



Ecological Assessment Report – Lower Hunter Lands

Gwandalan

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Executive Summary

Introduction

RPS Australia East Pty Ltd has been commissioned by Coal & Allied Industries Ltd (Coal & Allied) to undertake an *Ecological Assessment Report* over land within Gwandalan, for proposed development and conservation 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*. Due recognition and consideration of the *Threatened Species Conservation Act 1995* and the *Fisheries Management Act 1994* has been made throughout this assessment. Director General's Environmental Assessment Requirements were issued for the site on 19th August 2010.

This study is intended to investigate the potential ecological impacts of the proposal as required by the Part 3A DGEAR's. 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 Estate. To ensure completeness, ecological fieldwork and assessment has covered the full extent of the Coal & Allied surplus lands, including all development and conservation lands.

Background

Harper Somers O'Sullivan (2005) has previously undertaken Preliminary Vegetation Mapping over various holdings administered by Coal & Allied in the Lower Hunter Valley / Central Coast Region. This preliminary mapping was undertaken to provide a baseline dataset pertaining to the broad-scale distribution of ecological communities throughout the land holdings. This assessment was largely undertaken at a desktop level relying on aerial photography combined with existing regional mapping datasets and limited ground-truthing.

Between January 2007 – April 2010, ecological investigations were undertaken to inform the urban design and NSWG assessment process.

These investigations were intended to provide a brief assessment of the conservation status of previously delineated vegetation communities.

The report herewith builds on the existing dataset, and provides the necessary level of detailed information for the assessment of the proposals under relevant legislation.

A Concept Plan has been prepared for Gwandalan which will enable key site parameters associated with land use, infrastructure delivery and timing, and environmental conservation to be resolved up front, with subsequent detailed stages being submitted for approval progressively.

Methods

The DGEAR's stipulate assessment should have due regard to DECCW'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. To this end these documents have formed the core basis for ecological assessment over the site. In brief the methods employed to assess the ecological merit of the site involved the following (Note: Detailed assessment methods are presented within Section 3 of this report):

- Literature Review
- Preliminary (Desktop) Assessments

- Field Investigations
 - » Flora Assessment
 - Plant Identification and Vegetation Mapping
 - Floristic Structure Information
 - Targeted and Significant Flora Surveys
 - » Fauna Assessment
 - » Habitat Assessment and Mapping

Results

Flora

A total of 290 flora species were identified over the Gwandalan site during targeted flora surveys, including two threatened flora species and three Endangered Ecological Communities.

Threatened species include:

- *Angophora inopina*

A total of 3109 individual *Angophora inopina* trees were identified within the northern portion of the Gwandalan site. Of these, 2411 were within the offset lands and the remaining 698 were within the Development Estate. Of the 698, which are located within the Development Estate, 54 (0.02%) of the total population will be impacted upon by the development proposal. The remaining will be retained within the landscape buffer adjoining Kanangra Drive.

- *Tetratheca juncea*

A total of 10,089 *Tetratheca juncea* plants were located during the targeted surveys within the Gwandalan site (Figure 4-4 shows the distribution). Of these 6,591 will be retained within the conservation lands to the south and west of the Development Estate. Whilst, 3,498 (34%) are located within the Development Estate, it is likely that a further 226 individuals could be retained within the landscape areas of the Development Estate.

A further eleven threatened flora species (section 4.1.5) were considered to have potential habitat within the site. For one of these species, *Diuris praecox*, separate targeted searches were conducted during its flowering season, but the remaining ten species were targeted during *Tetratheca juncea* and *Angophora inopina* surveys, apart from *Cryptostylis hunteriana*, which flowers during summer.

No ROTAP listed species (Briggs and Leigh, 1996) were identified within the Gwandalan site.

Nine native vegetation communities have been delineated and described for the Gwandalan site, including three listed EECs which collectively comprise approximately 15.8% of the study area:

- Coastal Sheltered Apple – Peppermint Forest

This vegetation community occurs in the eastern and south-eastern portions of the site and encompasses 15.46ha, of which the entirety will be protected within conservation lands under the proposal. Narrabeen Coastal Sheltered Peppermint – Apple Forest (Bell 2002) (Coastal Plains Peppermint Apple Forest) is considered by Bell (2002) and being regionally significant due to its restricted distribution.

- Coastal Plains Smooth-barked Apple Woodland

This vegetation community occurs within the conservation lands, adjoining the Riparian Melaleuca Swamp Woodland and as a small section in the south-eastern portion of the site. This vegetation community encompasses 10.03ha of which the entirety will be protected within conservation lands under the current proposal.

- Coastal Plains Scribbly Gum Woodland

This vegetation community dominates the Gwandalan site and covers approximately 199.8 ha. 70% (138.92ha) of this community occurs with conservation lands with the remaining 30% (60.88ha) occurring within the Development Estate. Those areas of greatest quality will be retained within conservation lands.

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

This vegetation community occurs along the foreshore of Lake Macquarie and within the estuarine inlet of Mangrove Gully in the south-eastern portion of the site. The entire 6.17ha of this EEC occurring within the site will be protected within conservation lands.

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

This vegetation community occurs in the more estuarine drainage lines, adjoining the Riparian Melaleuca Swamp Woodland vegetation community. These drainage lines include the tributary of Tiembula Creek in the south-western portion of the site, Strangers Gully which flows in a north easterly direction into Lake Macquarie and the lower reaches of Mangrove Gully in the site's southeast. A total of 4.14ha of this community occurs within the site, the entirety of which will be protected with conservation lands.

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

This vegetation community occurs in drainage lines, often surrounding the Coastal Wet Sand Cyperoid Heath vegetation community. These drainage lines include the tributary of Tiembula Creek in the south-western portion of the site and the three drainage lines, which flow in a north easterly direction into Lake Macquarie. A total of 32.36ha of this community occurs within the site, of which 88% (28.36ha) will be protected within conservation lands and 12% (4ha) occurs within the Development Estate.

- Coastal Wet Sand Cyperoid Heath

This vegetation community occurs within alluvial soils of the Wyong group on Narrabeen Sandstone within the drainage depressions in the lower elevations of the site and encompasses 2.85ha. A total of 90% of this community will be protected as conservation lands within the proposal and the remaining 10% lie within the Development Estate. This vegetation community is commensurate with 'Narrabeen Coastal Alluvial Sedgeland (Wet Cyperoid Heath)' (Bell 2002) and is considered by Bell (2002) as being regionally significant due to its restricted distribution.

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

This vegetation community occurs within the lower lying area of Strangers Gully in the centre of the site. This community represents a total of 0.27ha of which the entirety is to be protected as conservation lands.

- Mangrove Estuarine Complex

This vegetation community occurs along the foreshore of Lake Macquarie within the site. This vegetation community covers approximately 0.48ha, of which the entirety will be protected within conservation lands. The Mangrove Estuarine Complex vegetation community present on site is protected under the Fisheries Management Act 1994.

SEPP 14 Wetland No. 890 is present within the estuarine area of Mangrove Gully, and encompasses part of the Mangrove Estuarine Complex and Swamp Oak Rushland Forest vegetation communities within the Gwandalan site, which will be protected within conservation lands under the proposal.

Fauna

Thirty-six (36) threatened fauna species (apart from oceanics) have been previously recorded with 10km of the site (as per existing records) and a further three species were considered as potentially occurring within 5km of the site. Of those 39 species eight (8) threatened fauna species were recorded within the site during fauna surveys, those being *Crinia tinnula* (Wallum Froglet), *Petaurus norfolcensis* (Squirrel Glider), *Glossopsitta pusilla* (Little Lorikeet), *Pteropus poliocephalus* (Grey-headed Flying-fox), *Falsistrellus tasmaniensis* (Eastern False Pipistrelle), *Miniopterus australis* (Little Bentwing-bat), *Miniopterus schreibersii oceanensis* (Eastern Bentwing-bat) and *Scoteanax rueppellii* (Greater Broad-nosed Bat).

A further 9 threatened fauna species are considered as having a moderate or greater opportunity of occurring within the site on at least an intermittent basis, due to the existence of potential habitat within the site and these are noted within Table 5-1.

Habitat

Generally the site is characterised by relatively intact native vegetation communities, although most areas are traversed by a network of tracks, which have provided opportunity for unauthorised rubbish dumping and access to unauthorised recreational motorcycle riding. There is some evidence of severe degradation and vegetation denudation within the proposed Development Estate and to a lesser extent within some of those lands to be protected as conservation lands as a consequence of the unauthorised activities.

The site contains potential habitat for threatened flora species, particularly within woodland habitats, although there are limited opportunities for threatened flora within swamp forest and riparian habitats. These are discussed within Section 4.1.5

The wooded areas of the site provide potential foraging opportunities for a number of threatened fauna guilds.

Widespread foraging occurs for insectivorous bat species, although habitats containing the greatest foraging resources are likely to be those exhibiting the greatest structural diversity, and these occur to the greatest extent outside the Development Estate.

Nectar producing trees occur across the site, but those of greatest significance to nectivorous species, such as Grey-headed Flying-fox, Swift Parrot and Regent Honeyeater occur within Swamp Mahogany and Forest Red Gum stands, which occur within those areas that will be protected as conservation lands under the proposal. The site has widespread *Allocasuarina spp.*, which are the almost exclusive food tree species of Glossy Black-Cockatoos.

Hollow-bearing trees are widespread within the site, within both woodland and open forest habitats, providing widespread roosting opportunities for hollow-dwelling Microchiropteran bats, and those of sufficient size to provide nesting opportunities for forest owls and Glossy Black-Cockatoos occur within open forest communities, which are to be protected as conservation lands under the proposal.

Open woodlands trees of sufficient age and size to provide nesting opportunities for estuarine birds of prey and there are foraging and nesting opportunities for Black Bitterns at the mouth of Mangrove Gully.

Conservation & Development Outcomes

The Lower Hunter Region's vegetation is of bio-geographic significance as it supports a transition between the northern and southern plant and animal assemblages. This north-south link is not evident elsewhere in the Hunter Valley. The Region also forms an east-west migratory pathway and a drought refuge for inland species.

The preservation of large vegetated areas that are linked to other similar areas has been recognised as fundamentally important to achieving long term regional biodiversity outcomes in the Lower Hunter region. The two most valued of these areas in the Lower Hunter contain large land areas owned and controlled by Coal & Allied. Firstly, is the green corridor that links the Watagans and Yengo National Parks with the coastal plains of the Tomago Sandbeds, Stockton Bight and Port Stephens. Secondly, the Wallarah Peninsula lands provide a regionally significant break between urban areas, and contain areas of high biodiversity, scenic amenity and heritage value.

The Coal & Allied lands proposed to be dedicated form both large vegetated areas in their own right, and complete linkage of identified regional corridors in key areas.

In addition to their important strategic location in a wider landscape context, the conservation lands contain valuable biodiversity resources. They contain and will conserve a range of important vegetation communities, including areas of Endangered Ecological Communities (EEC) and other vegetation types that have been depleted in the region. Several threatened plant species have been recorded within the lands, including significant occurrences of *Tetradlea juncea* (Black-eyed Susan).

The diverse nature of both the landform settings, varying from coastal ranges forests and woodlands to coastal heath to wetlands, provides a diverse array of habitats and resources for native fauna. The conservation lands are known to contain important populations of numerous threatened fauna species, including birds, mammals and herpetofauna. The conservation of these lands will provide secure regional biodiversity gene pools, and also through linkages facilitate valuable genetic material exchange and other key processes associated with sustainable ecological population dynamics.

In summary, the Coal & Allied conservation dedications provide outcomes that contribute to meeting the Environmental Protection goals outlined in the Sustainability Criteria contained within the Lower Hunter Regional Strategy. Such includes:

- Outcomes consistent with the Lower Hunter Regional Conservation Plan;
- Maintains/improves areas of regionally significant biodiversity;
- Maintains environmental areas for air & water quality; and
- Protects areas of Aboriginal cultural heritage value and historical heritage value.

These outcomes:

- Conserve in perpetuity key strategic parcels of land that complete long sought after regional biodiversity conservation corridors and buffer areas;
- Provide large intact areas of conserved habitat that will function as regional biodiversity gene pools;

- Protect an important array of vegetation communities, flora and fauna species, and natural landscape assets, including threatened species and EEC's; and
- Contribute significantly to the successful implementation of the Lower Hunter Regional Conservation Plan.

Conclusion & Recommendations

The detailed studies undertaken herewith have confirmed that development of a portion of the site, will provide a mechanism for adequate ecological outcomes within the proposed conservation lands for the vast majority of species and communities contained therein. The quantum of the offset lands, when viewed holistically with proximate existing and proposed conservation reserve areas, provides a robust long-term outcome for all species and communities. Furthermore, suitable actions are proposed to minimise potentially deleterious permanent and ongoing impacts to the conservation lands.

The field and desktop studies have recorded the following parameters of ecological significance within both the conservation 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.

With these potential ecological issues noted, a series of recommendations have been generated within this report, to aid in the reduction of potential impacts associated with the proposal.

Given that 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 conservation lands that have been set aside as part of the development provide sound ecological outcomes across the site. As a result of conservation of these offset lands, a large vegetation corridor will be conserved stretching from Gwandalan in the south and linking up with Wallarah National Park in the north. These conservation lands will link three state conservation reserves of Lake Munmorah State Conservation Area, Lake Macquarie State Conservation Area and Wallarah National Park. This large tract of native vegetation will provide protected habitat for a wide variety of native flora and fauna.

Therefore, it has been concluded that 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 proposed Development Estate is minimised as far as possible.

- Foremost, 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 conservation lands. As such, appropriate management plans should be prepared and implemented within the development framework in consultation with the NSW National Parks and Wildlife Service.
- The minimum amount of clearing necessary to facilitate the proposed development 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 or near those areas identified as containing vegetation consistent with EEC's.
- It is recommended that both an *Angophora inopina* and a *Tetratheca juncea* management plan be prepared to ensure the conservation and long term survival of these two threatened species within both the retained areas of the Development Estate and the conservation lands.
- Mature and / or hollow-bearing trees should be retained wherever feasible within the development framework.
- Pre-clearing inspections should be undertaken by an ecologist in wooded areas where threatened fauna species have been recorded or are considered likely to occur. This is particularly important in areas where threatened fauna have been noted during recent surveys either breeding or nest-building.
- 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 only**, 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 dominant 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.
- 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 downstream impacts are minimised 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.

Terms & Abbreviations

Abbreviation	Meaning
aff.	Affinity
CEEC	Critically Endangered Ecological Community
CMA	Catchment Management Authority
Coal & Allied	Coal & Allied Industries Ltd
Conservation OR Offset Lands	Land proposed for dedication to NSW Government
Development Estate	Proposed Development Lands
DBH	Diameter (centimetres) at Breast Height
DECCW	NSW Department of Environment, Climate Change and Water
DGEAR's	Director General's Environmental Assessment Requirements
DoP	NSW Department of Planning
EA	Environmental Assessment
EAR	Ecological Assessment Report
EEC	Endangered Ecological Community
EMP	Environmental Management Plan
<i>EPA Act</i>	<i>NSW Environmental Planning and Assessment Act 1979</i>
<i>EPBC Act</i>	<i>Commonwealth Environment Protection and Biodiversity Conservation Act 1999</i>
<i>FM Act</i>	<i>NSW Fisheries Management Act 1994</i>
ha	hectare
HBOC	Hunter Bird Observers Club
Hwy	Highway
LGA	Local Government Area
LHCCREMS	Lower Hunter and Central Coast Regional Biodiversity Strategy (NPWS 2000; House 2003)
LHRCP	Lower Hunter Regional Conservation Plan
LHRS	Lower Hunter Regional Strategy
NPWS	NSW National Parks and Wildlife Service
NSWG	NSW Government
PFC	Projected Foliage Cover
RPS	RPS Australia East Pty Ltd
ROTAP	Rare or Threatened Australian Plants (Briggs & Leigh 1995) ROTAP Codes are as follows:- 2 = Geographic Range in Australia is less than 100 km R = Rare C = Conserved - = Reserved population unknown
SEPP 14	State Environmental Planning Policy 14 "Coastal wetlands"
SEPP 44	State Environmental Planning Policy 44 "Koala Habitat Protection"
Ssp. or subsp.	Subspecies
Sp	Singular Species
Spp	Multiple Species
SSS	State Significant Site
<i>TSC Act</i>	<i>NSW Threatened Species Conservation Act 1995</i>
Var.	Variety

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DGEAR's

APPENDIX 2

Flora Species List

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Fauna Species List

APPENDIX 4

Vegetation Communities Photographs

APPENDIX 5

Qualifications of Personnel

APPENDIX 6

EPBC Act Approval

APPENDIX 7

DECC *A.inopina* Correspondance

APPENDIX 8

Justification of EPBC Approval Consistency

I Introduction

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1.1 Background

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1.2 Site Particulars

Locality – The proposed Gwandalan site is situated within land owned by Coal & Allied, on the Gwandalan peninsula. Kanangra Drive divides the site into eastern and western portions. In the southeast the site encompasses the western watershed of Mangrove Gully, while in the northeast it encompasses the watershed of Strangers Gully.

LGA – Wyong Shire Council.

Title(s) – LOT 2 DP 1043151 and LOT 57 DP 755266.

Area – The site is 268ha of which approximately 62.2ha is proposed for development and the remainder 205.8Ha) will be dedicated as conservation lands to the NSW Government (NSWG).

Zoning – Zone 7 (1) Conservation (Primary).

Boundaries – The villages of Gwandalan and Summerland Point occur to the north. Lake Macquarie State Conservation Area adjoins the south-western boundary. The eastern boundary is defined by the southwestern perimeter of Crangan Bay and in the west the site encompasses the north-eastern watershed of Tiembula Creek.

Current Land Use – Both the Development Estate lands and the conservation lands are currently vacant. They are primarily occupied by native vegetation. The general public currently utilises the lands for unauthorised motorbike and 4WD purposes.

Topography – The site is surrounded by low coastal hills, with a low northwest-southeast ridge upon which Kanangra Drive is situated. The land falls in both an easterly and westerly direction away from Kanangra Drive. To the west of Kanangra Drive, drainage flows into Tiembula Creek, which flows into Lake Macquarie. To the east of Kanangra Drive there is one unnamed creekline in the northeast of the site and in the sites lower Northeast Strangers Gully supports a small wetland and also drains east into Lake Macquarie.

1.3 Description of the Proposal

It is proposed that the entire Coal & Allied owned Gwandalan site be rezoned/listed as a 'State Significant Site' (SSS) in Schedule 3 of State Environmental Planning Policy (Major Development). A draft Schedule 3 listing will be prepared with the Concept Plan Application.

The development and conservation of the Coal & Allied land holdings, has been collectively classified into 'Southern Lands' and 'Northern Lands' (Refer to Figure 1-1). The Southern Lands encompass the Catherine Hill Bay (Middle Camp), Nords Wharf and Gwandalan Development Estates and associated Conservation Estates. Refer to Figure 1-1, Figure 1-2 and Figure 1-3.

The Concept Plan for a residential subdivision of the Gwandalan site will apply to the entire 268ha Gwandalan site. The key parameters for the proposed development of the site are as follows:

- Dedication of 205.75ha of conservation land to the New South Wales Government (NSWG) that is identified in the Lower Hunter Regional Strategy and Lower Hunter Regional Conservation Plan, comprising approximately 77% of the Gwandalan site.
- Maximum dwelling yield of 623 dwellings over 62.24ha.
- Indicative development staging. The number of lots and extent of staging for release areas will be largely dictated by the service infrastructure requirements as well as responding to market forces.
- The provision of associated infrastructure.
- Torrens title subdivision of the Gwandalan site. The Torrens title subdivision and boundary realignment of Coal & Allied land will enable land 205.75ha in area that is owned by Coal & Allied to be excised and dedicated to NSWG for conservation land.

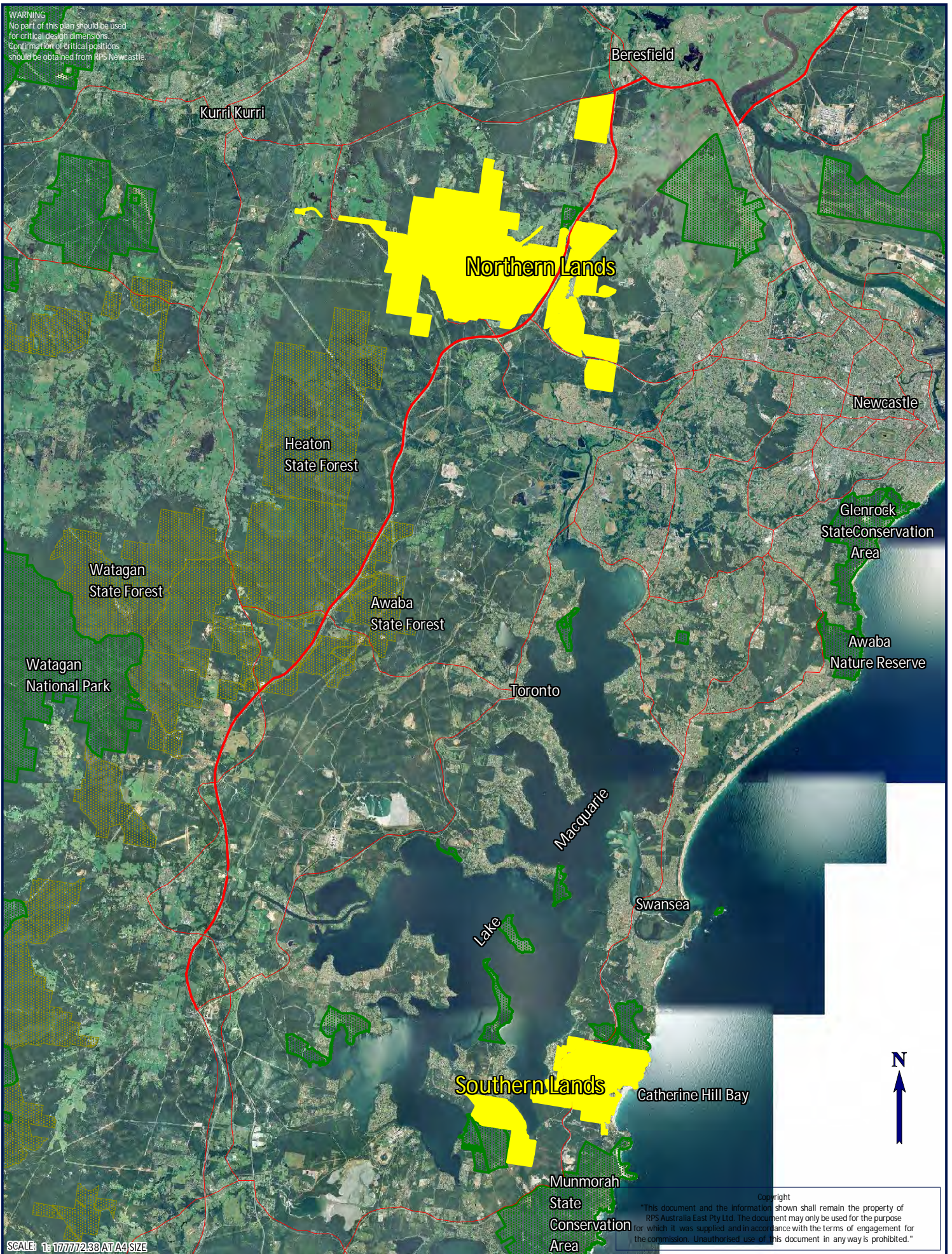
Approval will not be sought under the Concept Plan for a specific lot or road layout. An indicative lot layout will indicate how the maximum dwelling yield of 623 dwellings could be achieved on the site.

Similarly, approval will not be sought under the Concept Plan for subdivision or construction of individual houses. However, the desired future character of the proposed concept plan will be included in Urban Design Guidelines. Urban Design Guidelines will be prepared to inform the Concept Plan in respect of urban form, built form, open space and landscape, access and movement and visual impact for the site.

It is proposed to dedicate land for conservation purposes as part of the Major Project Application via a Voluntary Planning Agreement (VPA) between Coal & Allied and the NSWG in accordance with s.93F of the Environmental Planning & Assessment Act, 1979 (EP&A Act). Notably the Conservation Estates are identified in the LHRCP prepared by the DECCW and make significant contributions toward meeting conservation goals identified in the LHRCP. Refer to Figure 1-4.

A Concept Plan has been prepared for the Gwandalan site which will enable key site parameters associated with land use, infrastructure delivery and timing, and environmental conservation to be resolved up front, with subsequent detailed stages being submitted for approval progressively. Refer to Figure 1-5 and Figure 1-6

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Confirmation of critical positions
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TITLE: FIGURE 1-1 C & A SURPLUS LANDS

LOCATION: HUNTER REGION

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

DATE: 8/3/2010
PURPOSE: EAR

24\DRAWING\ECOLOGY\SOUTHERN LANDS\ALL WORKSPACES\2010
LAYOUT REF: 24530 FIG 1-1 SURPLUS LANDS
VERSION (PLAN BY): A (A.P.-M.D)

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TITLE: FIGURE 1-2 SOUTHERN LANDS

LOCATION: SOUTHERN LAND HOLDINGS

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

DATE: 10/3/2010
PURPOSE: EAR

J:\JOBS\24K\24530 HUNTER VALLEY\DRAWING\ECOLOGY\SOUTHERN LANDS
LAYOUT REF: VALL WORKSPACES\2010 NEW TEMPLATE WORKSPACES\FIG 3-1 STH LAND
VERSION (PLAN BY): A (A.P - M.D)

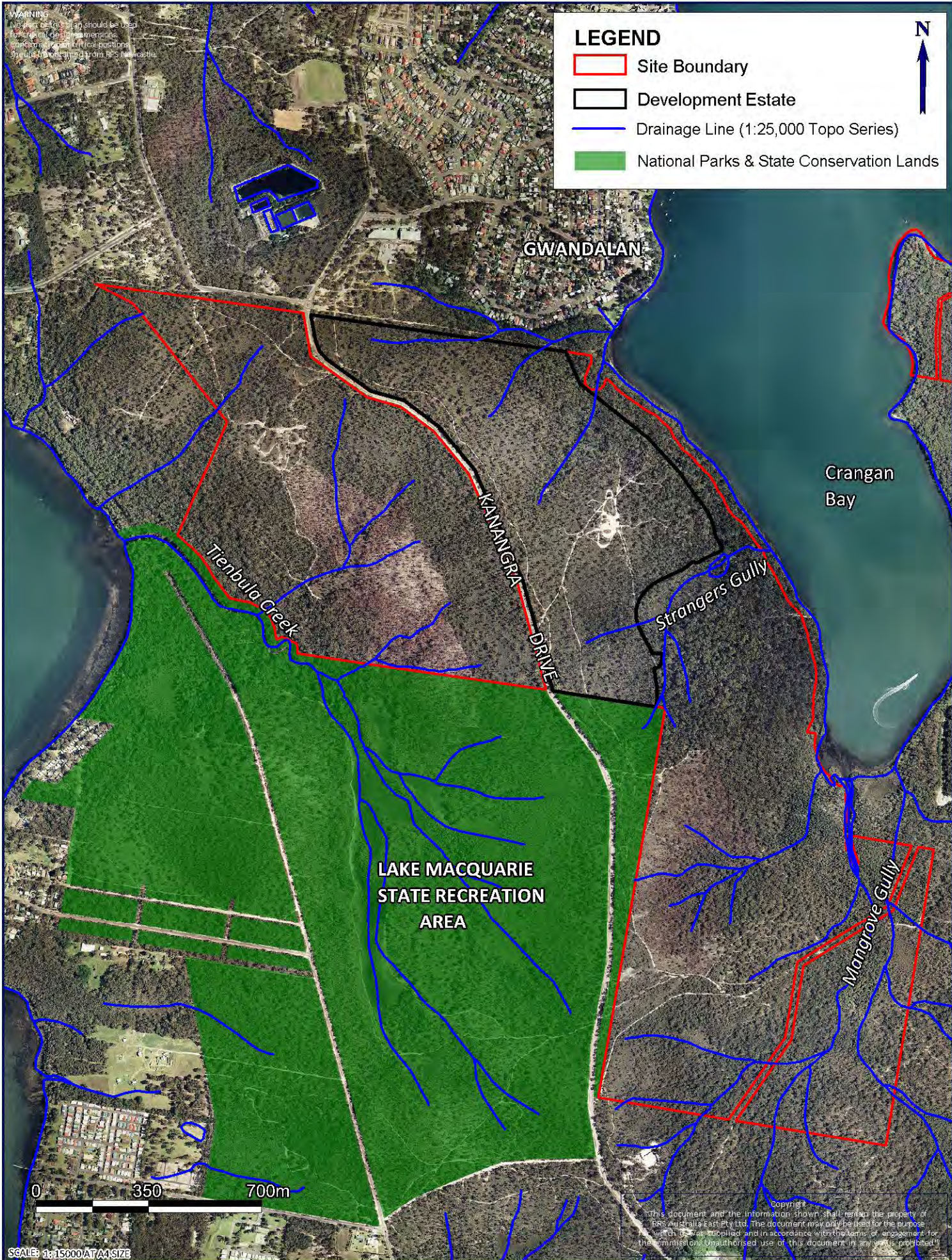
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TITLE: FIGURE 1-3 SITE LOCATION

LOCATION: GWANDALAN

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

DATE: 23/3/2010
PURPOSE: EAR

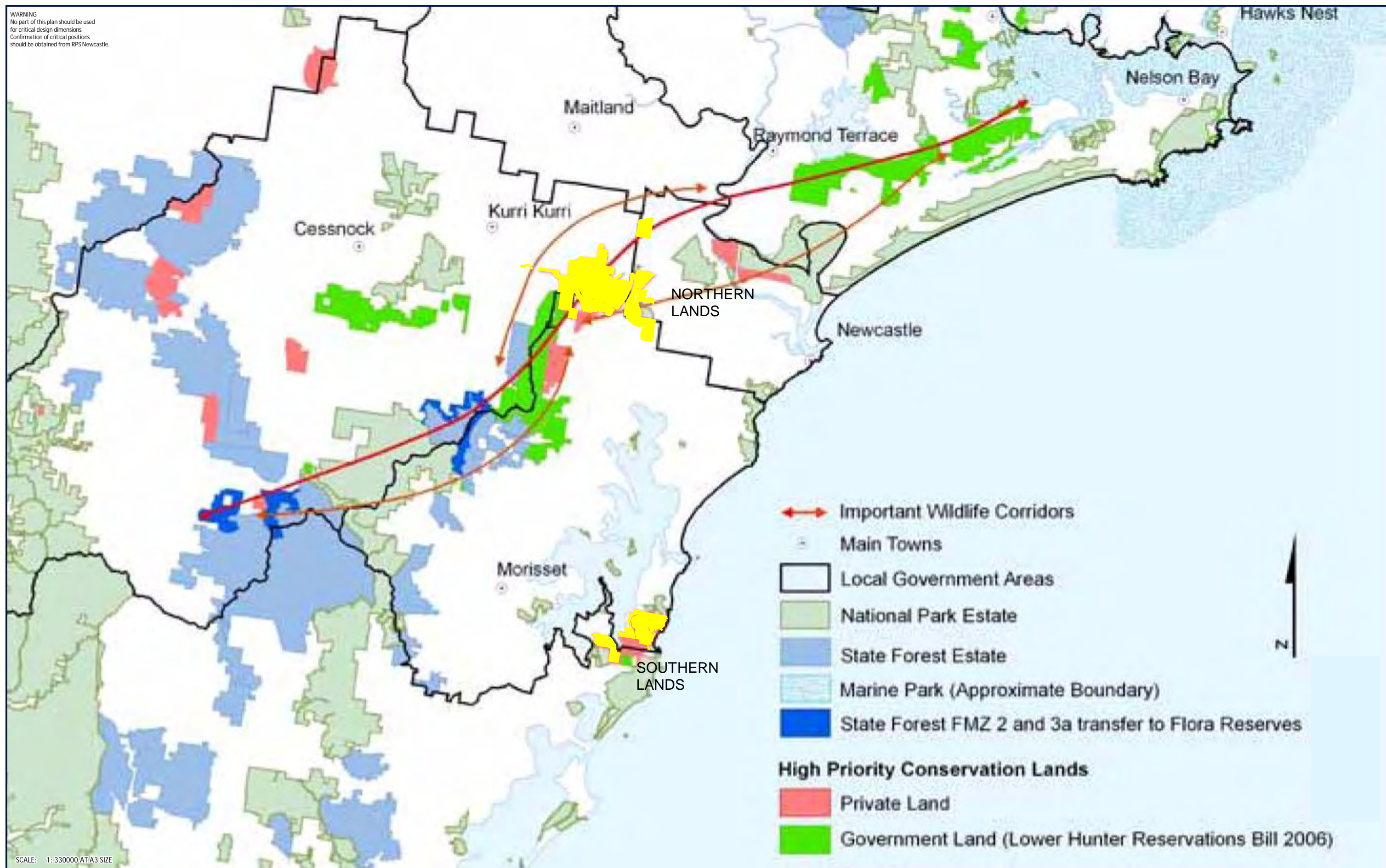
LAYOUT REF: FIGURE 1-3 SITE LOCATION A4
VERSION (PLAN BY) A (A.P-M.D)

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TITLE: FIGURE 1-4 LOWER HUNTER
REGIONAL CONSERVATION PLAN

LOCATION: HUNTER REGION

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

DATE: 1/4/2010
PURPOSE: EAR

24530\DRAWING\ECOLOGY\SOUTHERN\ALLWORKSPACES
LAYOUT REF: 2010TEMPLATE\FIGURE 1-4 LHRCP 2010 A3
VERSION (PLAN BY): A (A.P.M.D)

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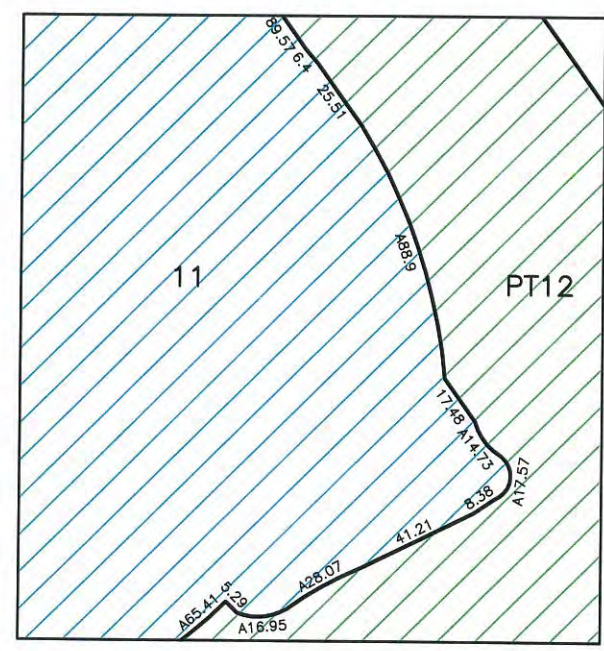
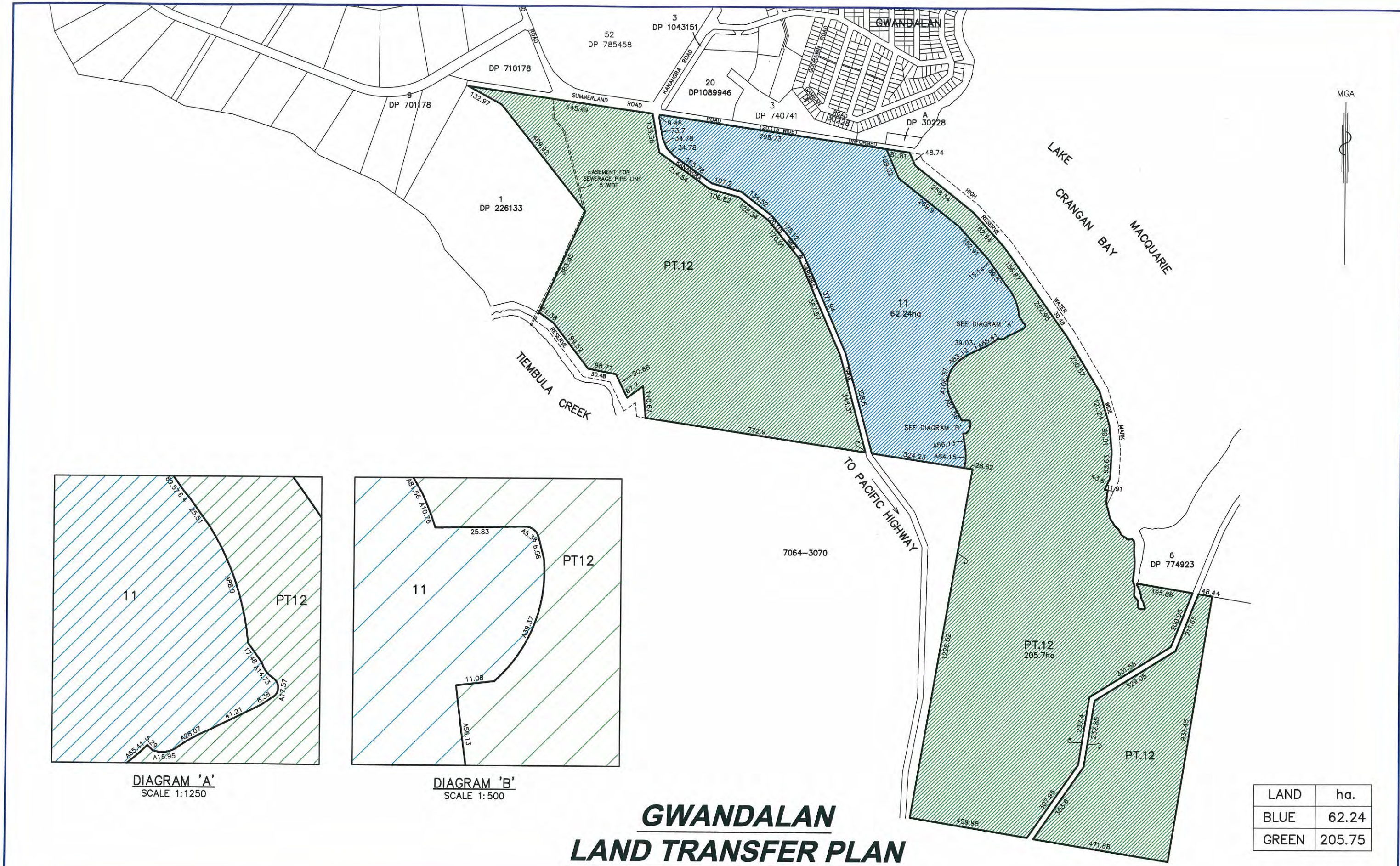


DIAGRAM 'A'
SCALE 1:1250

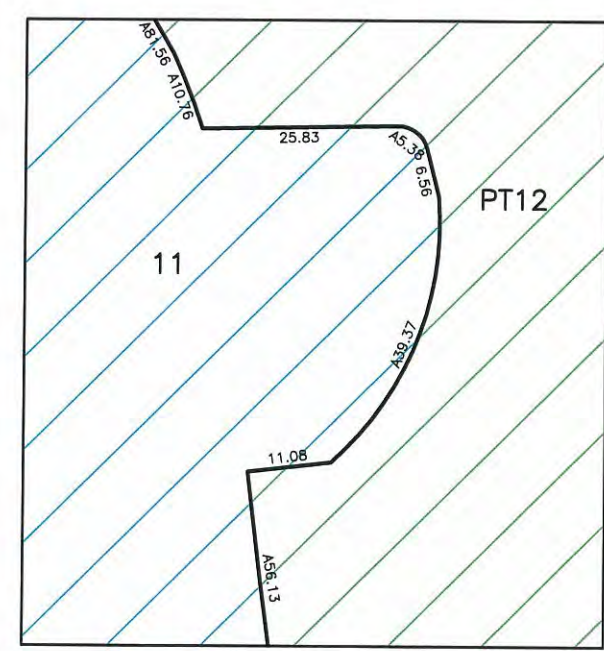


DIAGRAM 'B'
SCALE 1:500

GWANDALAN LAND TRANSFER PLAN

LAND	ha.
BLUE	62.24
GREEN	205.75

REVISIONS

C	CYPEROID HEATH REVISION TO BDY - AREAS REVISED	MAK	28/01/2009
B	REVISED AREAS	AJM	05/09/2008
No	Revision	Drawn	Date

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Surveyed	Drafted	SVET	Client
Drawn	MAK	Checked	RJM
REGISTERED SURVEYOR			Title
Scale @A1: 1:6000	Original Size		PLAN OF PROPOSED SUBDIVISION OF LOT 2 DP 1043151 AND PORTION 57 DP 7552266 KANANGRA ROAD, GWANDALAN
@A3: 1:12000	A1		
DO NOT SCALE			CAD File: 07183U.dwg

Ref No: 07/183	Date: 25/08/2008
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Sheet No. **1**
Revision **C**



Figure A1.3.1 Gwandalan Indicative Lot Layout

1.4 Scope of the Study

This EAR is intended to investigate the potential ecological impacts of the development proposal as required by the Part 3A DGEAR's. 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 Estates.

At the state level, the proposal is to be assessed pursuant to Part 3A of the EPA Act. To this end, in August 2010, the DGEAR's were issued for the site (Appendix 1).

To ensure completeness, ecological fieldwork and assessment has covered the full extent of the Coal & Allied surplus lands, including all development and Conservation Estates.

The 'Key' Assessment requirements for investigations required under the DGEAR's are:

- Identify the potential impact of the development on threatened species and their habitats having regard to the draft Threatened Species Assessment Guidelines (DEC July 2005), and outline measures proposed to avoid or mitigate impacts on threatened species and their habitat.
- Demonstrate that biodiversity impacts can be appropriately offset in accordance with the NSW Government's policy for 'improvement or maintenance' of biodiversity values.
- Address the impact of the development on wetlands identified under State Environmental Planning Policy No. 14 – Coastal Wetlands.
- Consider and identify measures to manage interface impacts on land proposed to be dedicated for conservation.
- Provide an assessment of the cumulative impacts on biodiversity of the proposed development, and other development proposed in the area, and
- Demonstrate consistency with the approval granted by the Commonwealth Department of Environment, Water, Heritage and the Arts under the Environmental Protection and Biodiversity Conservation Act 1999.

1.5 Definitions

The definitions given below are relevant to the Director-General's requirements:

'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 Estate**' refers to the area(s) scheduled for development.

The '**Conservation Lands**' refers to the area(s) scheduled for dedication to the NSW Government. Other terminology used for the '**Conservation Lands**' includes the '**Offset Lands**' or '**Dedication Lands**'.

Due to the size and separation of land holdings proposed for development and conservation, they have been broken down into two distinct geographical components. As such the sites have been condensed into the '**Southern Lands**' and '**Northern Lands**'.

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

1.6 EPBC Act 1999

In response to the DGEAR condition to demonstrate consistency with the approval granted under the EPBC Act (Refer to Appendix 6), the following should be noted:

- This assessment has been prepared in accordance with the application made to the Minister for the Environment for determination.
- To ensure consistency the threatened species, populations and ecological communities assessed within the EPBC Act Referral have been assessed herewith within Table 5-1.
- The development and conservation outcomes sought under this proposal remain consistent with those sought under the EPBC Act Referral. Refer to table 6-1.
- The habitat outcomes proposed within the EPBC Act Referral remain consistent. Refer to Table 6-2.
- The dedication of conservation Estates to the NSW Government, management under the provision of a Statement of Interim Management Intent (SIMI) and ongoing management as part of NSW NPWS Estate remain consistent.

Refer to Appendix 8 for a detailed justification of the EPBC Approval consistency.

1.7 Qualifications and Licensing

Qualifications

The principal author of this report was Matthew Doherty BLMC of RPS Harper Somers O'Sullivan Pty Ltd, with additional input from Craig Anderson BAppSc (EAM), Deborah Landenberger BSc (Hons), Allan Richardson BEnvSc (Hons), Sam Bishop BEnvSc, Emma Graham MEnvMgmt, Sarah Jones BEnvSc. GDipBPA, Anna McConville BENVSc, Robert Browne-Cooper BSc (BiolSci), and Toby Lambert BEnvSc. The academic qualifications and professional experience of all RPS ecologists involved in the project are documented in Appendix 5.

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).

1.8 Sub-consultants, Personal Communications and Observations

Sub-consultants

RPS used the following organisations during this study where appropriate input was required.

Plant Species Identification: Royal Botanic Gardens
National Herbarium of NSW
The Domain
Mrs Macquaries Road
SYDNEY NSW 2000
P: (02) 92318111

Microchiropteran Bat Analysis: Maria Adams
4110 Nelson Bay Road
ANNA BAY NSW 2316
P: (02) 4982 2350
E: mariaadams@aapt.net.au

Personal Observations

Relevant observations made by the authors or other RPS ecologists outside of the project or other published studies have been included within this report as 'personal observations' (pers. obs.).

Agency/ Group/ Organisation Consultation

The following agencies were consulted during the preparation of this EAR. (Note this list is not comprehensive).

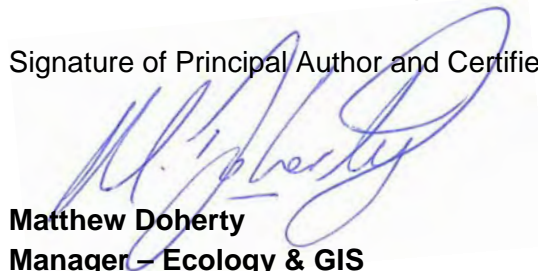
DECCW (Lucas Grenadier)	NPWS (Tom Bagnat)
WSC (Deb McKenzie)	LMCC (Robbie Economos)
Hunter-Central Rivers CMA	Hunter Environment Lobby
Lake Macquarie Coastal and Wetlands	The Newcastle Wilderness Society

1.9 Certification

As the principal author, I, Matthew Doherty 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 Australia East Pty Ltd
November 2010

2 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 investigations into the existing environment within the vicinity of the site 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.

Ecological Surveys

- Bell S.A.J. (2008) Review of flora issues relating to proposed Coal and Allied development on the Wallarah Peninsula. A report to the Department of Environment and Climate Change, NSW, March 2008.
- Conacher Travers (2004) *EPBC Referral for the Lake Sector Wallarah Peninsula NSW*.
- Conacher Travers (2006) *EPBC Referral for the Coastal Sector Wallarah Peninsula NSW*.
- Conacher Travers (2007) *EPBC Referral for the Northern Sector Wallarah Peninsula NSW*.
- DEC (2005) *Conservation Assessment of Lands South Wallarah Peninsula*.
- Harper Somers O'Sullivan (2005) *Phase One Vegetation Assessment Report, over Various Land Holdings in the Lower Hunter/Central Coast, NSW*. A report Prepared for Coal & Allied.
- RPS Harper Somers O'Sullivan (2007) *Ecological Constraints Investigations Phase 1, Over Various Land Holdings in the Lower Hunter/Central Coast NSW*. A report prepared for Coal & Allied.
- RPS Harper Somers O'Sullivan (2007) *Ecological Constraints Investigations Phase 1, Over Various Land Holdings in the Lower Hunter/Central Coast NSW – Addendum Report*. A report prepared for Coal & Allied.
- Wildthing Environmental Consultants (2003). *Ecological Constraints Study for Lot 3 DP5888206 Gwandalan NSW*. Report to Lakeside Living Pty Ltd, October 2003.
- Wildthing Environmental Consultants (2004a). *Statement of Effect on Threatened Flora and Fauna for the proposed development of Part Lot 2 DP809795 Catherine Hill Bay*. Report to Coastal Hamlets Pty Ltd, February 2004.
- Wildthing Environmental Consultants (2004b). *Statement of Effect on Threatened Flora and Fauna for the proposed development of Part Lot 2031 DP841175 Catherine Hill Bay*. Report to Coastal Hamlets Pty Ltd, February 2004.

Scientific Papers

- Barrett, G.W., Ford, H.A. and Recher, H.F. (1994). *Conservation of woodland birds in a fragmented rural landscape*. Pacific Conservation Biology 1, 245-256.
- Bell S.A.J. (2001) Notes on population size and habitat of the vulnerable *Cryptostylis hunteriana* (Orchidaceae) from Central Coast of New South Wales. *Cunninghamiana* 7(2) 195-204.
- Bell S.A.J. (2004) Distribution and Habitat of the vulnerable Tree Species *Angophora inopina* (Myrtaceae), on the Central Coast of New South Wales. *Cunninghamiana* 8(4) 477-484.
- Driscoll C. (2003) The pollination Ecology of *Tetratheca juncea* (Tremandraceae): Finding the Pollinators. *Cunninghamiana* 8(1) 133-140.
- Payne R.J. (1993) Predication of the Habitat for *Tetratheca juncea* in the Lake Munmorah Area near Wyong NSW. *Cunninghamiana* 3(1) 147-154.
- Phillips, S., Callaghan, J. and Thompson, V. (2000) The tree species preferences of Koalas (*Phascolarctos cinereus*) in the Campbelltown area south-west of Sydney, New South Wales. *Wildlife Research* 27(1): 509-516.
- Kavanagh, R. (2002). *Comparative Diets of the Powerful Owl (Ninox strenua), Sooty Owl (Tyto tenebricosa) and Masked Owl (Tyto novaehollandiae) in South-eastern Australia*. In: Newton, I., Kavanagh, R., Olsen, J. and Taylor, I. (eds)(2002). *Ecology and Conservation of Owls*, pp 175-188.
- Quin, D.G. (1995). Population Ecology of the Squirrel Glider (*Petaurus norfolcensis*) and the Sugar Glider (*P. breviceps*) (*Marsupialia* : *Petauridae*) at Limeburners Creek, on the Central North Coast of New South Wales. In: *Australian Wildlife Research* 22: pp 471-505.
- Tierney D.A. (2004) Towards an understanding of population change for the long lived resprouting tree *Angophora inopina* (Myrtaceae). *Australian Journal of Botany* 52(1) 31-38.

Vegetation Mapping Projects

- Bell, S.A.J. (1998) Lake Macquarie State Recreation Area, Pulbah Island Nature Reserve (NR) and Tingira Heights NR Vegetation Survey – A Fire Management Document, Volumes 1 and 2. Unpublished Report prepared for NSW National Parks and Wildlife Service, Hunter District by Eastcoast Flora Survey.
- Bell, S.A.J. (2002) The Natural Vegetation of the Wyong Local Government Area, Central Coast, NSW. A report prepared for Wyong Shire Council.
- Lower Hunter and Central coast Regional Environmental Management Strategy (LHCCREMS) (2000). Updated by House (2003). Lower Hunter and Central Coast Extant Vegetation. Draft Report.

Threatened Species Management Plans

- Bell S.A.J. (2001) *Distribution, Conservation and Management of the vulnerable Angophora inopina, A Technical Report and Conservation Management Plan*. A report prepared for Wyong Shire Council.
- Payne R. J. (2000) *Lake Macquarie Tetratheca juncea Conservation Management Plan, Robert Payne Ecological Surveys and Management*. An unpublished Report Prepared for Lake Macquarie City Council.
- Payne R.J. (2001) *Addendum to the Final November 2000 Tetratheca juncea Conservation Management Plan*. Robert Payne Ecological Surveys and Management and Lake Macquarie City Council.

Fauna Surveys / Reports

- Eby, P. (2001). *Surveys for roost sites/camps for the Grey-headed Flying Fox* (excel file). Surveys commissioned by the Northern Directorate of NPWS.
- Environment Australia (2001). *A Directory of Important Wetlands in Australia, Third Edition*. Environment Australia, Canberra.
- Forest Fauna Surveys (2002). *Current Status of the Squirrel Glider (Petaurus norfolcensis) in the Eleebana Area*. Draft Report (version no.4) to Lake Macquarie City Council, November 2002.
- Garnett, S. and Crowley, G. (2000). *The Action Plan for Australian Birds 2000*. Environment Australia, Canberra, ACT.
- Gibbons, P. and Lindenmayer, D. (2002). *Tree Hollows and Wildlife Conservation in Australia*. CSIRO Publishing Collingwood, Victoria.
- Hilton-Taylor, C. (compiler) (2000). *2000 IUCN Red List of Threatened Species*. IUCN, Gland, Switzerland and Cambridge, UK.
- Quin, D.G. (1993). *Sociology of the Squirrel Glider and the Sugar Glider*. PhD Thesis, Department of Ecosystem Management, University of New England.
- Recher, H.F (1995) *The conservation and management of Eucalypt forest birds: resource requirements for nesting and foraging*. Conservation of Australia's Forest Fauna. Royal Zoological Society of NSW, Mossman.
- Shortland Wetlands Consultancy (1996). *Eleebana Local Squirrel Glider Study*. Report to Lake Macquarie City Council, February 1996.
- Smith, A., Watson, G. and Murray, M. (2002). *Fauna Habitat Modelling and Wildlife Linkages in Wyong Shire*. Report to Wyong Shire Council by Austeco Environmental Consultants.
- Smith, A. (1998). *Effects of Residential Subdivision on the Squirrel Glider: Apollo Drive, Lake Macquarie City Council LGA*. Prepared by Austeco Environmental Consultants.
- Smith, A. P. (2002). *Squirrel Glider (Petaurus norfolcensis) Conservation Management Plan: Wyong Shire*. Wyong Shire Council. Wyong.
- 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
LMCC Wildlife Database

BioNet
Australian Museum Fauna Database
PlantNet
EPBC Act Database

3 Methods

The DGEAR's stipulate assessment should have due regard to DECCW'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. To this end these documents have formed the core basis for ecological assessment over the site.

For the purposes of continuity and to best represent a holistic survey approach, the guidelines considered as part of the combined survey design and efforts are as follows:

- The Flora and Fauna Survey Guidelines, Lower Hunter Central Coast Region (Murray et al 2002);
- The Flora and Fauna Survey Guidelines of the Lake Macquarie Local Government Area (July 2001);
- Flora and Fauna Guidelines for Development prepared by Wyong Shire Council (August 1999);
- Wyong Ground Orchid Survey Wyong Shire (Gunninah Environmental Consultants, 2003); and
- NSW NPWS Comprehensive Regional Assessment (CRA) Vertebrate Fauna Surveys.

3.1 Preliminary (Desktop) Assessments

Preliminary assessments drew on a number of information sources including previous preliminary reporting and information held on government databases and archives. Data gathered during preliminary assessments was used to assist in identifying distributions, suitable habitats and known records of threatened species so that field investigations could more efficiently focus survey effort. Preliminary assessment utilised a number of information sources, including:

- Vegetation Assessment Report, Harper Somers O'Sullivan (2005);
- Phase One Ecological Constraints Investigations, RPS HSO (2007);
- Aerial Photograph Interpretation (API) and literature reviews to determine the broad categorisation of vegetation within the site;
- Review of fauna and flora records contained in the DECCW Wildlife Atlas (Accessed January 2010);
- Literature reviews;
- EPBC Protected Matters Search;
- Regional vegetation mapping projects:
 - » LHCCREMS – Vegetation Survey, Classification and Mapping. (NPWS 2000, House 2003);
 - » Natural Vegetation of Wyong Local Government (Bell 2002);

- Hunter Bird Observers Club (HBOC) records;
- Birddata (web version of Birds Australia's New Atlas of Australian Birds);
- A review of GIS data including aerial photography, topographic maps, SEPP 14 Wetland Mapping, Soil Landscapes, Acid Sulphate Soil Potential;
- DECCW database of Threatened Species, Populations and Ecological Communities (website);
- Department of Environment and Water Resources (DEWHA) *EPBC Act 1999* Protected Matters Search; and
- Collective knowledge gained from extensive work in the area.

3.1.1 Survey Site Positioning & Delineation of Stratification Units

Stratification of the site was undertaken based on interpretation of Phase 1 base data, API and previous field inspections along with consideration of biophysical, vegetation structure, soil type and floristic boundaries.

Flora Stratification Units

The DECCW Biodiversity Survey Guidelines were consulted to determine survey requirements for large sites. These guidelines suggest that area should be initially stratified on biophysical attributes (e.g. soil, geology) followed by vegetation structure (e.g. Woodland, Forest, Shrubland) and then floristics i.e. species. Within the Gwandalan site four vegetation structures of Dry Open Forest, Coastal Wet Sclerophyll Forest, Cyperoid Heath and Freshwater Wetlands exist. However due to previous preliminary mapping (HSO 2005), these stratification units were able to be further delineated into eight stratification units. While ground-truthing was ongoing, amendments were made and thus some stratification units were dismissed as not occurring within the site and some new ones were created. Amendments to the survey effort were based on the area of the communities and thus the number of quadrats and transects were increased to ensure that all stratification units were surveyed across the site. A total of nine stratification units were delineated within the Gwandalan site.

Fauna Stratification Units

The DECCW Biodiversity Survey Guidelines were consulted to determine survey requirements for large sites. From these guidelines the requirement to reduce a site into stratification units based on area and the need to represent variation in vegetation communities across a site was derived. Stratification units designated for each trapping transect were defined by encompassing each vegetation community identified within the site and additional transects were added for every 100ha of community.

The site encompasses approximately 268ha and eight vegetation communities. Two of the vegetation communities, being, Mangrove Estuarine Complex and Coastal Wet Sand Cyperoid Heath were either, not of sufficient extent (some linear) to support threatened fauna species in isolation, were too wet in nature for trapping purposes or they did not conform to habitat which might be highly suitable to locally occurring mammal species. For these reasons dedicated trapping transects were not allocated to those communities, but trapping transects were located within other habitats in their vicinity. Due to the small

area of some vegetation communities represented within the Gwandalan site, each of six transects represented approximately 45ha.

3.1.2 Preliminary Vegetation Assessment

A variety of field survey techniques were employed over the course of fieldwork for this assessment to target the full suite of flora species and fauna guilds across the site. Nomenclature and classification of delineated vegetation communities followed the LHCCREMS Vegetation Community Mapping (NPWS 2000: House 2003) wherever those communities were commensurate with those encompassed by LHCCREMS mapping. However, where vegetation communities within the site differed from any described by LHCCREMS (NPWS 2000: House 2003), vegetation communities described by the Natural Vegetation of the Wyong Local Government Area (Bell, 2002) were used.

3.2 Field Investigations

3.2.1 Vegetation Mapping

Flora surveys and vegetation mapping carried out on the site 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 preliminary environmental studies conducted by HSO (2005) & RPS HSO (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);
- Flora surveys were carried out across the site, with an emphasis on potentially significant species, as outlined below. The general flora survey also included 14 – [20m X 20m] quadrats, 1 – [10 m X 40 m] quadrats and 8 – [100 m] transects throughout the native vegetation within the site, as well as approximately 12 hours of Random Meanders in line with methodology identified as the “Random Meander Technique” by Cropper (1993);
- Map the type and general extent of the community(s) present into definable map units where appropriate; and

- 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.

3.2.2 Plant Identification

It is unrealistic to expect to identify all species from all sites. During this survey when a plant could not be identified accurately within the field, a voucher sample was collected, together with notes on habitat, form and height, labelled and identified according to nomenclature in Harden (1992 – 2002). Opportunistic sightings of taxa were also collected if they were not found in any of the sampled sites. At a minimum, all dominant species were identified in all strata to ensure that an informed delineation resulted. All flora species recorded are documented in Appendix 2.

Voucher specimens were forwarded to Royal Botanical Gardens, Sydney, for verification of potential threatened flora species considered as difficult to separate from common flora species.

3.2.3 Landform and Geophysical Information

Topographic information was collected along with measurements of altitude, slope and aspect. Slope was determined from a slope map, which was derived from 2 m contours for the entire site. Aspect was measured using a Sunto compass with reference to magnetic north. Information on geology, soils, fire and other disturbances were collected on NPWS survey data sheets. Site location was recorded in eastings and northings using Map Grid of Australia (GDA 94) Zone 56 co-ordinated system on a Trimble GEO XT GPS, which has sub-metre accuracy following post-processing.

3.2.4 Floristic Structure Information

Vegetation structure was determined based on Specht *et al*, (1995) by estimation of the height and projected foliage cover (PFC) within each stratum present. Individual taxon data for each quadrat/transect was recorded using the NPWS species data forms. Species abundances were recorded utilising a modified Braun-Blanquet (1982) cover abundance six ranking scale as follows:

Cover Code	Projected Canopy Cover
1	<5% and uncommon
2	<5% and common
3	6-20%
4	21-50%
5	51-75%
6	76-100%

3.2.5 Significant Flora Survey

A list of potentially occurring significant flora species from the locality (10km radius) was compiled, which included, threatened species (Endangered or Vulnerable) and EEC listed under the *TSC Act (1995)*, those species listed on the *EPBC Act (1999)*, ROTAP listed flora species (Briggs and Leigh 1996), as well as any other species deemed to be of local importance.

Based on the environmental units and vegetation communities present, targeted searches were conducted for those species deemed as having the potential to occur on the site. Targeted searches were undertaken throughout the site for these species during the survey period (with the exception of *Cryptostylis hunteriana*). Refer to Table 3-1 for the flowering period of those flora species, which have potential habitat within the Gwandalan site.

3.2.6 Orchid Surveys

A review of the Wyong Ground Orchid Survey (Gunninah 2003) has revealed that the following threatened and some undescribed orchids have potential habitat within the Gwandalan site (Refer to Table 3-1 for seasonal survey details):

- *Caladenia porphyrea*;
- *Caladenia* sp. aff. *catenata* A (sp. complex);
- *Diuris* sp. aff. *aurea* / *Diuris* sp. aff. *chrysantha*;
- *Genoplesium rupprii*;
- *Petalochilus curtisepalus*;
- *Thelymitra* sp. aff. *pauciflora*; and
- *Thelymitra* aff. *nuda* X *Thelymitra pauciflora*.

Table 3-1: Threatened Flora and Rare Orchid Species Survey Techniques Analysis

Threatened Flora Species	TS C listed	EP BC listed	Habitats (But not confined to) Map units REMS	Targeted Survey Notes (LHCC Flora and Fauna Survey Guidelines 2002)	Flowering Period (Best time to Survey) in Months of the Year											
					J	F	M	A	M	J	J	A	S	O	N	D
<i>Acacia bynoeana</i>			26, 30, 31, 48	Rm, Safr.												
<i>Angophora inopina</i>			30, 31, 40, 48	Rm, Sa.												
<i>Caladenia porphyrea</i>	E	-	31	Rm												
<i>Caladenia</i> sp. aff. <i>catenata</i> A (sp. complex)	-	-														
<i>Caladenia tessellata</i>	V	V	34	Rm, Sfr. Recently burnt areas of note.												
<i>Callistemon linearifolius</i>	V	-	25, 37	Rm, Sa.												
<i>Cryptostylis hunteriana</i>	V	V	30, 31, 32, 33	Rm or Rq, Sfr.												
<i>Cynanchum elegans</i>	E	E	6	Rm, Sa.												
<i>Dendrobium melaleucaphilum</i>	V	-	Alluvial, <i>Melaleuca styphelioides</i>	Rm - epiphytic orchid <i>M. styphelioides</i> of note, Sa.												
<i>Diuris</i> sp. aff. <i>aurea</i> / <i>Diuris</i> sp. aff. <i>chrysantha</i>	-	-														
<i>Diuris praecox</i>	V	V	15, 30, 51	Rm, Sfr.												
<i>Eucalyptus camfieldii</i>	V	V	26, 29, 29a, 34, 44, 48a, 50	Rm -lateritic soils of note, Sa.	Flowers throughout the year											
<i>Genoplesium insignis</i>	E	-	31	Rm, Sfr.												
<i>Genoplesium rupprii</i>	-	-	31	Rm												
<i>Microtis angusii</i>	E	E	31	Rm, Sfr.												
<i>Petalochilus curtisepalus</i>	-	-	31	Rm												
<i>Rulingia prostrata</i>			40, 37, 42a, 46	Rm, Sa												
<i>Syzygium paniculatum</i>			1,4,5,6,50	Rm, Sa (flowering specimens preferential for ID)												
<i>Tetratheca juncea</i>			5, 11, 15, 17, 30, 31, 34, 34a, 37, 40a, 43, 44, 48	Rm – creekflat to ridgetop. Sfr - two surveys are required; spaced two months apart.												
<i>Thelymitra</i> sp. aff. <i>pauciflora</i>				Rm												
<i>Thelymitra</i> sp. aff. <i>nuda</i> X <i>Thelymitra pauciflora</i>				Rm												

Rm = Random meander, Rq = Replicated Quadrats, Sa = Survey anytime, Safr = Survey anytime, flowering period recommended, Sfr = Survey within flowering period required.

3.2.7 Targeted Flora Survey Methodology

Seasonal surveys were undertaken to maximise detection of all threatened flora species (Table 3-1). The following sections detail specific targeted surveys, which were undertaken for each species.

Angophora inopina

Two qualified ecologists undertook targeted searches (Refer to Table 3-3 for survey dates) within the Gwandalan site. Survey methodologies involved random meander method (Cropper 1993), particularly undertaken over lands on Doyalson soil landscape. The initial survey involved mapping of the extant population, within both the Development Estate and the offset lands. The second survey involved the recording of individuals by the use of a Trimble GeoXH GPS with sub-metre accuracy. Mapping of individual *A. inopina* trees follows field recording techniques, which delineated isolated individuals as point data and stands of individuals as area data. Notes on whether mature trees were setting seed was not taken as the trees were not flowering at the time of the survey, and the main flowering period for this species is in December to January (Bell, 2001).

Diuris praecox

Two ecologists undertook targeted searches (Refer to Table 3-3 for survey dates) within potential habitat within the Development Estate at Gwandalan. These areas included the open forest areas within the Coastal Plains Scribbly Gum Forest and the Coastal Sheltered Apple-Peppermint Forest. Parallel transects which were spaced at approximately 25 m intervals were utilised for searches across the survey area. The locations of all individuals were recorded by the use of a Trimble GeoXH GPS with sub-metre accuracy.

Tetradlea juncea

Six ecologists undertook targeted *Tetradlea juncea* searches. Refer to Table 3-3 for survey dates. Parallel transects were utilised (Cropper, 1993) and were spaced at 10 to 15m intervals. The area surveyed included the entire Development Estate, and partial survey of the offset lands to the south of the Development Estate (Refer to Figure 4-3 for area surveyed). These transects were performed from creekline to ridgetop as recommended by Payne (2000). The standardised method as set out by Payne *et al.* (2002) for counting *Tetradlea juncea* clumps involves the delineation of each plant clump by a distance of 30cm. The locations of all individuals were recorded by the use of a Trimble GeoXH GPS with sub-metre accuracy.

Other Cryptic Orchids

Several cryptic orchid species have potential habitat within the Gwandalan site. The majority of the orchids, which have potential habitat, flower in September and these flowering periods coincide with the flowering period for *Tetradlea juncea*. Therefore whilst these surveys were being undertaken these orchids were also targeted. The following orchids were surveyed during the targeted orchid surveys:-

- ***Caladenia porphyrea*;**
- *Caladenia* sp. aff. *catenata* A (sp complex)*;

- ***Caladenia tessellata* (Thick Lip Spider Orchid);**
- *Diuris* sp. aff. *aurea*/ *Diuris* sp. aff. *chrysantha**;
- ***Genoplesium insignis* (Variable Midge Orchid);**
- *Genoplesium ruppii*;
- ***Microtis angusii* (Angus's Onion Orchid);**
- *Petalochilus curtisepalus*;
- *Thelymitra* sp. aff. *pauciflora**; and
- *Thelymitra* aff. *nuda* X *Thelymitra pauciflora**.

Several of the above orchids (marked with an asterisk “*”) are undescribed and are not listed on the TSC Act (1995) or the EPBC Act (1999) but are considered to be regionally rare by Wyong Shire Council. As several of these orchids are undescribed it would be difficult to ascertain their presence within the site. However it must be noted that the site provides potential habitat for these undescribed orchids. Note: species that are listed in the TSC Act 1995 and/or the EPBC Act 1999 are bolded in the above list.

Other Threatened Flora Species

The remaining threatened flora species were also surveyed for opportunistically whilst performing the initial vegetation survey and during the *Tetradlea juncea* targeted searches. The following species were surveyed for:-

- *Acacia bynoeana*;
- *Callistemon linearifolius*;
- *Dendrobium melaleucaphilum*;
- *Eucalyptus camfieldii*;
- *Melaleuca biconvexa*; and
- *Syzygium paniculatum*.

3.2.8 Fauna Assessments

The fauna survey methodology initially consisted of the production of an Expected Fauna Species List for the area (Appendix 3) and an assessment of the potential use of the site by threatened fauna species (as listed under the TSC Act 1995 and EPBC Act 1999) identified from the vicinity of the site. This was achieved by undertaking literature and database reviews followed by confirmation through targeted field surveys. Additional species observed were also noted on the list.

Diurnal Birds

General and targeted searches were undertaken across the entire site during the survey period.

Trap lines were targeted as survey locations within the site through incidental observations during trapping, and targeted bird census surveys were undertaken for a period of 20 minutes at each survey site on at least 2 separate mornings.

Surveys included targeted searches for threatened species listed as having potential to occur within the site, including the seasonally occurring Swift Parrot and Regent Honeyeater. Targeted searches for Glossy Black Cockatoo were undertaken that included searches for chewed (*Allo*) *Casuarina* cones indicative of past feeding by this species.

For diurnal surveys, emphasis was placed on peak activity periods, i.e. dawn and dusk, to maximise chances of species encountered. Birds were identified by direct observation, by recognition of calls or distinctive features such as nests, feathers etc. Furthermore, whenever other survey work was conducted, during both diurnal and nocturnal day periods, opportunistic observations of those bird species encountered were recorded.

Targeted Swift Parrot Surveys

Swift Parrot surveys were undertaken within proposed Conservation Lands and Development Estate in June 2008. The survey period coincided with known Swift Parrot movements into south-eastern Australia. Surveys encompassed two different methodologies to ensure adequate coverage of potential Swift Parrot habitat was made, and included:

- Targeting of small discrete vegetation community areas containing potential foraging species, such as occur in riparian zones; and
- Traverses through more widespread foraging habitat to locate indicators (foraging aggregations of Honeyeaters / Lorikeets or the presence of blossom) that specific areas may have the potential to attract Swift Parrots during the current season.

As a component of the survey and in lieu of surveys across the entire Swift Parrot season, habitat evaluation was also undertaken to determine if and where the most favourable areas of potential Swift Parrot habitat occur across the Coal & Allied Lands

Nocturnal Birds

Pre-recorded calls of owl species with the potential to occur within the site were broadcast in an effort to elicit vocal responses from the owls or to attract an owl to the playback site. The calls were broadcast through an amplification system (loud haler) designed to project the sound for at least 1km under still night conditions. As described by Kavanagh and Peake (1993), Debus (1995), and NPWS (1997), the call of each species was broadcast for at least five minutes, followed by five minutes of listening, and stationary spotlighting. Following the final broadcast and listening, the area was spotlighted on foot. Species censused included *Ninox strenua* (Powerful Owl), *Ninox connivens* (Barking Owl), *Tyto tenebricosa* (Sooty Owl) and *Tyto novaehollandiae* (Masked Owl). Nocturnal surveys were carried out across the site over a period of five continuous nights. The callback locations were selected in areas where calls could be broadcast across large areas of the site. The broadcast location selection process was also informed by survey stratification units.

Arboreal and Terrestrial Mammals

A total of 6 Trap lines were set for a period of four nights during July 2007 (Table 3-3). Trap lines consisted of 25 Terrestrial Elliot A traps, 5 Terrestrial Elliot B traps, 5 Arboreal Elliot B traps, 5 Terrestrial Elliot E traps and a Cage Trap. This equates to 100 Terrestrial Elliot A trap nights, 20 Terrestrial Elliot B trap nights, 20 Arboreal Elliot B trap nights, 20 Terrestrial Elliot E trap nights and 4 Cage trap nights per trap line. In addition to this, targeted Koala and Quoll surveys were also conducted. In addition to this, targeted Koala and Spotted-tail Quoll surveys were conducted within the site and are outlined below.

Spotlighting was undertaken on site via the use of 75-Watt hand-held spotlights and head torches during walking. This was undertaken within each of the habitat assemblages identified, with priority given to those areas that were deemed most likely to contain nocturnal species, particularly arboreal and terrestrial mammals. Two ecologists undertook nocturnal surveys concurrently for a duration of four hours per night over five consecutive nights, giving a total of forty hours of spotlighting.

The potential presence of Yellow-bellied Glider was targeted by call playback through an amplified system at each of the nocturnal survey points during the fieldwork period.

Targeted Koala Surveys

Targeted Koala surveys were undertaken within both the proposed Development Estate and Conservation Lands within the Site.

Areas containing Koala feed tree species at densities greater than 15% are deemed to be areas of "Potential Koala Habitat" as set out within the guidelines of State Environmental Planning Policy 44 (SEPP 44) "Koala Habitat Protection". Vegetation mapping data obtained during the Flora and Fauna Assessment of the site, was used to identify areas where potential Koala habitat may exist, based on the occurrence of the Koala feed tree species including *Eucalyptus robusta*, *E. haemastoma*, *E. signata* and *E. tereticornis*. In particular, those areas containing potential feed tree species and occurring in close proximity to drainage lines where tree foliage densities are greater were included within surveys. Within potential habitat areas, searches were conducted via random meander technique to locate patches of known Koala feed tree species occurring at densities greater than 15% foliage cover.

Spot Assessment Technique (SAT)

The SAT is a technique developed to generate a measure of Koala activity in a given area. The SAT generates this by determining Koala activity in an area by counting the number of Koala faecal pellets occurring within a given area. Areas to be surveyed are selected by locating a tree that is utilised by Koalas, or a tree that is determined to be potentially important to Koalas, then faecal pellets are counted around that tree and thirty proximate trees with a diameter at breast height of over 100mm. During this survey no trees were found to exhibit conclusive evidence (faecal pellets and other signs) that Koalas had been present, so prominent feed tree species occurring within "Potential Koala Habitat" were selected as the centre tree around which the SAT was performed. Signs of Koala activity that were targeted as indicators that Koalas were present included the presence of:

- Koala scats below trees;
- Koala claw marks on trees; and
- Individual Koalas within trees.

All Random Meander locations and SAT points were recorded using a real-time GPS data logger

Targeted Spotted-tail Quoll Surveys

Targeted Spotted-tailed Quoll surveys were undertaken within both the proposed Development Estate and Conservation Lands within the Site. A combination of passive (hair-tube/ scat search and analysis) and non-passive (cage trap) surveying methodologies were employed to maximise the chances of survey success.

Habitat within the site encompasses a moderately diverse range of vegetation communities due to a range of different topographic features occurring within the site. Wooded areas cover a wide range of forms from stunted dry woodlands occurring upon the site's dry ridges, through dry open forest habitats on the lower slopes and near lake flats to swamp sclerophyll vegetation communities occurring on the lower reaches of the site's drainage lines. In light of the relatively secretive habits of this species and its reported avoidance of developed areas, potential trapping survey sites were selected within those vegetation communities exhibiting more complex structural diversity and higher densities of understorey vegetation and forest debris. Those habitats considered to most closely align with these criteria were found to occur within, open forest communities, riparian vegetation and lower reaches of the site's drainage lines. Based on the above criteria, seven areas were selected for trapping survey purposes.

Hair Tube Traps

Within each of the seven survey sites five hair tube traps were installed giving a total of 35 hair traps. Traps were baited with sardines. The location of each trap was recorded using GPS data logger (Figure 3-1). Hair traps were set for a total of 12 nights yielding a total of 420 hair trap nights. Hair samples collected were analysed for species identification (Table 4-4).

Scat Searches

Searches were made throughout the site for Quoll scats. If these were found, their location was recorded and a sample of the scat was taken for analysis.

Cage Traps

Within six selected survey sites occurring to the east of Kanangra Drive a total of 15 cage traps were set over a period of four nights, yielding a total of 60 cage trap nights. Three survey sites occurring within the proposed Development Estate were surveyed with three cage traps each and the remaining three sites occurring within conservation lands were surveyed with two cage traps each. The results are presented in (Table 4-4).

Opportunistic sightings of secondary indications (scratches, scats, diggings, tracks etc.) of resident fauna were noted. Such indicators included:

- Distinctive scats left by mammals. Any scats unable to be positively identified in the field were collected for further analysis, and scats of predator species containing fur / bones were sent for analysis if appropriate;
- Scratch marks made by various types of arboreal animals;
- Scats consistent with Koalas;
- Feeding scars on *Eucalyptus* trees made by Gliders.

Any other incidental observations of fauna were recorded during all phases of fieldwork. Refer to Figure 3-1: Fauna Survey Locations

Micro-chiropteran Bats

Bat echolocation call recording was undertaken across the site within each stratification unit over the survey period for a total duration of 80 hours.

Bat echolocation calls were recorded using an Anabat II Bat Detector. Emphasis was placed on those areas deemed likely to provide potential hunting sites for bats, including flyways, ecotones, forested areas and waterbodies. Anabat call detection was undertaken during trapping periods and nocturnal fieldwork and was carried out via both stationary and mobile forays. The recorded calls were given to a recognised expert in bat species call identification for analysis.

Mega-chiropteran Bats

These species, specifically the Grey-headed Flying Fox, were surveyed via targeted searches for suitable camp and / or day roost locations. Surveys for primary and secondary indications for this species were undertaken during both diurnal and nocturnal surveys.

Herpetofauna

Specific herpetofauna (frog and reptile) searches were carried out at each of the survey points and significant habitat areas present. Diurnal searches were made in areas of appropriate habitat. Such habitat included areas of thicker vegetation, in ground litter, near and under fallen timber, around piles of refuse / dumped rubbish, and wet / damp areas such as drainage lines and areas of poor infiltration capacity and / or periodic inundation.

Reptile searches were largely concentrated to the hottest part of the day (early afternoon). Frog searches were largely concentrated to nocturnal survey periods and/or periods of wet weather. Physical frog searches were augmented by call recognition. Any calls unable to be clarified in the field were recorded for later comparison with commercially available recordings.

3.2.9 Habitat Assessments

An assessment of the relative value of the habitat present on the site was carried out. This assessment focused primarily on the identification of specific habitat types and resources on the site favoured by known threatened species from the region.

Key features assessed for flora habitat included vegetation type and stratification, soil type, depth and drainage, landform pattern, aspect and past disturbance including fire regime. Habitat key features assessed for fauna type at each survey point included hollow bearing tree density, feed tree density, diversity and density of Proteaceae species, Eucalypt diversity, vegetation strata number and density of dead wood debris across the ground as outlined in Table 3-2 below. The assessment also considered the potential value of the site (and surrounds) for all major guilds of native flora and fauna.

Table 3-2: Ecological / Environmental Attributes Collected within Flora Survey Points

Feature	Variables	Value
Hollow Bearing Tree Density	<ul style="list-style-type: none"> Low Density Moderate Density High Density 	Determine the density and distribution of denning and roosting habitat for native fauna species across the site.
Eucalypt diversity	<ul style="list-style-type: none"> Low Density Moderate Density High Density 	Determine the diversity of Eucalypt feeding opportunities for native fauna species across the site.
<i>Allocasuarina</i> sp.	<ul style="list-style-type: none"> Low Density Moderate Density High Density 	Determine the density and distribution of this habitat resource across the site, particularly as a forage plant species for Glossy Black-Cockatoo.
<i>Proteaceae</i> sp.	<ul style="list-style-type: none"> Low Density Moderate Density High Density 	Determine the density and diversity of Proteaceae species across the site, as an indicator of winter foraging resources for threatened arboreal mammals, such as the Squirrel Glider and potentially the Pygmy Possum.
Structural Diversity	<ul style="list-style-type: none"> Low (1 layer) Moderate (2 layers) High (3+ layers) 	A measure of habitat quality across the site, particularly as an indicator of microhabitat diversity and niche opportunity for bird species, potential threatened terrestrial mammals and the prey species of forest owls.
Fallen Timber	<ul style="list-style-type: none"> Low (few or none) Moderate (scattered) High (intact) 	A measure of habitat quality across the site, particularly as an indicator of microhabitat diversity and niche opportunity for bird species, potential threatened terrestrial mammals and the prey species of forest owls.

The assessment was also based on the specific habitat requirements of each threatened fauna species in regards to home range, feeding, roosting, breeding, movement patterns and corridor requirements. Consideration was given to contributing factors including topography, soil, light and hydrology for threatened flora and assemblages.



TITLE: FIGURE 3-1 FAUNA
SURVEY LOCATIONS

LOCATION: GWANDALAN

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

DATE: 23/3/2010
PURPOSE: EAR

LAYOUT REF: FIGURE 3-1 FAUNA
SURVEY LOCATIONS A-A4
VERSION (PLAN BY) A (A.P.-M.D)

CLIENT: Coal & Allied Industries Ltd
JOB REF: 24530-1

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

3.3 Survey Dates, Type and Prevailing Conditions

The following table depicts the dates, survey type and prevailing weather during the ecological investigations conducted during the survey period.

Table 3-3: Survey Dates, Type and Prevailing Weather

DATE	SURVEY TYPE	WEATHER					
		Temperature	Rain (24 hrs to 9:00am)	Sun		Moon	
				Rise	Set	Rise	Set
Vegetation							
28/06/07	Quadrat and Transect Survey Random Meander Survey	6 – 12 ⁰ C	0mm	06:57	16:56	14:36	04:45
29/06/07	Habitat Assessment	9 – 15 ⁰ C	1mm	06:58	16:56	15:25	05:44
18/07/07	Quadrat and Transect Survey	3 – 12 ⁰ C	0mm	06:54	17:06	9:11	20:51
19/07/07	Random Meander Survey	6 – 12 ⁰ C	0mm	06:53	17:06	9:37	21:47
20/07/07	Habitat Assessment	6 – 12 ⁰ C	0mm	06:53	17:07	10:01	22:43
6/08/07	Targeted <i>Angophora inopina</i> surveys	6 – 18 ⁰ C	0mm	06:41	17:18	00:01	10:42
28/08/07	Targeted <i>Diuris praecox</i> surveys	9 – 24 ⁰ C	0mm	06:17	17:33	17:21	06:02
30/08/07		12 – 24 ⁰ C	0mm	06:15	17:34	19:38	07:03
20/09/07	Targeted <i>Tetratheca juncea</i> and cryptic orchid surveys ¹	12 – 18 ⁰ C	0mm	05:47	17:48	10:39	01:02
21/09/07		9 – 18 ⁰ C	1mm	05:45	17:49	11:39	01:53
24/09/07		9 – 24 ⁰ C	0mm	05:41	17:51	14:58	03:56
27/09/07		12 – 27 ⁰ C	0mm	05:37	17:53	18:27	05:31
28/09/07		9 – 27 ⁰ C	0mm	05:36	17:53	19:40	06:03
02/10/07		12 – 27 ⁰ C	0mm	05:31	17:56	-	09:03
03/10/07		9 – 33 ⁰ C	0mm	05:29	17:57	00:26	10:05
27/09/07	Targeted <i>Angophora inopina</i> surveys	12 – 27 ⁰ C	0mm	05:37	17:53	18:27	05:31

DATE	SURVEY TYPE	WEATHER					
		Temperature	Rain (24 hrs to 9:00am)	Sun		Moon	
				Rise	Set	Rise	Set
Trapping							
16/07/07	Trapping Lines (1 – 6)	0 – 12 ⁰ C	0mm	06:55	17:05	08:11	18:48
17/07/07		0 – 12 ⁰ C	0mm	06:54	17:05	08:43	19:51
18/07/07		3 – 12 ⁰ C	0mm	06:54	17:06	09:11	20:51
19/07/07		6 – 12 ⁰ C	0mm	06:53	17:06	09:37	21:47
Fauna Surveys							
28/06/07	Diurnal opportunistic	6 – 12 ⁰ C	0mm	06:57	16:56	14:36	4:45
10/07/07		6 – 12 ⁰ C	10mm	06:56	17:01	02:19	12:43
11/07/07		6 – 15 ⁰ C	0mm	06:56	17:02	03:31	13:29
12/07/07		3 – 15 ⁰ C	0mm	06:56	17:02	04:42	14:24
13/07/07		3 – 15 ⁰ C	0mm	06:56	17:03	05:47	15:27
16/07/07	Diurnal Opportunistic Diurnal Bird Survey – Trapping Lines (3, 4, 5, 6) Diurnal Herpetological Survey	0 – 12 ⁰ C	0mm	06:55	17:05	08:11	18:48
17/07/07		0 – 12 ⁰ C	0mm	06:54	17:05	08:43	19:51
18/07/07		3 – 12 ⁰ C	0mm	06:54	17:06	09:11	20:51
19/07/07		6 – 12 ⁰ C	0mm	06:53	17:06	09:37	21:47
29/07/07	Diurnal Bird Survey Diurnal Herpetological Survey – Trapping Lines (3, 4, 5, 6) Nocturnal Survey	3 – 15 ⁰ C	0mm	06:47	17:13	16:15	06:13
30/07/07	Diurnal Bird Survey Diurnal Herpetological Survey – Trapping Lines (1, 2) Nocturnal Survey	3 – 15 ⁰ C	0mm	06:47	17:13	17:23	06:55
31/07/07	Diurnal Herpetological Survey Nocturnal Survey	3 – 18 ⁰ C	0mm	06:46	17:14	18:31	07:31
1/08/07	Diurnal Bird Survey Diurnal Herpetological Survey – Trapping Lines (1, 2) Nocturnal Survey	6 – 21 ⁰ C	0mm	06:45	17:15	19:38	08:04
2/08/07	Diurnal Bird Survey (4, 6) Diurnal Herpetological Survey – Trapping Lines (4, 6) Nocturnal Survey	12 – 24 ⁰ C	0mm	06:44	17:15	20:45	08:34
6/08/07	Diurnal Bird Survey – Trapping Lines (1, 2)	6 – 18 ⁰ C	0mm	06:41	17:18	00:01	10:42
7/08/07	Diurnal Bird Survey – Trapping Lines (4, 6)	3 – 18 ⁰ C	0mm	06:40	17:19	01:21	11:25

DATE	SURVEY TYPE	WEATHER					
		Temperature	Rain (24 hrs to 9:00am)	Sun		Moon	
				Rise	Set	Rise	Set
Audit Works							
2/10/08	Ecological Audits	15-17 ⁰ C	0mm	5:;59	18:26	7:35	21:51
3/10/08	Ecological Audits	14 - 20 ⁰ C	0mm	5:57	18:26	8:10	22:50

Source:

Australian Government – Geoscience Australia [<http://www.ga.gov.au/geodesy/astro/.jsp>]

National Rainfall and Temperature Map Archives [<http://www.bom.gov.au/silo/products/ClimMaps.shtml>]

Note 1: *Tetratheca juncea* surveys include cryptic orchids listed in Section 3.2.7 under Other Cryptic Orchids

3.4 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 to ensure a holistic assessment.

Seasonality

Timing limitations are always encountered during ecological assessment surveys due to the seasonal variations across the broad spectrum of flora and fauna species to be studied. Preliminary surveys were carried out during March, targeted searches for threatened flora and fauna were undertaken during June - September. As such there was less survey work undertaken during times when migratory bird or bat species would have a higher probability for presence on the site and when some reptile and amphibian species might exhibit greater activity.

Most notably, several threatened flora species, particularly cryptic orchids, should be surveyed within their respective flowering periods. Several of the threatened orchids, which have potential habitat, could not be comprehensively surveyed to provide information on whether they occur within the site. Therefore, these threatened orchids cannot be discounted as occurring within the site.

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 Coal & Allied lands might represent for seasonal species.

In addition, the seasonality of the surveys also places limits on the number of flora species identified in the site as the optimum time to survey would be Spring to Summer when the majority of flora species flower.

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 ± 1 km.

- Threatened flora and fauna records within the region were predominantly sourced from the DECCW Atlas of Wildlife Database and a DEWHA Protected Matters Search. Other sources such as Birddata and HBOC were also utilised. Limitations are known to exist with regards to these data sources and their accuracy.

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

Access

The survey over the Development Estate was somewhat limited by access due to wet weather and track deterioration (some tracks have been severely degraded or remain blocked off by fallen timber). In some areas the topography or density of flora (i.e. *Lantana camara* tangles) restricted access to some parts of the site.

Survey guidelines

The identification of stratification units was varied from the DEC (2004) guidelines as previous preliminary ground truthing had been performed and stratification of the flora habitats was solely based upon vegetation communities. This stratification resulted in more stratification units and more frequent sampling as the biophysical attributes varied very little over the site. The stratification was mainly based upon vegetation structure and floristics and this ensured a greater area was sampled.

To ensure adequate survey effort was employed within the Gwandalan site a species area curve was plotted to ensure that the number of plots was adequate to represent the floristic composition of the vegetation sampled. Figure 3-2 is the species area curve plotting number of species against number of quadrats. Note that the curve has not quite reached its asymptote, but the transect data was not included within this data set. The curve however does show a levelling off, which is an indication that the survey effort was adequate to ensure the majority of plant species were detected.