyanum	Pearl Vine				X	X				X						
Stephania japonica var. *discolor*	Snake Vine				X	X				X						
MIMOSOIDEAE																
Acacia decurrens	Sydney Green Wattle													X		
Acacia falcata	Falcate Wattle													X		
Acacia fimbriata	Fringed Wattle					X										

Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Acacia irrorata ssp. *irrorata*		X				X				X						
Acacia linifolia	Flax-leafed Wattle		X													
Acacia longifolia var. *longifolia*	Sydney Golden Wattle	X		X		X		X					X	X		
Acacia longifolia var. *sophorae*	Coastal Wattle								X				X	X		
Acacia myrtifolia	Myrtle Wattle					X										
Acacia schinoides	Green Cedar Wattle															
Acacia suaveolens	Sweet-scented Wattle									X						
Acacia terminalis	Sunshine Wattle					X										
Acacia ulicifolia	Prickly Moses						X									
MORACEAE																
Ficus coronata	Sandpaper Fig	X								X						
MYRSINACEAE																
Rapanea variabilis	Mutton Wood	X			X					X						
MYRTACEAE																
Acmena smithii	Lilly Pilly	X				X				X						
Angophora costata	Smooth-barked Apple	X	X			X				X				X		
Backhousia myrtifolia	Grey Myrtle									X						
Callistemon citrinus	Crimson Bottlebrush									X			X			
Callistemon rigidus	Stiff Bottlebrush												X	X		
Callistemon salignus	Willow Bottlebrush	X				X				X						
Corymbia gummifera	Red Bloodwood		X	X		X	X	X								
Eucalyptus acmenoides	White Mahogany					X				X						
Eucalyptus capitellata	Brown Stringybark		X				X	X						X		
Eucalyptus globoidea	White Stringybark					X										
Eucalyptus haemastoma	Scribbly Gum					X	X									
Eucalyptus paniculata ssp. *paniculata*	Grey Ironbark				X	X										
Eucalyptus piperita	Sydney Peppermint		X			X				X						
Eucalyptus propinqua	Small-fruited Grey Gum					X										
Eucalyptus punctata	Grey Gum				X	X					X					
Eucalyptus resinifera ssp *resinifera*	Red Mahogany					X				X			X			
Eucalyptus robusta	Swamp Mahogany	X								X			X			
Eucalyptus signata	Scribbly Gum					X	X									
Eucalyptus tereticornis	Forest Red Gum				X					X	X					
Eucalyptus umbra ssp *umbra*	Broad-leaved White Mahogany					X		X								
Kunzea ambugia	Tick Bush							X	X					X		

Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Leptospermum juniperinum	Prickly Tea-tree									X				X		
Leptospermum laevigatum	Coastal Tea-tree			X			X		X					X		
Leptospermum polygalifolium	Lemon-scented Tea-Tree	X		X		X	X			X			X			
Leptospermum trinervium	Paperbark Tea-tree			X			X		X	X						
Melaleuca ericifolia	Swamp Paperbark												X	X		
Melaleuca lineariifolia	Snow-in-summer									X						
Melaleuca nodosa	Ball Honeymyrtle							X		X						
Melaleuca quinquenervia	Broad-leafed Paperbark									X			X			
Melaleuca sieberi	Sieber's Paperbark									X						
Melaleuca styphelioides	Prickly-leaved Paperbark					X				X						
Melaleuca thymifolia	Thyme Honey-myrtle												X			
Syncarpia glomulifera	Turpentine	X				X										
OCHNACEAE																
**Ochna serrulata*	Ochna				X	X				X						
OLEACEAE																
**Ligustrum sinense*	Small-leaved Privett									X						
Notelaea longifolia	Mock Olive				X	X				X						
Notelaea ovata	Mock Olive				X					X						
OXALIDACEAE																
**Oxalis corniculata*	Yellow Wood Sorrel													X		
**Oxalis latifolia*	Pink Shamrock													X		
Oxalis perennans					X											
PASSIFLORACEAE																
Passiflora herbertiana														X		
PITTOSPORACEAE																
Billardiera scandens	Apple Berry			X		X	X									
Bursaria spinosa	Blackthorn				X	X										
Citriobatus pauciflorus	Orange Thorn									X						
Pittosporum undulatum	Sweet Pittosporum									X						
PLANTAGINACEAE																
**Plantago lanceolata*	Lamb's Tongues													X	X	

Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
POLYGALACEAE																
Comesperma ericinum	Matchheads			X			X									
POLYGONACEAE																
Persicaria hydropiper	Water Pepper									X						
PRIMULACEAE																
**Anagallis arvensis*	Scarlet Pimpernel													X		
**Anagallis arvensis* var. *caerulea*	Blue Pimpernel													X		
Samolus repens	Creeping Brookweed										X					
PROTEACEAE																
Banksia aemula	Wallum Banksia			X			X									
Banksia integrifolia	Coastal Banksia															
Banksia oblongifolia				X				X					x	X		
Banksia robur	Swamp Banksia												X			
Banksia serrata	Old Man Banksia			X		X	X									
Banksia spinulosa var. *collina*	Hair-pin Banksia		X	X				X		X						
Grevillea sericea			X					X								
Hakea bakeriana							X									
Hakea dactyloides	Broad-leaved Hakea						X									
Hakea teretifolia	Dagger Hakea			X												
Isopogon anemonifolius	Drumsticks						X									
Lambertia formosa	Mountain Devil						X	X								
Persoonia lanceolata ssp. *lanceolata*	Lance-leaved Geebung													X		
Persoonia levis	Smooth Geebung			X		X	X									
Persoonia linearis	Narrow-leaved Geebung					X										
Xylomelum pyriforme	Woody Pear						X									
RANUNCULACEAE																
Clematis aristata	Old Man's Beard			X		X										
Clematis glycinoides	Forest Clematis					X										
RHAMNACEAE																
Alphitonia excelsa	Red Ash	X														
Pomaderris ferruginea	Rusty Pomaderris													X		

Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ROSACEAE																
Rubus hillii	Broad-leaved Bramble	X				X				X						
Rubus parvifolius	Native Raspberry									X						
**Rubus ulmifolius*	Blackberry													X	X	
RUBIACEAE																
Galium binifolium						X										
Galium propinquum					X	X										
Morinda jasminoides	Jasmine Morinda	X														
Pomax umbellata	Pomax					X										
**Richardia brasiliensis*	Mexican Clover													X	X	
RUTACEAE																
Boronia ledifolia	Sydney Boronia						X									
Correa reflexa	Common Correa			X			X									
Melicope micrococca										X						
Philotheca salsolifolia	Wax Flower			X			X									
Zieria smithii	Sandfly Zieria					X										
SANTALACEAE																
Exocarpus cupressiformis	Cherry Ballart				X	X										
SAPINDACEAE																
Dodonaea triquetra	Common Hop Bush	X			X	X								X		
Guioa semiglauca	Guioa									X						
SCROPHULARIACEAE																
Veronica plebeia	Speedwell					X										
SOLANACEAE																
**Solanum mauritinanum*	Wild Tobacco													X	X	
STACKHOUSIACEAE																
Stackhousia viminea							X									
STERCULIACEAE																
Lasiopetalum parviflorum										X						

Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
STYLIDIACEAE																
Stylidium graminifolium	Trigger Plant															
THYMELAEACEAE																
Pimelea linifolia ssp. *linifolia*	Slender Rice Flower		X	X				X								
TREMANDRACEAE																
***Tetratheca juncea* (V) (EV)**	**Black-eyed Susan**		X			X										
Tetratheca thymifolia				X			X									
VERBENACEAE																
Clerodendrum tomentosum	Hairy Clerodendrum				X	X				X						
**Lantana camara*	Lantana	X	X		X	X		X		X	X			X	X	
**Verbena bonariensis*	Purple-Top													X		
**Verbena rigida*														X		
VIOLACEAE																
Hybanthus monopetalus	Spade Flower							X		X						
Viola betonicifolia	Purple Violet									X			X			
Viola hederacea	Native Violet	X			X	X				X			X			
VITACEAE																
Cayratia clematidea	Slender Grape				X	X				X						
Cissus antarctica	Kangaroo Grape	X								X						
Cissus hypoglauca	Water Vine	X				X				X						
SUBCLASS LILIIDAE (Monocotyledons)																
ANTHERICACEAE																
Thysanotus tuberosus	Fringe Lily							X								
Tricoryne elatior	Yellow Rush-lily					X	X	X		X			X			
ARACEAE																
Gymnostachys anceps	Settlers Flax					X				X						
ARECACEAE																
Livistonia australis	Cabbage-tree Palm	X				X				X						

Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ASPARAGACEAE																
**Protasparagus aethiopicus*	Asparagus Fern									X						
COLCHICACEAE																
Burchardia umbellata	Milkmaids									X						
COMMELINACEAE																
Commelina cyanea	Hairy Wandering Jew															
CYPERACEAE																
Baumea juncea	Slender Twig Rush									X	X		X			
Carex appressa	Tall Sedge	X											X			
Carex fasicularis	Tassel Sedge	X														
Carex longebrachiata	Bergalia Tussock	X														
Eleocharis sphacelata	Tall Spike-rush															X
Fimbristylis dichotoma	Common Fringe-rush									X						X
Gahnia aspera	Saw Sedge				X											
Gahnia clarkei		X		X						X			X			
Gahnia melanocarpa		X								X			X			
Isolepis cernua											X					
Lepidosperma laterale	Variable Sword-sedge		X			X	X									
Ptilothrix deusta				X			X									
Schoenoplectus validus																X
Schoenus melanostachys		X				X				X						
DIOSCORACEAE																
Dioscoria transversa	Pencil Yam	X				X				X						
HAEMODORACEAE																
Haemodorum planifolium	Blood Root						X									
IRIDACEAE																
Patersonia glabrata	Leafy Purple Flag							X								
Patersonia sericea	Silky Purple Flag															
JUNCACEAE																

Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
**Juncus cognatus*																X
Juncus kraussii ssp. *australiensis*	Sand Rush										X	X				
Juncus mollis																X
Juncus subsecundus	Finger Rush															X
Juncus usitatus	Common Rush															X
LOMANDRACEAE																
Lomandra cylindrica	Mat Rush						X									
Lomandra longifolia	Spiny Mat Rush			X	X	X				X						
Lomandra multiflora						X										
Lomandra obliqua	Fish Bones		X	X			X	X								
LUZURIAGACEAE																
Eustrephus latifolius	Wombat Berry					X				X						
Geitonoplesium cymosum	Scrambling Lily				X	X				X						
ORCHIDACEAE																
Cryptostylis erecta						X	X									
***Cryptostylis hunteriana* (V) (EV)**							X									
Cryptostylis subulata							X									
Dipodium punctatum	Hyacinth Orchid					X										
PHILYDRACEAE																
Philydrum lanuginosum	Woolly Frogmouth															X
PHORMIACEAE																
Dianella caerulea var. *producta*	Blue Flax Lily			X		X				X						
Dianella longifolia var. *longifolia*			X													
POACEAE																
**Andropogon virginicus*	Whisky Grass													X		
Aristida vagans	Three-awn Speargrass		X													
Austrodanthonia linkii														X		
Austrodanthonia tenuior	Wallaby Grass					X								X		
Austrostipa ramosissima	Stout Bamboo Grass					X	X	X								
**Axonopus affinis*	Narrowleaf Carpet Grass													X		
**Briza maxima*	Quaking Grass															
**Briza minor*	Shivery Grass															
**Bromus cartharticus*	Prairie Grass															

Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
**Chloris gayana*	Rhodes Grass													X		
**Cortaderia selloana*	Pampas Grass					X							X	X		
Cynodon dactylon	Common Couch													X		
Dicanthium sericeum ssp. *sericeum*	Queensland Bluegrass													X		
Dichelachne micrantha	Plume Grass					X										
Echinopogon caespitosus var. *caespitosus*	Tufted Hedgehog Grass				X	X										
Echinopogon ovatus	Forest Hedgehog Grass				X	X										
**Ehrharta erecta*	Panic Veldtgrass													X		
Entolasia marginata	Bordered Panic									X			X			
Entolasia stricta	Wiry Panic	X		X		X				X				X		
Eragrostis brownii	Brown's Love Grass					X								X		
**Eragrostis tenuifolia*	Elastic Grass													X		
Hemarthria uncinata	Mat Grass									X						
**Hyparrhenia hirta*	Coolatai Grass													X		
Imperata cylindrica var. *major*	Blady Grass	X	X		X	X				X				X		
Joycea pallida	Silver-top Wallaby Grass		X			X										
Lolium sp.	Rye Grass															
Microlaena stipoides var. *stipoides*	Weeping Grass													X		
Oplismenus aemulus	Basket Grass	X		X	X	X				X						
Oplismenus imbecillus	Basket Grass	X			X	X				X						
Panicum simile	Two Colour Panic		X			X										
Paspalium distans						X										
**Paspalum dilatatum*	Paspalum							X						X		
Paspalium distichum	Water Couch															
**Paspalium urvellei*	Vasey Grass													X		
**Pennisetum clandestinum*	Kikuyu													X		
Phragmites australis	Native Reed												X			X
Poa affinis		X				X				X						
Poa labillardieri	Tussock Grass					X										
**Sporobolus africanus*	Parramatta Grass													X		
**Sporobolus elongatus*	Slender Rat's-tail Grass													X		
Sporobolus virginicus	Salt Couch										X					
**Stenotaphrum secundatum*	Buffalo Grass										X				X	
Themeda australis	Kangaroo Grass		X			X		X								
RESTIONACEAE																
Baloskion tetraphyllus ssp	Tassel Cord Rush	X											X			

Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
meiostachyum																
Leptocarpus tenax		X		X						X			X			
Lepyrodia scariosa		X								X			X			
SMILACACEAE																
Smilax australis	Smilax	X				X				X						
Smilax glyciphylla	Native Sarsaparilla									X						
TYPHACEAE																
Typha orientalis	Bull-rush															
XANTHORRHOEACEAE																
Xanthorrhoea glauca ssp *glauca*							X						X			
Xanthorrhoea latifolia ssp *latifolia*	Grass Tree						X	X								
Xanthorrhoea macromena	Grass Tree					X										
Xanthorrhoea resinifera			X													
XYRIDACEAE																
Xyris operculata	Tall Yellow-eye												X			

Appendix C

Vegetation Communities Photographs

Plate 1. Munmorah Palm-Apple Dry Drainage Line Forest

Plate 2. Coastal Plains Smooth- barked Apple Woodland

Plate 3. Coastal Sand Wallum Heath Scrub

Plate 4. Narrabeen Foreshore Redgum-Ironbark Forest

Plate 5. Narabeen Wallarah Sheltered Grassy Woodland

Plate 6. Narrabeen Doyalson Coastal Woodland

Plate 7. Coastal heathland Complex (Grassland & Shrubland)

Plate 8. Coastal Holocene Banksia Scrub

Plate 9. Coastal Sand Mahogany – Paperbark Swamp Forest (EEC – Swamp Sclerophyll Forest

Plate 10. Estuarine Swamp Oak Forest (EEC Swamp Oak Floodplain Forest)

Plate 11. Estuarine Mangrove-Saltmarsh Complex

Plate 12. Freshwater Wetland Complex (EEC – Freshwater Wetland on Coastal Floodplains)

Plate 13. Regenerating Vegetation

Plate 14 Dams

Appendix D

Qualifications of Personnel

Curriculum Vitae

MATTHEW DOHERTY

Manager - Ecology & GIS

Newcastle, NSW

Bachelor of Landscape Management and Conservation (Land & Water Conservation Major), University of Western Sydney, 2002

Bushland Regeneration Certificate II, Western Sydney Institute of TAFE, 1999

Spikeless Tree Climbing Techniques, Total Height Safety, 2004

OH&S Induction Training (Green Card)

NPWS Scientific Investigation Licence

NSW Animal Ethics Research Authority

Senior First Aid

AREAS OF EXPERTISE:

Matt has seven years experience in the environmental industry with key skills in project management, survey design, GIS and client relations. In his position as Ecology & GIS Manager, Matt manages environment department including the day to day running of projects, verification of reports and other outputs and ensures clients are well informed of project progress and key findings. Matthew's background in local government, state government and private consultancy gives him a high level of appreciation of the environmental and consultancy sector, thus allowing him to take a pragmatic approach to providing successful conservation and development outcomes whilst meeting the aims and objectives of clients and determining authorities.

SELECTED PROJECT EXPERIENCE:

Ecology and GIS

- **Various large-scale land development, mining, energy and infrastructure projects** – Matt has project managed and/or participated in numerous large-scale land development, mining, energy and infrastructure projects including Queensland Hunter Gas Pipeline (850km); Hunter Gas Pipeline; Rio Tinto Lower Hunter Lands Project; GIS biodiversity, large scale vegetation, habitat and predicative modelling mapping works; wind farms and coordination of environmental monitoring programs for mines

PREVIOUS EXPERIENCE:

Ecologist – Andrews Neil Pty Ltd **2004 - 2005**

Duties included: preparation of Fee Proposals for Ecological Services; General and Targeted Flora and Fauna Surveys including Flora and Fauna Identification; Desktop Studies and Literature Searches; Interpretation and Application of Legislation; report preparation including Threatened Species Assessments (8 part test), Vegetation Management Plans (Riparian Restoration/ Rehabilitation, Bush Regeneration), Species Impact Statements, Weed Management Strategies, Habitat Management Strategies and Tree Assessments; GIS/ Spatial Analysis and Database Management; Liaison with Client, Stakeholder Groups, State and Local Governing Bodies; Site Supervision of Ecological Conditions; Tree Climbing for installation, maintenance and monitoring of nestboxes.

Project Officer / Horticultural Services – Gosford City Council **06/2003 – 05/2004**

Comprehensively reviewed noxious weed management; performed vegetation surveys on GCC landfills to identify the presence of noxious weeds; quantify the extent of infestation of each noxious weeds species and map the

affected areas; developed a management plan for the control of NW species identified in the survey in accordance with relevant legislation; maintained Japanese Gardens along with City Wide Gardens and Streetscapes.

Various Roles whilst at University **1997 - 2002**

Environmental Officer - Dept of Land & Water Conservation, Newcastle **01/1999 – 12/1999**
Liaised with relevant agency and stakeholder groups; researched and prepared an extensive literature review of issues pertaining to riparian vegetation; assessed current best practice for revegetation and rehabilitation of degraded sites; prepared a Riparian Revegetation Management Strategy

Volunteer – Maitland City Council **07/1999 – 12/1999**
Assisted with Rivercare implementation throughout LGA. Utilised primary, secondary and field research to prepare a River Plan under 'Rivercare' guidelines.

Volunteer – Brisbane Waters & Gosford Lagoons Catchment Management Committee **03/1998 – 05/1998**
Prepared Riparian Zone Rehabilitation Plan for Degraded Creek Management, Research and prepared a Riparian Zone Rehabilitation Project. Member on several Gosford City Council steering committees and working groups.

MEMBERSHIPS & ACHIEVEMENTS:

- Fire Protection Association Australia (FPAA)

Curriculum Vitae

CRAIG ANDERSON

Senior Ecologist – Senior Project Manager

Newcastle, NSW

Bachelor Applied Science (Environmental Assessment & Management), University of Newcastle, 1994

Graduate Diploma in Archaeological Heritage, UNE, Current

RFS/PIA NSW Consulting Planners Bushfire Training

AREAS OF EXPERTISE:

Craig has over 15 years experience in a wide range of environmental consulting. He has undertaken and managed commissions for a diverse range of projects within land development, energy, mining, infrastructure and conservation, including State Significant developments.

Craig has an extensive background in ecological field surveys, encompassing all aspects of flora and fauna identification, targeted surveying and mapping. He was involved in the initial formulation of an Association of Consulting Ecologists for NSW in 1998 and has acted as an expert witness in several Land and Environment Court matters relating to ecology and bushfire assessment. He is an experienced negotiator of ecological / development outcomes, and has a detailed understanding of legislation related to ecological matters.

Craig has been actively involved in representations to the Department of Environment on behalf of the NSW Urban Taskforce in regards to proposed changes to the NSW Threatened Species Conservation Act, and for the Urban Development Institute of Australia (UDIA) on matters relating to issues such as the proposed listing of endangered ecological communities, regional environmental biodiversity strategies, and the Native Vegetation Act and the operations of the Catchment Management Authority (CMA).

SELECTED PROJECT EXPERIENCE:

Ecology

- **Buttaba Hills (336 Lots) –** Species Impact Statement
- **Hunter Economic Zone (800+ ha industrial estate) –** Species Impact Statement
- **Pelaw Main By-Pass to Hunter Economic Zone –** Species Impact Statement
- **Residential development / Eco-Resort / Fauna Sanctuary at Paxton -** Flora and Fauna Assessment incorporating Seven Part Tests of Significance of Impact under Threatened Species Legislation
- **SEPP 5 Aged Care facilities, Kariong, Hawks Nest, Wallsend, Glenhaven -** Flora and Fauna Assessment incorporating Seven Part Tests of Significance of Impact under Threatened Species Legislation
- **Caravan Park extensions, Fern Bay -** Flora and Fauna Assessment incorporating Seven Part Tests of Significance of Impact under Threatened Species Legislation
- **Road & Rail Infrastructure for the Hunter Economic Zone -** Flora and Fauna Assessment incorporating Seven Part Tests of Significance of Impact under Threatened Species Legislation
- **Alignments for Hunter Gas Pipeline Infrastructure -** Flora and Fauna Assessment incorporating Seven Part Tests of Significance of Impact under Threatened Species Legislation
- **Landscape Concept Plan, rural subdivision at Oakhampton Heights -** Vegetation Management Plan
- **Creek Rehabilitation Plan, Warners Bay -** Vegetation Management Plan
- **Vegetation Management Plan for a retained creek line with Sugar Valley Golf Course, West Wallsend -** Vegetation Management Plan
- **Individual Koala Plan of Management under SEPP 44 at Hawks Nest –** Management Plan

- **Ecological Constraints Management Plan, Hawks Nest North -** Management Plan
- **Management Plan for the Green & Golden Bell Frog at Culburra -** Management Plan
- **Fuel Management Plan over lots within a rural-residential estate at Glen Oak -** Management Plan
- **Ecological Constraints Master Plan for Hunter Economic Zone -** Management Plan
- **Environmental Plan of Management for Residential / Tourism Sanctuary Project at Paxton -** Management Plan
- **Green and Golden Bell Frog Survey and Management Plan, Gillieston Heights -** Targeted Species Study
- Targeted Species Studies as part of the Ecological Constraints Master Plan for the Hunter Economic Zone

PREVIOUS EXPERIENCE:

Senior Ecologist, Wildthing Environmental Consulting **1995 – 2000**
Oversaw operations in NSW and Qld, and project managed and undertook numerous ecological and bushfire assessments for a diverse array of clients / projects.

Environmental Officer, Pulver Cooper & Blackley / Kel Nagle Cooper & Associates **1994 - 1995**
Undertook a range of environmental, planning and survey investigations; fieldwork; reporting for a range of land development; and golf course development projects.

MEMBERSHIPS & ACHIEVEMENTS:

- Frog and Tadpole Study Group (FATS)
- Hunter Birds Observers Club (HBOC). Committee Member 2009. Records Appraisal Committee, 2008 – present
- Bird Observers Club of Australia (BOCA)
- Donaldson Conservation Trust. Board member (independent environmental expert). 2009 – present.

Curriculum Vitae

SARAH JONES

Ecologist / Bushfire Planner

Newcastle, NSW

B. Env.Sc, University of Newcastle

G.Dip (Design for Bushfire Areas)

RFS / PIA NSW Consulting Planners Bushfire Training Course

AREAS OF EXPERTISE:

Sarah has over 10 years experience as an Ecologist, including over 8 years with RPS as the company's bushfire planning specialist. Sarah has gained extensive experience in Bushfire Threat Assessment & Management reporting, Bushfire Risk Management Plans, Fuel Management Plans, Bushfire Evacuation Plans, understanding of fire regimes upon flora and fauna, Vegetation Management Plans, Terrestrial flora and fauna surveys, Flora and Fauna Assessments, along with understanding of environmental legislation and threatened species issues.

PREVIOUS EXPERIENCE:

Ecologist – Ecotone Environmental Consultants, Waratah, NSW **Jan 2001 – Nov 2001**

Volunteer Environmental Educator – Community Partnership, Newcastle City Council **Sept 2000 – Dec 2000**

MEMBERSHIPS & ACHIEVEMENTS:

- Member of the Fire Protection Association Australia (FPA)
- Member of the Bushfire Planning and Design Special Interest Group (BPAD)
- NSW Driver's Licence (Class C)
- OH&S Induction Training (Green Card)
- NPWS Scientific Investigation Licence
- NSW Animal Ethics Research Authority