WARNING

No part of this plan should be used for critical design dimensions. Confirmation of critical positions should be obtained from Harper Somers O'Sullivan Pty Ltd.
Map Source: Draft Lower Hunter Conservation Strategy

Maitland

Raymond Terrace

Nelson Bay

Consolidation of Watagans to Stockton habitat linkage

Kurri Kurri

Cessnock

Newcastle

Stockton coastal heath and wetland vegetation

Western Lake Macquarie: very diverse vegetation, large forest owl habitat

Regionally significant Squirrel Glider population

Morisset

Corridor linking Olney State Forest and western shore of Lake Macquarie

Wallarah-Munmorah Sensitive coastal and lake foreshore environments Regional north-south wildlife

Important Wildlife Corridors

Main Towns

Local Government Areas

National Park Estate

State Forest Estate

Extant vegetation

Marine Park (Approximate boundary)

Northern Estates

0 0.5 1km

TITLE: Figure 1-4 Regional Corridor (Draft Lower Hunter Conservation Plan)

CLIENT: Coal & Allied Operations Pty Ltd

PLANNING SURVEYING ECOLOGY

HARPER SOMERS O'SULLIVAN

SCALE: 1: 30000 at A3 Size **DRAWN:** A. McConville **APPROVED:** M. Doherty

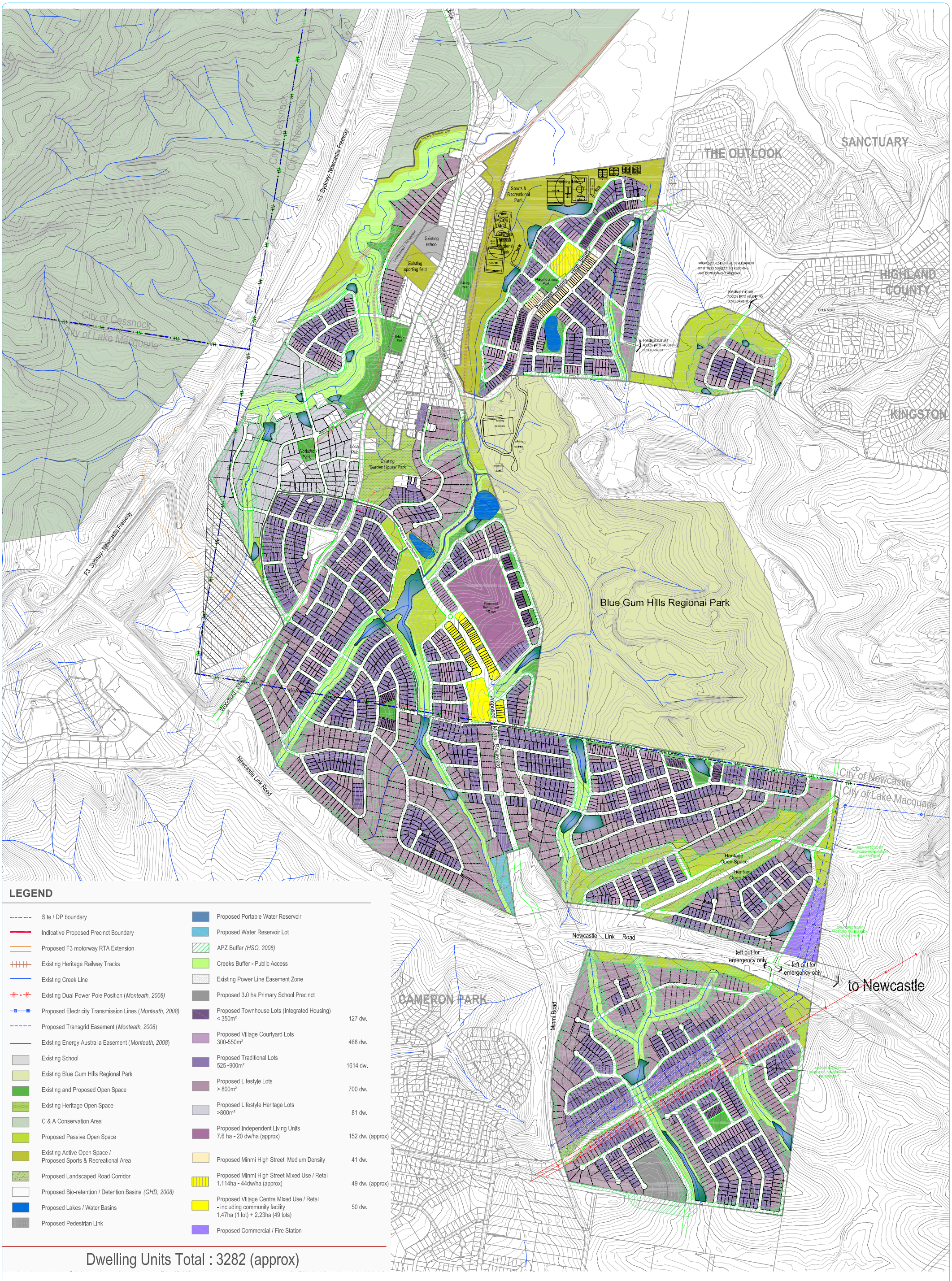
DATUM: MGA Zone 56 (GDA 94) **DATE:** 3/11/2008

LAYOUT REF: J:\JOBS\24k\24530 Hunter Valley\Drafting\Ecology\Northern Lands\ALL WORKSPACES\REPORTS\EPBC Report\24530 FIGURE 4 Nth Lands Regional Corridors A-A3.wor

CONTOUR INTERVAL: N/A

JOB REF: 24530

241 DENISON STREET BROADMEADOW PO BOX 428 HAMILTON NSW 2303
T: 02 4961 6500 F: 02 4961 6794 E: survey@hso.com.au W:www.hso.com.au ABN 11 093 343 858



LEGEND

- Site / DP boundary
- Indicative Proposed Precinct Boundary
- Proposed F3 motorway RTA Extension
- Existing Heritage Railway Tracks
- Existing Creek Line
- Existing Dual Power Pole Position (*Monteath, 2008*)
- Proposed Electricity Transmission Lines (*Monteath, 2008*)
- Proposed Transgrid Easement (*Monteath, 2008*)
- Existing Energy Australia Easement (*Monteath, 2008*)
- Existing School
- Existing Blue Gum Hills Regional Park
- Existing and Proposed Open Space
- Existing Heritage Open Space
- C & A Conservation Area
- Proposed Passive Open Space
- Existing Active Open Space / Proposed Sports & Recreational Area
- Proposed Landscaped Road Corridor
- Proposed Bio-retention / Detention Basins *(GHD, 2008)*
- Proposed Lakes / Water Basins
- Proposed Pedestrian Link
- Proposed Portable Water Reservoir
- Proposed Water Reservoir Lot
- APZ Buffer *(HSO, 2008)*
- Creeks Buffer - Public Access
- Existing Power Line Easement Zone
- Proposed 3.0 ha Primary School Precinct

Proposed Townhouse Lots (Integrated Housing) < 350m²	127 dw.
Proposed Village Courtyard Lots 300-550m²	468 dw.
Proposed Traditional Lots 525 -900m²	1614 dw.
Proposed Lifestyle Lots > 800m²	700 dw.
Proposed Lifestyle Heritage Lots >800m²	81 dw.
Proposed Independent Living Units 7.6 ha - 20 dw/ha (approx)	152 dw. (approx)
Proposed Minmi High Street Medium Density	41 dw.
Proposed Minmi High Street Mixed Use / Retail 1.114ha - 44dw/ha (approx)	49 dw. (approx)
Proposed Village Centre Mixed Use / Retail - including community facility 1.47ha (1 lot) + 2.23ha (49 lots)	50 dw.
Proposed Commercial / Fire Station	

Dwelling Units Total : 3282 (approx)

Note:

All dimensions and areas are approximate only, and are subject to survey and Council approval.

The boundaries shown on this plan should not be used for final detailed engineers design.

AMENDMENTS

DATE	DESCRIPTION	BY
20/01/09	• Revise street and lot layout • Revised heritage open space • Revised detention/bio-retention basin	MS

Level Datum	
Orlgln	
Scale	1:5000@A0
Date	20 January 2009
Surveyed	
Comp By.	SC/MS/ERF
DWG Name.	06083 CON3R
Local Authority	Newcastle/Lake Macquarie
Job Reference	06083

CLIENT

Coal & Allied

Indicative Concept plan

PROJECT

PROPOSED SUBDIVISION

Plan Reference

06083 CON3 R

CONICS

CONICS (BRISBANE) PTY LTD
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web: www.conics.com.au

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 April 2008, the DGEAR's were issued for the site (Appendix B). These DGEAR's state that Tank Paddock is to be assessed as part of the Conservation Estates for the Black Hill site. The entirety of the Conservation Estates have been referred to in discussions within the EAR regarding environmental offsets for the proposal. This has been done as Tank Paddock and Stockrington sites cannot be considered in isolation as together they form an important part of the vegetation corridor from Hexham Swamp to the Watagans.

To ensure completeness, ecological fieldwork and assessment has covered the full extent of the C&A surplus lands, including all development and Conservation Estates. This EAR should be read in conjunction with the Northern Estates Conservation Estates Ecological Inventory (Refer to Appendix C) since the proposed protection of the Conservation Estates forms an integral component of the proposal, aiming to offset any potential ecological impacts associated with the Development Estate.

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

General Requirements

The Environmental Assessment (EA) must include

1. an executive summary;

2. a detailed description of the project including the:
    a. strategic justification for the project;
    b. alternatives considered;
    c. various components and stages of the project in detail (and should include infrastructure staging); and
    d. map indicating the footprint of the proposed work;

3. a thorough site analysis and description of the existing environment;

4. justification of the project, taking into consideration the environmental impacts of the proposal, the suitability of the site and whether or not the project is in the public interest;

5. a consideration of the following relevant statutory and non-statutory provisions and identification of any non-compliance with such provisions (especially the SEPP (Major Projects) 2005, SEPP 44, SEPP 55, Draft SEPP 66, SEPP (Infrastructure) 2007, SEPP (Mining, Petroleum Production and Extractive Industries) 2007, Planning Circular PS 07-018 (Infrastructure Contributions), Newcastle LEP 2003, Hunter Regional Environmental Plan

1989, Lake Macquarie LEP 2004, Hunter Regional Environmental Plant 1989 (Heritage), Lower Hunter Regional Strategy, the Western Corridor Lands Study that is currently being prepared;

6. a draft Statement of Commitments, outlining commitments to the public benefits, environmental management, mitigation measures (especially in relation to flooding, biodiversity and stormwater) to be established on site and clear identification of who is responsible for these measures;

7. a signed statement from the author of the EA certifying that the information contained in the report is neither false nor misleading;

8. the likely scope of developer contributions between: (a) the proponent and Newcastle City Council and Lake Macquarie City Council and (b) the proponent and the State Government agencies for provision of community, regional and local infrastructure, public transport provision, social infrastructure and facilities etc; and

9. a report from a quantity surveyor identifying the correct capital investment value for the concept plan and estimated cost of future development.

Key Requirements

1. Assess the impact of the proposed rezoning and land clearing on the existing native flora and fauna and surrounding areas (including BGHRP, Pambalong Nature Reserve, Hexham Swamp, Hunter Estuary National Park and the dedicated conservation areas). The assessment must be conducted in accordance with the Guidelines for Threatened Species Assessment (DECC July 2005) and include a field study.

2. Descibe the actions that would be taken to avoid or mitigate impacts on biodiversity, threatened species, their habitat and ecological corridors.

3. Identify proposed riparian areas and future management options for these lands.

4. Demonstrate the linkages between proposed conservation lands and adjoining lands and the benefits in providing biodiversity habitats in these locations.

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

Due to the size and separation of land holdings proposed for development and conservation under the NSWG MoU, and for assessment purposes, the land holdings 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 Qualifications & Licensing

1.6.1 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, Alex Saddington BAppSc, Shaun Corry Dip Cons & Lnd Mgt, Anna McConville BEnvSc; and Toby Lambert BEnvSc. The academic qualifications and professional experience of all RPS HSO ecologists involved in the project are documented in Appendix F.

1.6.2 Licensing

Research was conducted under the following licences:

- NSW National Parks and Wildlife Service Scientific Investigation Licence S10300 (Valid 30 November 2008);
- Animal Research Authority (Trim File No: 01/1142) issued by NSW Agriculture (Valid 12 March 2008);
- Animal Care and Ethics Committee Certificate of Approval (Trim File No: 01/1142) issued by NSW Agriculture (Valid 12 March 2010); 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 26 May 2008).

1.7 Sub-Consultants, Personal Communications & Observations

1.7.1 Sub-consultants

RPS HSO 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
Ph: (02) 92318111

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

1.7.2 Personal Observations

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

1.7.3 Agency/ Group/ Organisation Consultation

The following agencies were consulted during the preparation of this EAR. (Note this list is not comprehensive). For a full account of the consultation undertake during the project (Charette) process, refer to the Charette outputs document included within the wider EA submission.

DECC (Lucas Grenadier)	NPWS (Tom Bagnat)
WSC (Deb McKenzie)	LMCC (Robbie Economos-Shaw)
Hunter-Central Rivers CMA	Green Corridor Coalition (Brian Purdue)
Lake Macquarie Coastal and Wetlands Alliance	The Newcastle Wilderness Society
URGE (Peter Morris)	Department of Primary Industries
Hunter Environment Lobby	

1.8 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
Environmental & GIS Manager
RPS Harper Somers O'Sullivan
November 2008

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 Development Estate 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 10 of this report.

2.1 Ecological Surveys

- EcoBiological (2006) *Abel Underground Mine – Part 3A Assessment, Appendix J Flora and Fauna Lists and Descriptions*. An unpublished report prepared for Donaldson Coal Pty Ltd.

- 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 (2007a) *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 (2007b) *Ecological Constraints Investigations Phase 1, Over Various Land Holdings in the Lower Hunter/Central Coast NSW – Addendum Report.* A report prepared for Coal & Allied.

- RPS Harper Somers O'Sullivan (2008) *Ecological Assessment Report, Northern Lands Black Hill.* A report prepared for Coal & Allied.

- Umwelt Environmental Consultants (2003) *Minmi corridors Assessment – Maintaining and Enhancing Natural and Cultural Heritage Values.* An unpublished report prepared for Newcastle City Council, August 2003.

- WBM Oceanics Australia (2001) *Review of Rezoning Proposal for the Tank Paddock, Lenaghans Drive, Minmi.* An unpublished report prepared for Newcastle City Council, December 2001.

2.2 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 the Distribution and Conservation status of some restricted plant species from sandstone environments of the upper Hunter Valley, New South Wales *Cunninghamii* **7(1)** 77-88.

- Driscoll C. (2003) The pollination Ecology of *Tetratheca juncea* (Tremandraceae): Finding the Pollinators. *Cunninghamia* **8(1) 133-140.**

- Payne R.J. (1993) Predication of the Habitat for *Tetratheca juncea* in the Lake Munmorah Area near Wyong NSW. *Cunninghamia* **3(1) 147-154.**

- Phillips, S., and Callaghan, J. (2000) The tree species preferences of Koalas (*Phascolarctos cinereus*) inhabiting forest and woodland communities on Quaternary deposits in the Port Stephens area, New South Wales. *Wildlife Research* 27(1): 1-10.

- 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.

- Wells R.W. (2007) A Review of Threatened Species Considerations for the Proposed Rezoning of Lot 2 DP 534168 and Lot 11 DP 1044935 Minmi Road, Fletcher, New South Wales for Northwest Residential Pty Ltd. *Australian Biodiversity Record* **(10): 1-72.**

2.3 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.

- Department of Environment and Conservation (2006) *Pambalong Nature Reserve Plan of Management.*

- Lower Hunter and Central coast Regional Environmental Management Strategy (LHCCREMS) (2000). Updated by House (2003). *Lower Hunter and Central Coast Extant Vegetation.* Draft Report.

2.4 Threatened Species Management Plans

- Payne R. J. (2000) *Lake Macquarie Tetratheca juncea Conservation Management Plan,* Robert Payne Ecological Surveys and Management. An unpublished Report Prepared for Lake Macquaire 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.

2.5 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, Mosman.

- 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.

2.6 Biodiversity Databases

The Atlas of NSW Wildlife
CANRI
Atlas of Australian Birds
FaunaNet
LMCC Wildlife Database
BioNet
Australian Museum Fauna Database
PlantNet

2.7 Regional Conservation Reserves Overview

2.7.1 Blue Gum Hills Regional Park

Blue Gum Hills Regional Park (BGHRP) is located directly adjacent to the proposed Minmi – Link Road development site. The Park aims to become a high quality recreational facility and a conservation asset that will attract visitors to and within the region.

Management Objectives

The Regional Parks Plan of Management identifies a number of objectives designed to maintain and enhance the Blue Gum Hills' ecological value. Appropriate measures for the proposal will be generated to ensure consistency with conservation plans. The following objectives are considered of high priority to BGHRP.

- Protect and enhance the value of the remnant and regenerated plant communities;
- Acknowledge the dependency of the parks natural systems on surrounding areas;
- Include collaborative process in management, working with adjoining landholders, managers and stakeholders;
- Maintain offsite connectivity via corridors and vegetation patches;
- Develop and explore reciprocal arrangements and management efficiencies between NPWS and adjacent site managers;
- Establish co-operative weed control programmes with adjacent landholders; and
- Encourage councils to plan adjoining open space and pedestrian / cycle ways to link development with the park.

2.7.2 Pambalong Nature Reserve

Pambalong Nature Reserve is located east of the Sydney to Newcastle freeway between Lenaghan and Minmi and adjacent to proposed Conservation Estates at Stockrington.

Management Objectives

The main management objectives of Pambalong Nature reserve are outlined below:

- Conservation of the wetland vegetation communities;
- Lathams Snipe is of particular interest to the reserve due to its international status under migratory species agreements. Revegetation of cleared and degraded areas in order to protect the habitat for the waders and waterbirds (particularly Latham's Snipe) is a high priority for the Nature reserve;
- The reserve currently has a low level of visitor use, and is limited to bird enthusiasts, researchers and recreational visitors. It is a high priority of the reserve that visitor use remains at a low level and is ecologically sustainable; and
- Aquatic weeds, particularly water hyacinth, have invaded the wetland areas. It is a high priority of the reserve that pest species are controlled and where possible, eradicated.

2.7.3 Hexham Swamp Nature Reserve

Hexham Swamp Nature Reserve is in an extremely important position in terms of the lower Hunter's biodiversity. It forms part of a vital corridor between Watagans and Lake Macquarie, the wetlands of the Hunter Estuary and Stockton Bight.

Management Objectives

The main management objectives of Hexham Swamp Nature Reserve are:

- Manage water and salinity levels to maximise waterfowl habitats and to manage the natural environment of the area for all species;
- Protection and preservation of natural features;
- Negotiate agreements with landholders and/or support acquisition of lands to help ensure water quality in the estuary catchment;
- Conservation of wildlife;
- Encourage plant diversity. Remove weeds adjacent to high tide roosts;
- Undertake monitoring of bird populations; and
- Emphasis within the local community, part neighbours of the nature reserves, the importance and purpose of management programs relating to the protection of their natural values and the control of fire, weeds and feral animals.

2.7.4 Western Corridors Study

The Lower Hunter Regional Strategy (LHRS) provides the land use planning framework to guide sustainable growth over the next 25 years in the Lower Hunter region. The LHRS recognises the lands in the western corridor as proposed urban and employment lands, subject to more detailed planning investigations and analysis.

Management Objectives

The Lower Hunter Regional Strategy (LHRS) recognises the lands in the western corridor as proposed urban and employment lands, subject to more detailed planning investigations and analysis.

The LHRS aims to ensure that adequate land is available and appropriately located to sustainably accommodate the projected housing (115 000 new dwellings) and employment (66 000 new jobs) needs of the Region's population over the next 25 years.

This Strategy recognises a vegetation corridor along Newcastle Link Road connecting to Blackbutt Reserve and also along George Booth Drive to provide a visual green entry statement as well as fauna (primarily bird) corridor. The width of the corridor shall be determined by flora and fauna investigations.

Vegetation offsets will need to be justified and preferably link or adjoin existing conservation lands, including identified riparian areas, to provide greater biodiversity conservation outcomes.

2.7.5 Department of Environment and Climate Change (DECC) Guidelines

Developments adjoining DECC or conservation land are regulated by DECC guidelines. These guidelines aim to prevent direct or indirect adverse impacts on the land managed by DECC as a result of development. The following heads of consideration should be incorporated into all developments:

- *Erosion and Sediment Control*

Prevent detrimental change in hydrological regimes, minimise erosion and prevent sediment movement into DECC land occurring during the construction and post-construction phases of development.

Sedimentation control will comply with the relevant guidelines ('Managing Urban Stormwater – Soils and Construction, Volume 1' (Landcom 2004)) preventing sediment flow from the development site onto DECC land.

- *Stormwater Runoff*

The aim of this guideline is to assure nutrient levels and flow regimes/patterns of stormwater/ runoff mimic natural levels prior to reaching DECC land.

Water sensitive urban design techniques will be employed to maximise natural site hydrology and ensure high water quality of stormwater with no excessive export of sediments and nutrients.

- *Management Implications, Pets, Weeds, Edge Effects*

Ensure the development does not promote weed growth, provide Park access to domestic pets, facilitate the use or construction of informal tracks, have any negative impact on cultural or natural heritage due to higher visitation rates, compromise natural fire regimes, or result in encroachments and impede DECC access for management purposes.

- *Fire and the location of Asset Protection Zones*

DECC requires all asset protection zones to be located within the development area and not incorporate DECC land. DECC require that there will be no expectation for DECC to alter the existing fire management regimes for the park.

- *Boundary Encroachments*

It is important that no activities associated with construction occur on DECC land. No pre-construction, construction or post-construction activities are to occur on DECC managed land. All material and works associated with construction will occur on the proposed development site.

- *Visual, Odour, Noise, Air Quality Impacts and Amenity*

Consideration of visual, odour, noise and air quality impacts that may occur to the on DECC estate during the construction and post construction stages of development must be made and where possible measures to avoid and mitigate these impacts be taken.

- *Threats to Ecological Connectivity*

Proposals should aim to maintain (and possibly enhance) existing vegetation and habitats that provide a linkage, buffer, home range and/or refuge role on land that is adjacent to DECC Estate.

3 METHODS

The DGEAR's stipulate assessment should have 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 (DECC 2004) and any relevant recovery plans and threat abatement plans for ecological assessment. To this end these documents have formed the core basis for the adopted ecological assessment methodology over the site.

For the purposes of continuity and to best represent a holistic survey approach, the regional 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); and
- Wyong Ground Orchid Survey Wyong Shire (Gunninah Environmental Consultants, 2003).

This section refers to the methodology applied to the Development Estate only. Refer to Appendix C for a detailed survey methodology for the Conservation Estates.

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 DECC Wildlife Atlas (Accessed April 2008);
- Literature reviews;
- LHCCREMS – Vegetation Survey, Classification and Mapping. (NPWS 2000, House 2003);
- Hunter Bird Observers Club (HBOC) records;
- Birdata (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;
- DECC database of Threatened Species, Populations and Ecological Communities (website); and

- Collective knowledge gained from extensive work in the area.

3.2 Survey Site Positioning & Delineation of Stratification Units

Stratification of the Development Estate 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 DECC Flora Survey Guidelines and other relevant guidelines were consulted to determine survey requirements for large sites. These guidelines suggest that areas 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 Minmi - Link Road site, three vegetation structures of Dry Open Forest, Coastal Wet Sclerophyll Forest, Freshwater Wetlands and cleared/weeds exist. During ongoing groundtruthing, amendments were made and thus some stratification units were dismissed as not occurring within the site, covertly some new units 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.

Fauna Stratification Units

The DECC 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 526 ha and nine broad vegetation types. Three of the vegetation communities, being Cleared Land, Modified Vegetation and Dams 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 these communities, but trapping transects were located within other habitats in their vicinity. Vegetation communities likely to contain native fauna encompassed approximately 378 ha. Due to the small area of some vegetation communities represented within the Link Road - Minmi development estate, each of the 10 transects represented approximately 38 ha of native vegetation.

3.3 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 Development Estate. 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.

3.4 Vegetation Mapping

Flora surveys and vegetation mapping carried out on the Development Estate has been undertaken as follows:

- 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) and RPS HSO (2007);
- Review of the Lower Hunter and Central Coast Regional Environmental Management Strategy (LHCCREMS) Vegetation Mapping (NPWS 2000; House 2003) for the Development Estate and surrounding areas;
- The conservation status of the derived vegetation communities was considered in light of the findings of the LHCCREMS Vegetation Mapping (2003);
- Vehicle reconnaissance was carried out on all the unformed tracks within the Development Estate. These general traverses were used to gain a general understanding of distribution of the vegetation communities;
- Flora surveys were carried out across the site, with an emphasis on potentially significant species, as outlined below. The general flora survey also included 38 - 20m X 20m quadrats and 32 - 100 m transects throughout the native vegetation within the site (Figure 3-1), as well as approximately fifteen hours of Random Meanders in line with methodology termed as the "Random Meander Technique" by Cropper (1993). These random meanders entailed 12.65 km of foot traverses throughout the development estate (Figure 3-2);
- The freshwater wetland vegetation community present within the development estate was surveyed by a walk around the edge of the wetland and recording all species observed with the most common species noted.
- Map the type and general extent of the community(s) present into definable map units where appropriate;
- Assessment of the potential for the derived vegetation communities to constitute EEC's as listed within the *TSC Act (1995*) was also undertaken. The floristic composition, geomorphological characters and geographic distribution were considered when determining whether an EEC was present; and
- Vegetation mapping was mapped utilising a combination of the PATN Analysis, API and groundtruthing.

3.5 Plant Identification

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 stratums to ensure that an informed delineation resulted. All flora species recorded are documented in Appendix D.

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.

3.6 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 Zone 56 (GDA 94) co-ordinated system on a Trimble GEO XH GPS, which has sub-metre accuracy following post-processing.

3.7 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%

WARNING

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

- Conservation Lands
- Development Estate
- 20m X 20m Quadrat
- 100m Transect
- MU 15 - Coastal Foothills Spotted Gum - Ironbark Forest
- Cleared Areas/Tracks (No LHCCREMS Equivalent)
- MU 19 - Hunter Lowland Redgum Forest
- Dam (No LHCCREMS Equivalent)
- MU 5 - Alluvial Tall Moist Forest
- Weeds/Disturbed Vegetation (No LHCCREMS Equivalent)
- MU 12 - Hunter Valley Moist Forest
- MU 30 - Coastal Plains Smooth-barked Apple Woodland
- MU 17 - Lower Hunter Spotted Gum Ironbark Forest
- MU 37 - Swamp Mahogany - Paperbark Forest
- MU 40 - Swamp Oak - Rushland Forest
- MU 46 - Freshwater Wetland Complex
- MU 1a - Subtropical Rainforest

Q30 Q25 T24 T25 T26 Q26 Q27 T27 Q28 Q29 T28 Q - 102 Q19 Q - 103 Q31 T17 Q - 101 T16 Q18 Q32 Q37 Q - 104 T29 T31 T32 Q34 Q33 Q36 Q35 T30 Q - 78 77 T15 T5 Q9 Q17 Q6 T4 Q8 T2 Q7 Q1 Q4 Q - 50 T3 Q5 Q3 Q - 51 Q2 T1 Q40 T11 Q13 Q39 Q14 Q15 Q12 T12 Q42 Q38 Q16 Q41 Q44 T14 Q45 Q43 T13 Q11 T9 T10 T6 Q46 Q10 Q6A T7 T8

0 0.5 1km

TITLE: Figure 3-1 Flora Quadrat Survey Locations Minmi - Link Road

CLIENT: Coal & Allied Operations Pty Ltd

PLANNING SURVEYING ECOLOGY

HARPER SOMERS O'SULLIVAN

SCALE:	1: 18000 at A3 Size	DRAWN:	D. Landenberger
DATUM:	MGA Zone 56 (GDA 94)	APPROVED:	M. Doherty
LAYOUT REF:	J:\JOBS\24k\24530 Hunter Valley\Drafting\Ecology\Northern Lands\ALL WORKSPACES\MinmiLink Road\24530 Fig 3-1 flora Quad Trans Location A-A	DATE:	10/3/2008
CONTOUR INTERVAL:	N/A		
JOB REF:	24530-2		

241 DENISON STREET BROADMEADOW PO BOX 428 HAMILTON NSW 2303
T: 02 4961 6500 F: 02 4961 6794 E: survey@hso.com.au W:www.hso.com.au ABN 11 093 343 858

WARNING

No part of this plan should be used for critical design dimensions. Confirmation of critical positions should be obtained from Harper Somers O'Sullivan Pty Ltd.

LEGEND

- Minmi - Link Road Development Estate
- Northern Conservation Estates
- Random Meander (Total 14 km for Minmi - Link Road Development Estate)

0 0.5 1

kilometres

TITLE: Figure 3-2 Random Meander Survey Locations
Minmi - Link Road Development Estate

CLIENT: Coal & Allied Operations Pty Ltd

PLANNING SURVEYING ECOLOGY

HARPER SOMERS O'SULLIVAN

SCALE: 1: 15000 at A3 Size **DRAWN:** D. Landenberger **APPROVED:** A. McConville

DATUM: MGA Zone 56 (GDA 94) **DATE:** 5/11/2008

LAYOUT REF: J:\JOBS\24\24530 Hunter Valley\Drafting\Ecology\Northern Lands\ALL WORKSPACES\REPORTS\MinmiLinkRdReport\24530-2 Figure 3-2 Minmi LR Random Meander Locations 051108 A-A3

CONTOUR INTERVAL: N/A

JOB REF: 24530-2

241 DENISON STREET BROADMEADOW PO BOX 428 HAMILTON NSW 2303
T: 02 4961 6500 F: 02 4961 6794 E: survey@hso.com.au W:www.hso.com.au ABN 11 093 343 858

3.8 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's listed under the *TSC Act* and 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 habitat on the site. Targeted searches were undertaken throughout the site for these species and flora species which were recorded within a 10 km radius of the site during the survey period. Refer to

Table 3-1.

Table 3-1: Threatened Flora Species Techniques Analysis

Threatened Flora Species	TSC listed	EPBC 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
Acacia bynoeana	E	V	26, 30, 31, 48	Rm, Safr.	■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■
Arthropteris palisotii	E	-	1, 2, 3, 4	Not in Guidelines Rm, Sa and or Rq	**Fern – Non-flowering**
Caladenia tessellata	V	V	34	Rm, Sfr. Recently burnt areas of note.	■ ■ ■ ■ ■ ■ ■ ■ ■ ■
Callistemon linearifolius	V	-	5, 15, 17, 42	Rm, Sa.	■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■
Cryptostylis hunteriana					■ ■ ■ ■ ■ ■ ■ ■ ■ ■
Cynanchum elegans	E	E	6	Rm, Sa.	■ ■ ■ ■ ■ ■ ■ ■ ■
Dendrobium melaleucaphilum	V	-	Alluvial, *Melaleuca styphelioides*	Rm - epiphytic orchid *M. styphelioides* of note, Sa.	■ ■ ■ ■ ■ ■ ■ ■ ■
Diuris praecox	V	V	15, 30, 51	Rm, Sfr.	■ ■ ■ ■ ■
Eucalyptus glaucina	V	V	13, 19	Rm, Sa.	■ ■ ■ ■ ■
Grevillea parviflora subsp. *parviflora*	V	V	5, 15, 17, 30	Rm, Sa	**Flowers all year**
Rutidosis heterogama	V	V	17	Rm, Sa	■ ■ ■
Syzygium paniculatum	V	V	1,4,5,6,50	Rm, Sa (flowering specimens	■ ■

Threatened Flora Species	TSC listed	EPBC 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
				preferential for ID)												
Tetratheca juncea	V	V	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.												
Zannichellia palustris	E	-	46 and saline habitats	Rm, Safr												

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

3.9 Groundwater Dependent Ecosystems

Groundwater Dependent Ecosystems (GDE's) is a broad definition covering all ecosystems which are dependent upon groundwater either permanently or occasionally to survive (DLWC, 2002). An assessment of whether GDE's occur within the Development Estate has been made within this EA.

In this report the NSW State Groundwater Dependent Ecosystem Policy (DLWC 2002) and Groundwater Dependent Ecosystems Assessment, Registration and Scheduling of High Priority (DWE 2006) were consulted to determine if any GDE's present within the Development Estate and classify them according to these policies.

There are differing types of Groundwater Systems (DLWC, 2002) these include:-

1. Deep Alluvial Groundwater Systems;
2. Shallow Alluvial Groundwater Systems;
3. Fractured Rock Groundwater Systems;
4. Coastal Sand Bed Groundwater Systems; and
5. Sedimentary Rock Groundwater Systems.

Three of these types of groundwater systems have the potential to occur in the Hunter region and these include Shallow Alluvial, Coastal Sand Bed and Sedimentary Rock Groundwater Systems. The most likely system to occur within the Development Estate would be Shallow Alluvial Groundwater System and thus the soil mapping is important in assessing the potential for the presence of groundwater aquifers. Thus the soil mapping of Newcastle (Matthei, 1995) was consulted to determine the boundaries of alluvial soil mapping within the Development Estate.

3.10 Data Analysis

Vegetation data was collected from a total of 107 quadrats within the entire Northern Estates. A total of six quadrats were located within Black Hill Development Estate and 39 of these quadrats were located within the Minmi - Link Road Development Estate. The remaining 62 quadrats were sampled within the Conservation Estates at Tank Paddock and Stockrington. Agglomerative cluster analysis of the vegetation data collected was performed using the PATN Statistical Analysis Package Ver. 3.11 (Belbin 2006), to assist in the delineation of the vegetation communities across the Northern Estates. This statistical program has been used in previous large vegetation surveys in the region (Bell 2002, Bell 2004, Hill 2003, NPWS 2000 & Peake 2006). Cluster analysis groups objects that are similar to one another. In the case of vegetation community analysis this statistical tool groups communities based on their similarity of plant species recorded.

Cluster analysis groups objects (in this case survey sites) together by way of an assessment of the association between data pairs. PATN provides several association measures which are applicable to different types of data. For the data collected within the Northern Estates, both the Bray Curtis and Kulzcynski association measures were explored on the data with the default PATN settings. Belbin (2003) suggests that the Bray Curtis association measure is most appropriate where matches between higher values are more significant than matches between lower values and this would suggest that this measure is the most appropriate for abundance data. An unweighted pair-group arithmetic averaging (UPGMA) clustering strategy was applied to both association matrices with a default beta value of -0.1.

Dendrograms were produced using both association measures, with the Bray Curtis analysis giving clearer delineation of the vegetation communities present. Thus this methodology was employed for the dendrograms and further analysis of vegetation delineation. Exotics species were removed from the analysis to refine the delineations and give a clear idea of the native vegetation communities present. A two-step analysis was then performed upon the data using the species as variables and the quadrats as objects, to detect noisy and outlier variables (as recommended by Belbin 2008, Marine Community Example). Box Whisker were also produced which are plots which graphically display of the ability of a specific variable to discriminate between groups, this analysis also gives a Kruskal-Wallis statistic for each variable (this statistic is a non-parametric version of the f-ratio (Belbin, 2006, PATN ver. 3.11 help)). A two way table was produced and this table assisted in the analysis of which species were dominant in the different variants of the vegetation communities produced.

The data was transposed and using the quadrats as variables and the species as objects, the Two-step analysis was performed and noisy quadrats with a low KW statistic (<0.1) were also removed from the analysis. Three quadrats were identified as noisy and were removed from the analyses, these quadrats were placed in highly disturbed areas in which few native specioes were present and were not representative of the vegetation. Two were in the Alluvial Tall Moist Forest and had severe weed infestations, with the remaining quadrat was located in Coastal Foothills Spotted Gum Ironbark Forest which had been recently subjected to a severe fire. Removal of these quadrats and species did not alter the analysis significantly; however' it did help to clearly delineate the vegetation communities.

The number of groups which is to be determined from the Dendrogram can be based on the point at which a levelling of scree plot of dissimilarity and number of fusion points occur. At this levelling point many clusters are formed at essentially the same linkage distance. Thus row fusion points were exported from PATN and plotted to assist in determining the cut off point for delineation of the vegetation communities.

The Freshwater Wetland Complex was not included within the data as it is clearly distinct from the dry sclerophyll and wet sclerophyll forests that occur elsewhere within the site. Moreover, quadrats are difficult to perform within this type of vegetation community. In addition, quadrats were not performed within the Weeds and cleared areas or the Dams vegetation communities. Sampling was undertaken by opportunistic survey and random meanders for these vegetation communities.

3.11 Targeted Flora Survey Methodology

Seasonal surveys were undertaken to maximise detection of all threatened flora species. The following sections details specific targeted surveys which were undertaken for each species. Refer to Figure 3-3.

Diuris praecox

Four ecologists undertook targeted searches (Refer to Table 3-2 for survey dates) within the Link Road - Minmi Development Estate. Parallel transects (Cropper 1993) which were spaced at approximately 25 m intervals were utilised for searches across the survey area (Refer to Figure 3-2 for area surveyed). The location of transects and the recording of potential threatened flora was undertaken by use of a Trimble GeoXH GPS capable of sub-metre accuracy.

Caladenia tessellate

Targeted searches were not undertaken separately for this species. However there is sub-optimal habitat for this species within the Development Estate and therefore the possibility that it may occur cannot be discounted. Thus, whilst undertaking targeted *Diuris praecox* surveys this species was also targeted. Since the flowering seasons for these two species overlap therefore they were searched for together. See the discussion below for further information on the methodology used.

Cryptostylis hunteriana

There is some potential habitat in the form of Coastal Plains Smooth-barked Apple Woodland; however, no other *Cryptostylis* species which are usually associated with this species were located within the Development Estate. This species is leafless and thus lacks chlorophyll and survives by an intimate symbiotic relationship with a mycorrhizal fungus at its roots. This fungus provides all the nutrients required by the plant, this fungus in turn obtains these nutrients from the decaying organic matter (Jones, 1988). The pollinator of this species has been recorded as the ichneumonid wasp *Lissopimpla excelsa*, which also pollinates five other *Cryptostylis* species in Australia (Bell, 2001). Therefore, this may be one of the reasons this species is often found with other *Cryptostylis* species. In the Lake Macquaire region this species has been observed by RPS HSO Ecologists growing with *Cryptostylis subulata* and *Cryptostylis erecta*. These species both have above ground leaves which are visible all year round. Bell (2001) describes two main vegetation communities in which *C. hunteriana* has been found and these include Coastal Plains Smooth-barked Apple Woodland and Coastal Plains Scribbly Gum Woodland. As neither of the *Cryptostylis*

species or any of the habitats were located within the Development Estate, no targeted surveys were conducted for *C. hunteriana* within the Development Estate. However, vegetation surveys were conducted within the beginning of the flowering period for this species (Early November 2007) and this species was surveyed for opportunistically during those surveys.

Microtis* sp. aff. *angusii

Microtis angusii has been tentatively identified on the edge of a wetland adjoining Smooth-barked Apple open forest in the Wyong LGA to the south of the site (Gunninah Environmental Consultants, 2003). *Microtis angusii* has been listed as a threatened flora species on the TSC Act and it is unsure if this species is *M. angusii* or a new species. As the taxonomy of this species has not been fully determined it is difficult to determine if this species would have potential habitat within the site, however a cautionary approach has been taken and it is possible that this species has sub-optimal habitat within the Development Estate. In addition to the aforementioned comments, another species of this genus was located within the power easement of the site, therefore this species is considered as having sub-optimal habitat within the Development Estate. Thus, whilst undertaking targeted *Diuris praecox* surveys this species was also targeted. Since the flowering seasons for these two species overlap, concurrent searches were undertaken. See the discussion for *Diuris praecox* above for further information on the methodology used.

Tetratheca juncea

Targeted searches for this species were included in the targeted searches for *Diuris praecox*. Whilst the majority of onsite vegetation (ie Spotted Gum Ironbark) was not considered to be potential habitat for *Tetratheca juncea*, searches were conducted during *Diuris praecox* surveys. Where plant clumps were located, individual plant counts adhered to the standardised method as set out by Payne *et al.* (2002) i.e. where plant clumps are only considered as representing multiple plants when a 30 cm interval occurs between adjacent plant clumps. This method was chosen because, at present, it is the only widely used standardised method and this methodology is easily replicated by other ecologists. Comparisons can then be made between counts to obtain some measure of the abundance of the species within a particular area. It is noted that this methodology may not define a genetic individual as this species is clonal and multiple plant clumps can often be one genetic individual. Some plant species are clonal to the extent that all above ground stems are one genetic individual. Currently there is no data available regarding colonialism in *Tetratheca juncea* and as such it is difficult to define individuals on a genetic basis.

Other Threatened Flora Species

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

- *Acacia bynoeana;*
- *Callistemon linearifolius;*
- *Caladenia tessellata;*
- *Cynanchum elegans;*
- *Dendrobium melaleucaphilum;*

- *Eucalyptus glaucina;*
- *Grevillea parviflora* subsp. *parviflora;*
- *Rutidosis heterogama;* and
- *Syzygium paniculatum.*

WARNING

No part of this plan should be used for critical design dimensions. Confirmation of critical positions should be obtained from Harper Somers O'Sullivan Pty Ltd.

LEGEND

- Development Estate Boundary
- Conservation Land Boundary
- TargetedThreatened Flora Search Area

0 300 600m

TITLE: Figure 3-3 Targeted Threatened Flora Survey Map Minmi - Link Road

CLIENT: Coal & Allied Operations Pty Ltd

PLANNING SURVEYING ECOLOGY

HARPER SOMERS O'SULLIVAN

SCALE: 1: 13000 at A3 Size **DRAWN:** S. Corry **APPROVED:** D. Landenberger

DATUM: MGA Zone 56 (GDA 94) **DATE:** 17/4/2008

LAYOUT REF: J:\JOBS\24k\24530 Hunter Valley\Drafting\Ecology\Northern Lands\ALL WORKSPACES\REPORTS\MinmiLinkRdReport\24530 Fig 3-2 Targeted Flora Search A. A3.WOR

CONTOUR INTERVAL: N/A

JOB REF: 24530-2

241 DENISON STREET BROADMEADOW PO BOX 428 HAMILTON NSW 2303
T: 02 4961 6500 F: 02 4961 6794 E: survey@hso.com.au W:www.hso.com.au ABN 11 093 343 858

3.12 Fauna Assessment

The fauna survey methodology initially consisted of the production of an Expected Fauna Species List for the area (Appendix E) and an assessment of the potential use of the site by threatened fauna species (as listed under the *TSC Act* 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 two separate mornings.

Surveys included targeted searches for threatened species listed as having potential to occur within the site, including the seasonally occurring *Lathamus discolor* (Swift Parrot) and *Xanthomyza phrygia* (Regent Honeyeater). Targeted searches for *Calyptorhynchus lathami* (Glossy Black Cockatoo) were undertaken that included searches for chewed *Allocasuarina* 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 the 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.

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 surveyed 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 four 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.

Targeted Swift Parrot Surveys

Swift Parrot surveys were undertaken within proposed Conservation Estates and Development Estates over two days during July 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

- Driving 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 survey effort was limited to one part of the potential Swift Parrot season, habitat evaluation was also undertaken to determine where the most favourable areas of potential Swift Parrot habitat might occur across the C&A Lands.

Arboreal and Terrestrial Mammals

A total of 10 Trap lines were set for a period of four nights during October - November 2007 (Figure 3-4). Trap lines consisted of 25 Terrestrial Elliot A traps, five Terrestrial Elliot B traps, 10 Arboreal Elliot B traps, and one Cage Trap. This equates to 1000 Terrestrial Elliot A trap nights, 200 Terrestrial Elliot B trap nights, 400 Arboreal Elliot B trap nights and 40 Cage trap nights undertaken within the Minmi-Link Road Development Estate.

Arboreal mammals were further targeted with hair tubes mounted on tree trunks during a subsequent fauna survey. A total of seven hair tube survey lines were set over a period of 10 nights during January 2008 (Table 3-2). Survey lines consisted of five small type (tube radius 50mm) hair tubes, five large type (tube radius 100mm) hair tubes and three faunatech hair tubes. This equates to a total of 130 hair tube nights per survey line, realising a total of 910 hair trap nights within the Minmi-Link Road Development Estate.

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 to be the most likely to contain nocturnal species, particularly arboreal and terrestrial mammals. Two teams of two ecologists undertook nocturnal surveys concurrently for a duration of four hours per night over five consecutive nights, giving a total of 80 person hours of spotlighting.

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

The presence of *Phascolarctos cinereus* (Koala) was assessed through the identification of potential Koala food trees, followed by inspection for signs of Koala usage. Trees were inspected and identified for the presence of *Phascolarctos cinereus* (Koala), characteristic scratch and claw marks on the trunk and scats around the base of each tree. This species was also targeted though spotlight surveys and the use of call playback through an amplified system.

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; and/or
- Feeding scars on *Eucalyptus* trees made by Gliders.

Any other incidental observations of fauna were recorded during all phases of fieldwork.

Refer to Figure 1-1.

Diurnal Koala habitat searches

For all areas of potential Koala habitat within the site, transects were walked to check for the occurrence of Koala feed tree species. Where a feed tree species was found to occur at a density greater than 15%, the Spot Assessment Technique (SAT) was used based on Phillips and Callaghan (*manuscript submitted 2008*), adopted as current best practice by the Australian Koala Foundation. A centre tree was selected that either:

- had a Koala present;
- had Koala scats at the base;
- had scratches indicative of Koalas; or
- was a Koala feed tree;

Within each SAT plot, the closest 30 trees (greater than 20cm diameter at breast height) to the centre tree were searched for Koala activity such as:

- Koala individuals;
- Koala scats; and/or
- Koala scratches.

A total of 31 transects within the Link Road - Minmi Development Estate were checked for the presence of potential Koala habitat based on the relative abundance of Koala feed tree species. From this a total of 23 SAT plots were undertaken within the site. The location of each Koala SAT plot is shown in Figure 3-5 and transects were undertaken throughout all potential Koala habitat within the site. In addition, Koala feed trees were searched for Koala signs opportunistically throughout the site.

Microchiropteran 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 and CF Zcaim. 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.

Megachiropteran Bats

These species, specifically *Pteropus poliocephalus* (Grey-headed Flying-fox), were surveyed via nocturnal spotlighting and 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.

Herptofauna

Specific herptofauna (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.

WARNING

No part of this plan should be used for critical design dimensions. Confirmation of critical positions should be obtained from Harper Somers O'Sullivan Pty Ltd.

T5
T6
T7
T8
T9
T10
T11
T12
T13
T14

LEGEND

- Proposed Development Estate
- Trapping Transects
- Spotlighting Lines

0 400 800m

TITLE: Figure 3-4 Fauna Survey Locations
Minmi - Link Road

CLIENT: Coal & Allied Operations Pty Ltd

SCALE: 1: 15000 at A3 Size **DRAWN:** A.Saddington **APPROVED:** M.Doherty

DATUM: MGA Zone 56 (GDA 94) **DATE:** 21/4/2008

LAYOUT REF: J:\JOBS\24k\24530 Hunter Valley\Drafting\Ecology\Northern Lands\ALL WORKSPACES\REPORTS\MinmiLinkRdReport24530-2 Fig3-3 fauna survey locations

CONTOUR INTERVAL: N/A

JOB REF: 24530-2

PLANNING SURVEYING ECOLOGY

HARPER SOMERS O'SULLIVAN

241 DENISON STREET BROADMEADOW PO BOX 428 HAMILTON NSW 2303
T: 02 4961 6500 F: 02 4961 6794 E: survey@hso.com.au W:www.hso.com.au ABN 11 093 343 858

WARNING

No part of this plan should be used for critical design dimensions. Confirmation of critical positions should be obtained from Harper Somers O'Sullivan Pty Ltd.

LEGEND

Conservation Estate

Minmi - Link Road Development Estate

Koala Survey

SAT Koala Survey Point

Koala Survey Transect

T19

T10, T11

T26, T27

T8, T9

SAT 16

SAT 18

SAT 17

T13,14,15

SAT 10

T16,17,18

SAT 11

SAT 9

SAT 19

T5,T6

SAT 5

SAT 6

SAT 4

SAT 8

SAT 13

SAT 14

SAT 12

T3,T4

SAT 3

SAT 7

SAT 15

T7

SAT 23

T20, T21

SAT 2

SAT 20

T1,T2

T19

SAT 1

SAT 21

SAT 22

T24, T25

T22, T23

0 0.5 1km

TITLE: Figure 3-5 Koala Survey Locations
Minmi - Link Road

CLIENT: Coal and Allied Operations Pty Ltd

SCALE: 1: 14500 at A3 Size **DRAWN:** H. Boyce **APPROVED:**

DATUM: MGA Zone 56 (GDA 94) **DATE:** 24/4/2008

LAYOUT REF: \JOBS\24k\24530 Hunter Valley\Drafting\Ecology\Northern Lands\Fauna Tables

CONTOUR INTERVAL: N/A

JOB REF: 24530

PLANNING SURVEYING ECOLOGY

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3.13 Survey Dates, Type & Prevailing Conditions

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

Table 3-2: Development Estate Survey Dates, Type & Prevailing Weather

DATE	SURVEY TYPE	WEATHER					
		Temperature	Rain (24 hrs to 9:00am)	Sun		Moon	
				Rise	Set	Rise	Set
Vegetation Surveys							
07/09/07	Targeted *Tetratheca juncea, Diuris praecox, Microtis angusii* and *Caladenia tessellata* searches in Development Estate	11-17.8^{0}C	1mm	06:03	17:39	3:23	13:18
10/09/07		6.8-22^{0}C	2mm	05:59	17:41	5:13	16:23
11/09/07		12.2–23.5^{0}C	0mm	05:58	17:41	5:40	15:26
13/09/07		8 – 22.8^{0}C	0mm	05:55	17:43	6:30	19:18
14/09/07		11 – 28.8^{0}C	0mm	05:54	17:43	6:55	20:14
17/09/07		9.7 – 21^{0}C	0mm	05:50	17:45	8:23	23:07
16/10/07	Quadrat and Transect Survey Threatened Species Search Random Meander Survey Habitat Assessment	16.2 – 33.7^{0}C	0mm	05:12	18:05	7:43	22:53
17/10/07		14.8 –18.5^{0}C	0mm	05:11	18:06	8:32	23:45
18/10/07		13.4–22^{0}C	0mm	05:09	18:07	9:23	-----
19/10/07		9.5–30.2^{0}C	0mm	05:08	18:08	10:28	00:32
23/10/07		17.8 – 25.2^{0}C	0mm	05:04	18:11	14:51	2:55
24/10/07		17.8 – 22.2^{0}C	0mm	05:03	18:12	16:00	3:25
26/10/07		16.2 – 25.8^{0}C	1.8mm	05:00	18:13	18:26	4:30
29/10/07		20.2 – 33.2^{0}C	0mm	04:57	18:15	22:10	6:49
30/10/07		13.5 – 27.5^{0}C	0mm	04:56	18:17	23:12	7:52
31/10/07		20 – 25.7^{0}C	0mm	04:55	18:18	-----	8:59
01/11/07		18.5 – 24.8^{0}C	0mm	04:54	18:18	0:02	10:07
02/11/07		17.5 – 25.5^{0}C	0mm	04:54	18:19	0:44	11:13
06/11/07		12.5 – 20.3^{0}C	4mm	04:55	18:23	2:39	15:07
14/03/08		17.8 - 27^{0}C	0mm	05:52	18:12	12:59	22:41
18/03/08	Quadrat and Transect Survey Threatened Species Search Random Meander Survey Habitat Assessment	17.2 – 28.6^{0}C	0mm	05:55	18:07	16:10	02:00
27/03/08		15.4 – 23.6^{0}C	0mm	06:01	17:55	20:47	10:57
03/04/08		16.2 - 24^{0}C	0mm	06:06	17:46	02:34	15:54
07/04/08		13.2 – 21.8^{0}C	13mm	06:09	17:41	07:06	18:02
Trapping							
29/10/07	Fauna Trapping, Diurnal opportunistic,	20.2 – 33.2^{0}C	0mm	04:57	18:15	22:10	6:49
30/10/07		13.5 – 27.5^{0}C	0mm	04:56	18:17	23:12	7:52

DATE	SURVEY TYPE	WEATHER					
		Temperature	Rain (24 hrs to 9:00am)	Sun		Moon	
				Rise	Set	Rise	Set
31/10/07	Bird survey, Diurnal Herpetofauna survey	20 – 25.7^{0}C	0mm	04:55	18:18	-----	8:59
01/11/07		18.5 – 24.8^{0}C	0mm	04:54	18:18	0:02	10:07
02/11/07		17.5 – 25.5^{0}C	0mm	04:54	18:19	0:44	11:13
05/11/07		14.8 – 20.5^{0}C	0mm	04:51	18:22	02:14	14:11
06/11/07		12.5 – 20.3^{0}C	4mm	04:55	18:23	2:39	15:07
07/11/07		15.7 – 19^{0}C	0.4mm	04:50	18:23	03:03	16:02
08/11/07		13.3 – 19.5^{0}C	41.8mm	04:49	18:24	03:28	16:58
09/11/07		14.5 – 20.2^{0}C	15.2	04:49	18:25	03:55	17:55
Fauna Surveys							
31/10/07	Bat Survey, Diurnal opportunistic, Bird survey, Diurnal Herpetofauna survey	13.5 – 27.5^{0}C	0mm	4:56	18:17	23:12	7:52
01/11/07		20 – 25.7^{0}C	0mm	4:55	18:18	-----	8:59
11/11/07	Nocturnal Survey	13.6 – 24.2^{0}C	0mm	05:46	19:27	05:01	19:51
12/11/07		13 – 24.5^{0}C	0mm	05:45	19:28	05:42	20:47
13/11/07		13 – 25.4^{0}C	0mm	04:45	19:30	06:29	21:41
14/11/07		14 – 29.2^{0}C	0mm	04:44	19:30	07:23	22:29
15/11/07		16.3 – 25.2^{0}C	0mm	04:44	19:31	08:21	23:12
07/01/08	Hair Tube Survey	21.4 – 24.5^{0}C	4.6mm	05:52	20:05	03:11	18:22
08/01/08		21.3 – 26.5^{0}C	2mm	05:53	20:05	04:07	19:09
09/01/08		20.7 – 26.8^{0}C	0mm	05:54	20:05	05:08	19:50
10/01/08		20.4 – 28.3^{0}C	0mm	05:55	20:05	06:11	20:26
11/01/08		18.8 – 29.5^{0}C	0mm	05:55	20:05	07:15	20:58
12/01/08	Hair Tube Survey	18.2 – 31.0^{0}C	0mm	05:56	20:05	08:18	21:27
13/01/08		19.2 – 34.0^{0}C	0mm	05:57	20:05	09:21	21:55
14/01/08		21.3 – 34^{0}C	0mm	05:58	20:05	10:24	22:24
15/01/08		20 – 26.8^{0}C	0mm	05:59	20:05	11:29	22:54
16/01/08		19.7 – 32.3^{0}C	0mm	06:00	20:04	12:36	23:28
25/01/08	Targeted Koala Survey	17.4 – 26^{0}C	0mm	06:09	20:01	20:41	07:35
28/01/08		18.5 – 26.5^{0}C	0mm	06:11	20:00	22:00	10:32
29/01/08		22.2 –. -------	0mm	06:12	19:59	22:28	11:29
30/01/08		----------	0mm	06:13	19:58	22:58	12:27
31/01/08		------ – 32^{0}C	0mm	06:14	19:57	23:33	13:24
04/02/08		20.7 – 24.8^{0}C	18mm	06:18	19:55	01:55	17:02

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]

3.14 Habitat Assessments

An assessment of the relative value of the habitat present on the Conservation Estate 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 3-3 below. The assessment also considered the potential value of the site (and surrounds) for all major guilds of native flora and fauna.

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

Feature	Variables	Value
Hollow Bearing Tree Density	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	Low Density Moderate Density High Density	Determine the diversity of Eucalypt feeding opportunities for native fauna species across the site.
Allocasuarina sp.	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.
Proteaceae sp.	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	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.

Feature	Variables	Value
Fallen Timber	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.

3.15 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 September, November and January. As such there was less survey work undertaken during times when certain 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 C&A 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 throughout Spring and 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 ± 1km.

Threatened flora and fauna records within the region were predominantly sourced from the DECC Atlas of Wildlife Database. Other sources such as Birdata and HBOC were also utilised. Similar 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.

Access

The survey over Development Estates was somewhat limited by access due to wet weather and track deterioration. In some areas the topography or density of flora (i.e. *Lantana camara* tangles) restricted access to some parts of the site. Furthermore, due to weather events notably the June 2007 long weekend storm, some tracks have been severely degraded or remain blocked off by fallen timber.

Access issues were particularly applicable to surveys conducted within the Conservation Estates, notably Stockrington lands, due to the steepness of topography and the deterioration of track integrity under poor weather conditions.

Fauna

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

- Seasonal constraints as outlined above.

- Diurnal Birds - Habitat assessment and previous records and reporting were used to determine the probability of site use. Bird surveys outlined in the aforementioned methods in combination with opportunistic surveys conducted during other fieldwork were considered as representing a wider and more thorough coverage of the site than short periods over limited transects. Survey coverage was determined by stratification units designed to represent other fauna guilds and flora surveys. Surveys for seasonally occurring threatened species, including the *Lathamus discolor* (Swift Parrot) and *Xanthomyza phrygia* (Regent Honeyeater), were mostly limited to incidental observations undertaken during threatened flora surveys. A limited targeted survey period was allocated for the onsite survey of these species, however, adequate assessment of the Development Estate's potential to support these species is contained within habitat assessment of the site.

- Nocturnal Birds – The number of nights surveyed for nocturnal birds was less than required, as a consequence, assessment of development impact was based upon the mobility of local species, local records, habitat opportunities and observed species.

- Herptofauna – Given that surveys did not coincide with heavy rainfall events and high seasonal temperatures, some local frog species may have been inactive during survey events and hence results varied. The same seasonal limitations constrained the extent of reptile activity observed during fauna surveys. However, habitat assessment of the site has carefully considered the likelihood that local species might potentially occur within the site.

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

4 RESULTS

4.1 Flora

A total of 345 flora species were identified during the survey period over the Development Estate within the quadrats, transects and random meander surveys. Additional orchids have also been added which were detected during the targeted *Diuris praecox* surveys. A complete list of the flora species identified is provided in Appendix D of this report.

4.1.1 Vegetation Community Delineation

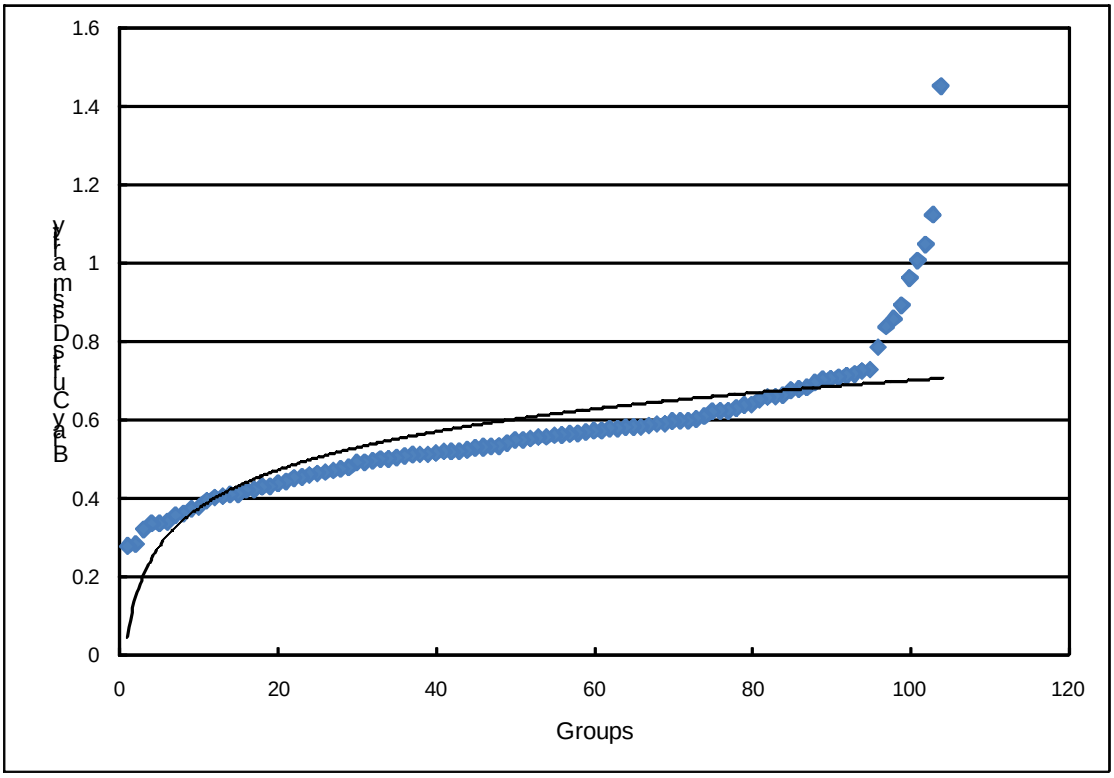
Vegetation communities have been delineated via the methods outlined within Section 3. Following the initial field surveys and mapping, subsequent statistical analysis was employed to qualify and test the results.

A scree plot, Figure 4-1 below, shows the dissimilarity against groups in which it shows the point of inflection at 0.70 dissimilarity level. Therefore 15 groups have been recognised by the non-parametric statistical analysis (PATN Ver. 3.11, Belbin 2006). However, the data levels off at 0.72 dissimilarity showing 9 groups. These nine groups are supported by ground truthing with nine vegetation communities being delineated.

Figure 4-2 includes the Dendrogram produced by the PATN program (Ver. 3.11, Belbin 2006), which indicates the floristic relationships between the vegetation communities. A combination of statistical analysis and groundtruthing has delineated nine vegetation communities within both the Conservation Estates and the Development Estates. Extensive survey effort of over 100 quadrats was used within the statistical analyses. A clear delineation is shown between the dry sclerophyll and wet sclerophyll forests within the Northern Estates. However, several variants of these vegetation communities were delineated at a lower level of dissimilarity and are shown in the Dendrogram of the site (Figure 4-2). When taking into consideration the variants there are 15 which correspond to the scree plot. Therefore as a result of groundtruthing and statistical analysis 9 vegetation communities have been delineated within the Northern Estates, with some communities containing several variants. These variants are described within the description of the individual communities. It must be noted that the variants are not defined vegetation communities in their own right but floristic variation does occur throughout the community. These have not been mapped due to the time constraints imposed on this project and in any case are not necessary as they do not assist the assessment of conservation significance of any of these communities to any further significant degree.

The PATN analysis did not delineate between two the community of Swamp Oak Rushland Forest or Swamp Mahogany Paperbark Forest and this is due to low sampling in these communities (1 quadrat each) as these communities occurred in Tank Paddock in small areas (<1ha).

Figure 4-1: Scree Plot of Bray Curtis Association Measure results



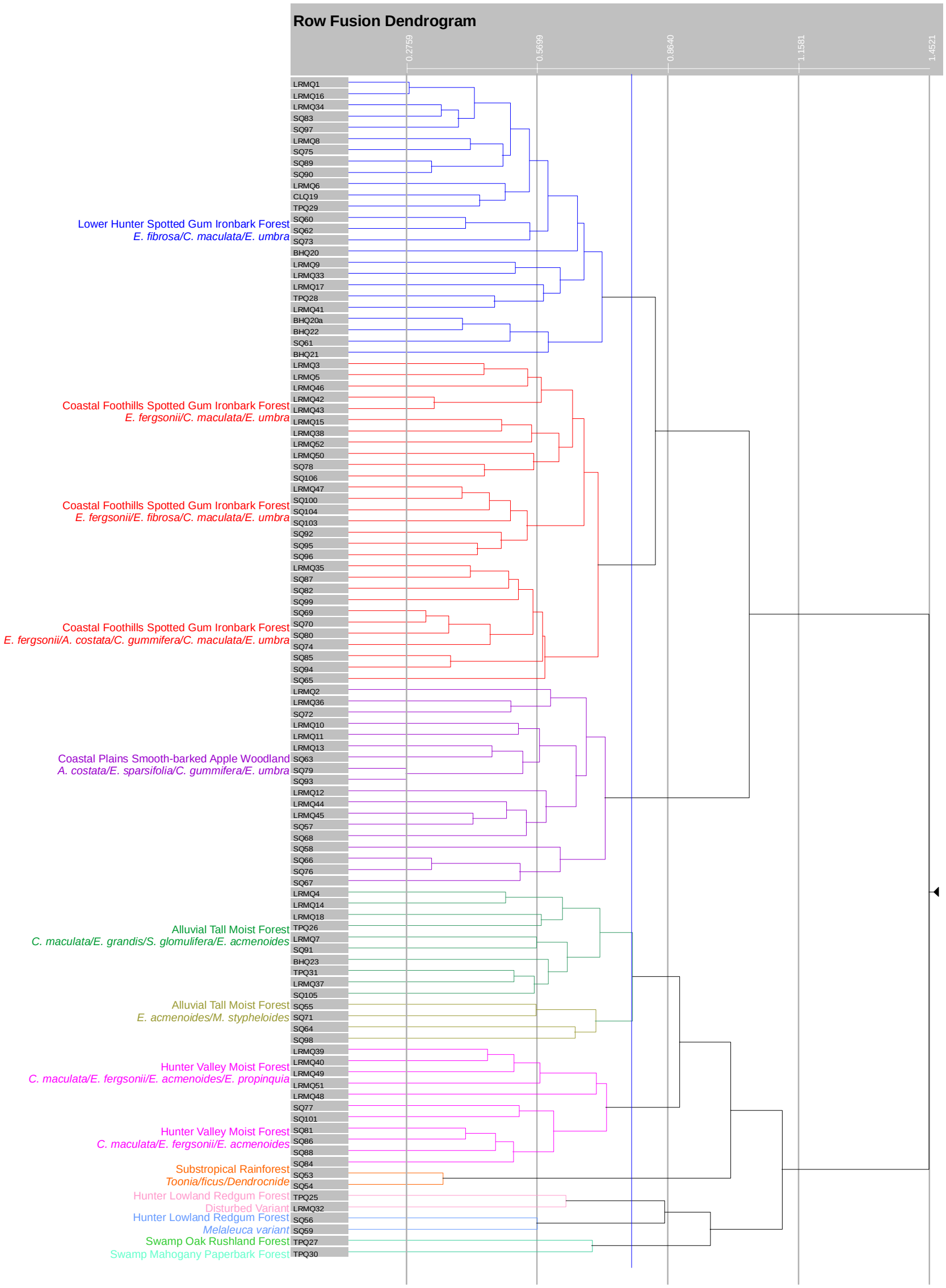


Figure 4-2: Dendrogram showing vegetation communities and dissimilarity association for the Northern Estates

4.1.2 Description of Vegetation Communities

A description of each community and classification into the regional vegetation classification, LHCCREMS has been undertaken. The following nine vegetation communities were delineated within the Minmi - Link Road Site as shown in Figure 4-3 and listed below:

1. Coastal Plains Smooth-barked Apple Woodland;
2. Coastal Foothills Spotted Gum Ironbark Forest;
3. **Lower Hunter Spotted Gum Ironbark Forest (EEC – Lower Hunter Spotted Gum Ironbark Forest);**
4. Alluvial Tall Moist Forest;
5. Hunter Valley Moist Forest
6. **Hunter Lowland Redgum Forest (EEC – Hunter Lowland Redgum Forest);**
7. **Freshwater Wetland Complex (EEC – Freshwater Wetlands on Coastal Floodplains);**
8. Weeds and Cleared Areas; and
9. Dams.

1 Coastal Plains Smooth-barked Apple Woodland

This vegetation community occupies several small areas within the vicinity of the Link Road and encompasses 22.98 ha of the Development Estate. This community occurs on the slopes and 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. *Eucalyptus punctata* (Grey Gum) was recorded within this community. This species is generally absent and thus represents an unusual variant of Smooth-barked Apple Woodland. Several unformed tracks (both 4WD and motorbike) criss cross the community which have rubbish dumped along the edges consisting of both garden and general household waste. Regrowth of this vegetation community has occurred within the middle of the transmission line.

The delineation of the Coastal Plains Smooth-barked Apple Woodland (CPSBAW) was complicated by integrations with Coastal Foothills Spotted Gum Ironbark Forest (CFSGIF). The discussion which follows is concentrated on the vegetation that occurs on the land lying to the south of the Link Road within the Development Estate. The following factors are considered to have an influence on the floristics of these two communities:-

1. There are in some areas of the development estate with strongly delineated borders between Lower Hunter Spotted Gum - Ironbark Forest (LHSGIF) and CPSBAW, which appears to be only attributable to soil variation. Whereas in other areas the boundaries separating these communities are less obvious. This suggests that the Northern Estates occur within an area where soil types suited to both CPSBAW and LHSGIF are in spatial transition. As a consequence, it is possible that those communities exhibiting attributes in common with CFSGIF are ecotonal areas between CPSBAW and LHSGIF, as CFSGIF contains floristic components of both of these communities within both its understorey and canopy layers.

2. Soil mapping describes the soils as the erosional Killingworth group. Whilst the soil is not mapped as different throughout, there may be slight variations in the soil structure depending upon erosion as a function of slope and this in turn will affect the components of the soils, i.e. silt/clay composition. These influences will then impact upon the vegetation compositions and structures resulting on these soils and may be adding further mechanisms driving mixed community assemblages.

3. Position on slope. The area to the south of the Link Road has a wide variation in slope, with steep slopes in the order of 10^{o} - 18^{o} below the northern and western ridges of the site. Steep slope values also occur at the head of gullies running down through the centre of the site. The lower slopes average clines in the order of 5^{o} - 10^{o} and these slope variations will obviously influence moisture retention and soil composition and thus floristic composition.

4. Slope aspect is also influencing moisture retention throughout the site, with south facing slopes supporting communities such as Hunter Valley Moist Forest (HVMF).

5. Successional growth stages as a function of land-use history have also occurred which have modified the floristic structure and composition of the vegetation communities. These factors include possible clearing or severe bushfire and separation by the two electricity easements which run in a south west to north east direction through the centre of the site. Modification is evidenced by regrowth of the forest and with young cohorts of canopy trees, particularly *Corymbia maculata*. It was noted that very few mature and hollow bearing trees were present, which indicates that the forest is either regrowth from clearing, severe or frequent fire events or logging. It may be probable that all three of these events have occurred within the development lands over various periods since European settlement.

The cluster analysis (Figure 4-2) assisted in the delineation of these two vegetation communities at Link Road Minmi, and thus this was used in combination with groundtruthing to determine the exact areas which these vegetation communities occupied.

In conclusion, these two communities are variable within the Link Road Minmi area where they cross over hence resulting in a 'mottled' delineation within the vegetation mapping (Figure 4-3). The main observation of the floristic composition is that *Corymbia maculata* only occurred within CFSGIF and was absent within the CPSBAW, the CPSBAW shrub layer differed in that *Banksia spinulosa* subsp. *collina* and *Leptospermum polygalifolium* were dominant. Thus, for the purposes of this study the two communities have been delineated as per the descriptions set out in LHCCREMS (2000), this is to assist in determining that appropriate offsets are provided within the Conservation Estates.

WARNING

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.

Swamp Mahogany - Paperbark Forest

LEGEND

- Conservation Estate
- Development Estate

Vegetation Communities

- MU 15 - Coastal Foothills Spotted Gum - Ironbark Forest
- Cleared Areas/Tracks (No LHCCREMS Equivalent)
- MU 19 - Hunter Lowland Redgum Forest
- Dam (No LHCCREMS Equivalent)
- MU 5 - Alluvial Tall Moist Forest
- Weeds/Disturbed Vegetation (No LHCCREMS Equivalent)
- MU 12 - Hunter Valley Moist Forest
- MU 30 - Coastal Plains Smooth-barked Apple Woodland
- MU 17 - Lower Hunter Spotted Gum Ironbark Forest
- MU 37 - Swamp Mahogany - Paperbark Forest
- MU 40 - Swamp Oak - Rushland Forest
- MU 46 - Freshwater Wetland Complex
- MU 1a - Subtropical Rainforest

0 0.5 1km

TITLE: Figure 4-3 Vegetation Communities
Minmi - Link Road

CLIENT: Coal & Allied Operations Pty Ltd

PLANNING SURVEYING ECOLOGY

HARPER SOMERS O'SULLIVAN

SCALE: 1: 18000 at A3 Size **DRAWN:** D. Landenberger **APPROVED:** M. Doherty

DATUM: MGA Zone 56 (GDA 94) **DATE:** 10/3/2008

LAYOUT REF: J:\JOBS\24k\24530 Hunter Valley\Drafting\Ecology\Northern Lands\ALL WORKSPACES\MinimiLink Road\24530 Fig 4-2 Vegetation Communities A-A3

CONTOUR INTERVAL: N/A

JOB REF: 24530-2

241 DENISON STREET BROADMEADOW PO BOX 428 HAMILTON NSW 2303
T: 02 4961 6500 F: 02 4961 6794 E: survey@hso.com.au W:www.hso.com.au ABN 11 093 343 858

Upper Stratum – 16 m to 20 m with a PFC of 30 to 40%, the dominant species being *Angophora costata* (Smooth-barked Apple), *Corymbia gummifera* (Red Bloodwood), *Eucalyptus punctata* (Grey Gum) and *Eucalyptus globoidea* (White Stringybark).

Mid Stratum 1 – 4 m to 8 m with a PFC of 10% to 40%, the dominant species being *Allocasuarina littoralis* (Black She-oak) and juvenile *Eucalyptus sp*.

Mid Stratum 2 – 2 m to 6 m with a PFC of 40% to 50%, the dominant species being *Banksia spinulosa* var. *collina* (Hair-pin Banksia), *Acacia ulicifolia* (Prickly Moses), *Leptospermum polygalifolium* (Lemon-scented Tea-tree), *Leptospermum trinervium* (Paperbark Tea-tree), *Dillwynia retorta* (Eggs and Bacon), *Doryanthes excelsa* (Gymea Lily) and *Acacia myrtifolia* (Myrtle Wattle).

Lower Stratum – 0.4 to 1m with a PFC of 60% to 90%, the dominant species being *Lepidosperma laterale, Lomandra obliqua* (Fish Bones), *Xanthorrhoea latifolia* subsp. *latifolia* (Forest Grass Tree), *Themeda australis* (Kangaroo Grass), *Entolasia stricta* (Wiry Panic) and *Dianella caerulea* var*. producta* (Blue Flax Lily).

2 Coastal Foothills Spotted Gum Ironbark Forest

This community occupies mostly the south facing slopes and ridgetops within the Development Estate to the south of the Link Road and covers approximately 170.21 ha. This vegetation community is commensurate with MU 15 Coastal Foothills Spotted Gum – Ironbark Forest as described by LHCCREMS (NPWS 2000; House 2003). This community is variable with the southern areas of the Development Estate having some *Angophora costata* as a co-dominant within the canopy layer and other areas with only *Corymbia maculata* and *Eucalyptus fergusonii* subsp*. dorsiventralis* as the dominant canopy species.

The cluster analysis has delineated three variants at a dissimilarity level of 0.6, and this has mostly been attributed to the presence of *Angophora costata* and *Corymbia gummifera* in the more sheltered aspects of the site. The more exposed sites within the Development Estate on northerly facing aspects and ridgetops mostly had these two species absent. The exception to this rule is where the community had a common interface with CPSBAW or LHSGIF and ecotones therein have species common to both communities within them. Within the Link Road Minmi development estate the first variant was the most common with the other two variants occurring where they ecotoned with either LHSGIF or CPSBAW. Further detailed description of the three variants is provided below.

E. fergusonii / C. maculata / E. umbra

This was the most abundant of the three variants and commonly occurring on the ridgetops and south facing slopes with both the Conservation Estates and Development Estates. These three canopy species were joined by co-dominants of *E. acmenoides* and *E punctata.* The understorey consisted of *Acacia floribunda* and occasionally *Indigofera australis.* The groundlayer consisted of *Themeda australis, Entolasia stricta, Imperata cylindrica* and *Lomandra longifolia.*

E. fergusonii / A. costata / C. gummifera / C. maculata / E. umbra

At the base of the slopes where CFSGIF is ecotoning with HVMF it is not uncommon to have a mixture of canopy species from the two communities. *Doryanthes excelsa* (Gymea Lilly) was noted to be an informative species for this community on this site given that it only occurred within CFSGIF and along the fringes of CPSBAW. The mid storey in this variant consisted of more moist species including *Rhodamnia rubescens* (Brush Turpentine), *Gymnostachys anceps* (Settlers Flax), *Rapanea*

variabilis (Muttonwood) and *Smilax australis.* This variant was dominated by *Acacia fimbriata* in the south eastern portion of the conservation estate.

E. fergusonii / E. fibrosa / C. maculata / E. umbra

It was observed that where CFSGIF was occupying a north facing slope or on level areas, the mid and lower storeys are dominated more by dry species and almost appeared to resemble LHSGIF. The canopy is still dominated by *E fergusonii* ssp. *dorsiventralis, C. maculata, E umbra* ssp. *umbra* and *E punctata,* however, *E. fibrosa* were also recorded within this variant. The mid storey consisted of *Daviesia ulicifolia, Pultenea villosa* and *Macrozamia reducta* with *Joycea pallida* replacing *Themeda australis* as the dominant ground cover.

<u>*Upper Stratum*</u> – 18 m to 20 m with a PFC of 30% to 40%, the dominant species being *Corymbia maculata* (Spotted Gum), *Eucalyptus fergusonii* ssp*. dorsiventralis*, *E. fibrosa* (Broad-leaved Ironbark), *E. umbra Eucalyptus punctata* (Grey Gum), *Angophora costata* (Smooth-barked Apple) and *Corymbia gummifera* (Red Bloodwood).

<u>*Mid Stratum 1*</u> – 3 m to 10 m with a PFC of 10% to 20%, the dominant species being *Allocasuarina littoralis* (Black She-oak) and juvenile *Eucalyptus sp.*

<u>*Mid Stratum 2*</u> – 2 m to 3 m with a PFC of 30% to 40%, the dominant species being *Acacia ulicifolia* (Prickly Moses), *Acacia floribunda* (White Sally), *Pultenaea villosa,* and *Persoonia linearis* (Narrow-leaved Geebung).

<u>*Lower Stratum*</u> – 0.3 m to 1.5 m with a PFC of 40% to 60%, the dominant species being *Lepidosperma laterale* (Variable Sword Sedge), *Microlena stipoides* var. *stipoides* (Weeping Rice Grass), *Lomandra longifolia* (Mat Grass), *Goodenia heterophylla* var. *heterophylla* (Variable-leaved Goodenia)*, Imperata cylindrica* var. *major* (Blady Grass)*, Themeda australis* (Kangaroo Grass), *Entolasia stricta* (Wiry Panic), *Lomandra multiflora* subsp. *multiflora* and *Hibbertia aspera*.

***3 Lower Hunter Spotted Gum Ironbark Forest* (EEC)**

This community occupies the majority of the Development Estate and covers approximately 136.82 ha and generally occurred on the north-facing slopes of the Development Estate. This vegetation community is commensurate with MU 17 Lower Hunter Spotted Gum – Ironbark Forest as described by LHCCREMS (NPWS 2000; House 2003). This community varied in some areas with a dense shrub layer of *Melaleuca nodosa* and other areas a dense understorey of *Daviesia ulicifolia*. The remaining areas of the Development Estate have a grassy understorey dominated by *Themeda australis, Entolasia stricta, Imperata cylindrica* and *Joycea pallidea.* This community differs from the CFSGIF community in that the dominant ironbark is *Eucalyptus fibrosa* and the understorey is dominated by *Melaleuca nodosa, Daviesia ulicifolia* and *Bursaria spinosa.* The scientific determination for LHSGIF describes this vegetation community as occurring principally on Permian geology with some occurrences on Triassic Narrabeen Group. The Development Estate occurs on Permian Geology of Newcastle and Tomago Coal Measures. The dominant species which are described within the scientific determination are present within this community. The only difference is the co-dominant tree *Eucalyptus propinqua* and the dominant understorey grass of *Joycea pallidea.*

This vegetation community occurred on exposed ridgetops and slopes which were mostly north facing. The community is disjunct and occurs in small localised patches throughout the Development Estate. Most occurrences were disjunct and isolated

due to the variable topography, ranging from generally flat areas to steep slopes of greater than 18^{o}.

Upper Stratum – 16 m to 22 m with a PFC of 30% to 50%, the dominant species being *Corymbia maculata* (Spotted Gum), *Eucalyptus fibrosa* (Broad-leaved Ironbark), *Eucalyptus propinqua* (Small-fruited Grey Gum), *Eucalyptus punctata* (Grey Gum), *Eucalyptus globoidea* (White Stringybark) and *Eucalyptus umbra* subsp. *umbra* (Broad-leaved Mahogany).

Mid Stratum – 6 m to 12 m with a PFC of 20% to 40%, the dominant species being Juvenile Eucalypts and *Melaleuca nodosa* (Ball Honeymyrtle).

Mid Stratum – 2 m to 6 m with a PFC of 20% to 70%, the dominant species being *Melaleuca nodosa* (Honeymyrtle), *Callistemon rigidus* (Stiff Bottlebrush), *Daviesia ulicifolia* (Gorse Bitter Pea), *Bursaria spinosa* (Blackthorn) and *Persoonia linearis* (Narrow-leaved Geebung).

Lower Stratum – 0.5 m to 2 m with a PFC of 80% to 90%, the dominant species being *Lepidosperma laterale* (Variable Sword Sedge), *Cheilanthes sieberi* var. *sieberi, Lomandra filiformis* subsp. *coriacea, Lomandra multiflora* subsp. *multiflora, Microlena stipoides* var. *stipoides* (Weeping Rice Grass), *Cymbopogon refractus* (Barbed-wire Grass), *Austrodanthonia tenuior* (Wallaby Grass), *Joycea pallidea* (Silver-top Wallaby Grass), *Imperata cylindrica* var. *major* (Blady Grass), *Themeda australis* (Kangaroo Grass), *Entolasia stricta* (Wiry Panic) and *Aristida vagans* (Three-awned Spear Grass).

4 Alluvial Tall Moist Forest

This vegetation community occurs within the Creeklines within the Development Estate, these creeklines include Minmi Creek, Maryland Creek and Brush Creek. This community has severe infestations of weeds which have been dispersed from surrounding rural lands. The main weed present within the creeklines is *Lantana camara* (Lantana). Whilst weed infestations are present there are a number of natives still present throughout this vegetation community. This vegetation community covers approximately 30.58 ha and is commensurate with MU 5 Alluvial Tall Moist as described by LHCCREMS (NPWS 2000; House 2003). The dominant tree cover varied throughout this vegetation community. The north eastern portion of the Development Estate adjoining Fletcher was co-dominated by *Eucalyptus grandis* whilst the remaining portions of the vegetation community contained dominants of *Eucalyptus acmenoides*, *Corymbia maculata* and *Syncarpia glomulifera*. The cluster analysis has separated this community into two variants of which only the first variant occurs within the Link Road Minmi Development Estate and whilst *Melaleuca styphelioides* was present within this community on site it was a co-dominant with broad-leaf species dominating the understorey. These two variants are described below:-

***Corymbia maculata / Syncarpia glomulifera / Eucalyptus acmenoides* variant**

This variant occurred in the wider drainage lines where more broad-leaf species were present due to a more closed canopy cover. This variant contained an upper stratum dominated by *Alphitonia excelsa* (Red Ash) and *Cryptocarya microneura* with *Hibiscus heterophyllus, Glochidion ferdinandi* var. *ferdinandi* and *Commersonia fraserii* dominating the mid storey with a sparse understorey. This variant was not delineated as rainforest as the canopy was not closed and contained a co-dominance of *Melaleuca styphelioides* in the sub canopy layer in addition to the rainforest species. Whilst these species did not occur within all the areas of this variant, the

floristic composition generally contained more diversity of broad-leaf species than the variant below.

***Melaleuca styphelioides / Eucalyptus acmenoides* variant**
This variant only occurred within the Conservation Estates. In this variant the shrub *Melaleuca styphelioides* was the dominant sub canopy layer whilst *Eucalyptus acmenoides* always occurred within this variant. However, the other canopy species that occurred varied. The broad-leaf species were absent from this variant as the canopy cover was more open. In some areas this was due to *Lantana camara* infestation and others it was where the drainage line narrowed allowing for drying along the banks of the drainage lines.

<u>*Upper Stratum*</u> – 18 to 22 m with a PFC of 30% to 60%, the dominant species being *Eucalyptus grandis* (Flooded Gum), *Eucalyptus paniculata* (Grey Ironbark), *Eucalyptus resinifera* (Red Mahogany), *Eucalyptus propinqua* (Small-fruited Grey Gum), *Syncarpia glomulifera* (Turpentine), *Cryptocarya microneura* (Murrogun), *Corymbia maculata* (Spotted Gum) and *Eucalyptus acmenoides* (White Mahogany).

<u>*Mid Stratum 1*</u> – 10 m to 18 m with a PFC of 10% to 20%, the dominant species being, *Melaleuca styphelioides* (Prickly-leaved Melaleuca), *Commersonia fraseri* (Brush Kurrajong), and *Callistemon salignus* (Willow Bottlebrush).

<u>*Mid Stratum 2*</u> – 2 m to 8 m with a PFC of 30% to 80%, the dominant species being, *Backhousia myrtifolia* (Grey Myrtle), *Acmena smithii* (Lilly Pilly), *Clerodendrum tomentosum* (Hairy Clerodendrum), *Hibiscus heterophyllus* (Native Rosella), *Cassine australis* (Red Olive Plum), *Glochidion ferdinandi* var. *ferdinandi* (Cheese Tree) and *Lantana camara* (Lantana).

<u>*Lower Stratum*</u> – 0.3 to 1.5m with a PFC of 30% to 40%, the dominant species being *Gahnia clarkei* (Tall Saw Sedge), *Gahnia melanocarpa, Carex appressa*, *Adiantum aethiopicum* (Common Maidenhair), *Blechnum cartilagineum, Carex longebrachiata, Doodia apsera* (Rasp Fern), *Hydrocotyle peduncularis, Dichondra repens* (Kidney Weed), *Oplismenus aemulus* (Basket Grass), *Smilax australis* (Native Raspberry), *Stephania japonica* var. *discolor* (Snake Vine), *Geitnoplesium cymosum* (Scrambling Lily), *Parsonsia straminea* (Monkey Rope) and *Cissus antarctica* (Native Grape).

5 Hunter Valley Moist Forest

This vegetation community occurs on sheltered gullies and south facing slopes below steep sandstone outcrops throughout the Development Estate. This vegetation community covers approximately 21.94 ha and is commensurate with MU 12 Hunter Valley Moist Forest as described by LHCCREMS (NPWS 2000; House 2003). Variations on this community occur when it forms an ecotone with the adjoining Alluvial Tall Moist Forest (ATMF) and LHSGIF. This vegetation community has a high diversity of natives and was at times difficult to delineate from the ATMF. It was considered that ATMF generally occurred in the well developed drainage line on alluvial soils, and this produced a greater diversity of *Melaleucas* particularly the dominance of *Melaleuca styphelioides* and certain Eucalypts such as *Eucalyptus grandis, Eucalyptus siderophloia* and mature *Syncarpia glomulifera* trees. HVMF had a dominant canopy cover of *Eucalyptus fergusonii* ssp. *dorsiventralis, Corymbia maculata* and *Eucalyptus acmenoides,* with *Syncarpia glomulifera* and *Melaleuca styphelioides* being present as a shrub species only. This community is most likely an ecotone between ATMF and CFSGIF in sheltered steep gullies as it contains species from both of these communities.

The cluster analysis delineated two variants at a dissimilarity level of approximately 0.72. These two variants are described below:

***C. maculata / E. fergusonii / E. acmenoides / E. propinqua* Variant**
This variant occurred within both the Conservation and the Development Estate, *Eucalyptus propinqua* was a dominant canopy tree. The understorey included dryer species such as *Pteridium esculentum* (Bracken Fern) and

***C. maculata / E. fergusonii / E. acmenoides* Variant**
This variant was similar to the previous one with *E. propinqua* absent from the canopy cover. In addition the understorey had a dominance of wetter species such as *Gymnostachys anceps, Rhodamnia rubescens,* and *Oplismenus aemulus*. Whilst these two variants were similar the dominance in the understorey varied within the community.

The examples of this community within the Development Estate had *Eucalyptus propinqua* present throughout.

<u>*Upper Stratum*</u> – 15 to 20 m with a PFC of 30% to 60%, the dominant species being *Corymbia maculata* (Spotted Gum), *Eucalyptus fergusonii* subsp. *dorsiventralis, Eucalyptus propinqua* (Small-fruited Grey Gum), *Eucalyptus acmenoides* (White Mahogany) and *Syncarpia glomulifera* (Turpentine).

<u>*Mid Stratum 1*</u> – 10 m to 15 m with a PFC of 10% to 30%, the dominant species being, *Allocasuarina torulosa* (Forest She-oak) and Juvenile Eucalypts.

<u>*Mid Stratum 2*</u> – 2 m to 8 m with a PFC of 10% to 40%, the dominant species being, , *Clerodendrum tomentosum* (Hairy Clerodendrum), *Notelaea longifolia* (Native Olive), *Rhodamnia rubescens* (Brush Turpentine), and *Glochidion ferdinandi* var. *ferdinandi* (Cheese Tree).

<u>*Lower Stratum*</u> – 0.3 to 1.0m with a PFC of 50% to 80%, the dominant species being *Entolasia stricta* (Wiry Panic), *Imperata cylindrica* var. *major* (Blady Grass), *Oplismenus aemulus* (Basket Grass), *Adiantum aethiopicum* (Common Maidenhair), *Indigophera australis, Macrozamia reducta, Pteridium esculentum* (Bracken Fern), *Doodia apsera* (Rasp Fern), *Smilax australis* (Native Raspberry), *Sigesbeckia orientalis* (Indian Weed), *Geitonoplesium cymosum* (Scrambling Lily).

6 Hunter Lowland Redgum Forest (EEC)

This vegetation community occurs in a small patch in the northern portion of the development estate adjoining Minmi and encompasses 0.39 ha. This vegetation community is commensurate with MU 19 - Hunter Lowland Redgum Forest as described by LHCCREMS (NPWS 2000; House 2003). This is a highly disturbed community due to high weed incursions with a small diversity of natives present. It adjoins an unformed track which backs onto urban development with some areas having mowed grass acting as bushfire asset protection zones. The community is described as a highly disturbed remnant of HLRF.

The cluster analysis has delineated this community into two variants and it is considered that they are one community. The reason for this is the quadrats which were performed at Tank Paddock Conservation Estate and the Link Road Minmi Development Estate are highly degraded with mostly the canopy being representative of this community. The remaining areas (within the Stockrington

Conservation Estates) in which the quadrats were performed had an understorey of *Melaleuca decora* and *Melaleuca lineariifolia*.

Upper Stratum – 18 m to 20 m with a PFC of 30% to 50%, the dominant species being *Eucalyptus tereticornis* (Forest Red Gum).

Mid Stratum 1 – 10 m to 15 m with a PFC of 10% to 40%,.the dominant species being juvenile *Eucalyptus tereticornis* (Forest Red Gum).

Mid Stratum 2 – 2 m to 5 m with a PFC of 30% to 80%, the dominant species being *Lantana camara** (Lantana), *Alphitonia excelsa* (Red Ash), *Melia azedarach* var. *azedarach* (White Cedar), *Bursaria spinosa* (Blackthorn), *Polyscias sambucifolia* (Elderberry Panax), *Rubus ulmifolius** (Blackberry), *Breynia oblongifolia* (Coffee Bush), *Senna pendula* var*. glabrata** (Senna), and *Ozothamnus diosmifolium* (Everlasting).

Lowest Stratum 0.1 m to 0.5 m with a PFC of 60% to 100%, the dominant species being *Paspalum dilatum* (Paspalum), *Sida rhombifolia* (Paddy's Lucerne), *Cynodon dactylon* (Common Couch), *Pennisetum clandestinum** (Kikuyu), *Hypochaeris radicata** (Flatweed), *Dichrondra repens* (Kidney Weed), *Trifolium repens ** (White Clover), *Oplismenus aemulus* (Basket Grass), *Commelina cyanea* (Wandering Dew), *Thunbergia alata** (Black-eyed Susan) and *Microlena stipoides* (Weeping Rice Grass).

7 Freshwater Wetland Complex (EEC)

This vegetation community occurs in the northern section of the development estate adjoining Minmi. This vegetation community is part of the north western edge of Hexham Swamp. Cattle are currently grazing in the paddocks surrounding the wetland and as a result of grazing, weed incursions have occurred within and surrounding the wetland. This vegetation community covers approximately 0.37 ha and is commensurate with MU 46 Freshwater Wetland Complex as described by LHCCREMS (NPWS 2000; House 2003). The terrestrial vegetation described below immediately surrounds the Freshwater Wetland Complex.

Upper Stratum – 5 m to 15 m with a PFC of 10% to 20%, the dominant species being *Alphitonia excelsa* (Red Ash), *Eucalyptus paniculata* (Grey Ironbark), *Eucalyptus acmenoides* (White Mahogany) and *Corymbia maculata* (Spotted Gum).

Mid Stratum – 1.5 to 3 m with a PFC of 30% to 40%, the dominant species being, *Pittosporum undulatum* (Sweet Pittosporum), *Rubus ulmifolius** (Blackberry) and *Melia azedarach* var. *azedarach* (White Cedar),

Lower Stratum – 0.2 to 0.8 m with a PFC of 50% to 100% around the edge of the freshwater wetland, the dominant species being *Paspalum distichum* (Water Couch), *Cynodon dactylon* (Common Couch), *Pennisetum clandestinum** (Kikuyu), *Sida rhombifolia* (Paddy's Lucerne), *Verbena bonariensis** (Purpletop), *Dichondra repens* (Kidney Weed) and *Verbena rigida** (Veined Verbena).

Emergents – 0.5 m to 1.5 m with a PFC of 80% to 100%, the dominant species being, *Triglochin microtuberosum* (Water Ribbons), *Ludwigia peploides, Persicaria lapathifolium* (Knotweed) and *Typha orientalis* (Typha).

Aquatics – Floating on water surface between *Typha orientalis* is *Azolla pinnata* (Ferny Azolla).

8 Weeds and Cleared Areas

This vegetation community occurs within the central portion of the Development Estate and is the result of clearing for mining operations and the majority of these areas are now utilised for grazing of horses and cattle. The remaining areas are either unformed tracks or electricity easements. This community encompasses approximately 141.68 ha and is not commensurate with any vegetation communities that have been described by LHCCREMS (NPWS 2000; House 2003). These areas are highly disturbed and have high weed incursions. The canopy cover of this community generally exists as scattered examples of Eucalypt trees which are outlined below.

Upper Stratum – 15 to 18 m with PFC of 5% to 10%, the dominant species being *Eucalyptus punctata* (Grey Gum), *Eucalyptus propinqua* (Small-fruited Grey Gum), *Melaleuca styphelioides* (Prickly-leaved Melaleuca), *Corymbia maculata* (Spotted Gum), *Erythrina* x *sykesii* (Coral Tree) and *Eucalyptus acmenoides* (White Mahogany).

Mid Stratum – 1.5 m to 3 m with a PFC of 20 to 50%, the dominant species being *Acacia longifolia* var. *longifolia* (Sydney Golden Wattle), *Kunzea ambigua* (Tick Bush), *Acacia falcata* (Sickle Wattle), *Lantana camara* (Lantana), *Cinnamomum camphora* (Camphor Laurel) and *Grevillea robusta,* (Silky Oak).

Lower Stratum – 0.3 m to 1 m with a PFC of 80% to 90%, the dominant species being *Pennisetum clandestinum* (Kikuyu), *Pteridium esculentum* (Bracken Fern), *Cynodon dactylon* (Common Couch), *Verbena bonariensis* (Purple Top), *Ageratina adenophorum,* (Crofton Weed), *Eragrostis curvula* (African Lovegrass), *Physalis peruviana* (Cape Gooseberry), *Senecio madagascariensis* (Fireweed), *Paspalum dilatum* (Paspalum), *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).

9 Dams

This vegetation community occurs as artificial dams within the cleared areas of the Development Estate. The large dams in the north east of the Development Estate were utilised as water reservoirs for the mining operations. This community encompasses approximately 1.31 ha and is not commensurate with any vegetation communities that have been described by LHCCREMS (NPWS 2000; House 2003). The terrestrial vegetation described below is the vegetation which occurs within the immediate surrounds of the dam. The edges of the dams have high weed infestations particularly of pasture weeds and *Lantana camara.* The emergent vegetation fringes the shallow areas of the dam and are dominated by *Typha orientalis.*

Upper Stratum – 15 m to 18 m with a PFC of 5%, the dominant species being *Eucalyptus punctata* (Grey Gum), *Eucalyptus propinqua* (Small-fruited Grey Gum), *Eucalyptus paniculata* (Grey Ironbark), *Grevillea robusta* (Silky Oak), *Syncarpia glomulifera* (Turpentine), *Eucalyptus acmenoides* (White Mahogany) and *Cinnamomum camphora* (Camphor Laurel).

Mid Stratum –2 m to 4 m with a PFC of 5% to 10%, the dominant species being, *Acacia longifolia* var. *longifolia* (Sydney Golden Wattle), *Acacia suaveolens, Pittosporum undulatum* (Sweet Pittosporum), *Alphitonia excelsa* (Red Ash), *Lantana camara* (Lantana), *Senna pendula* var. *glabrata* (Winter Senna) and *Glochidion ferdinandi var. ferdinandi* (Cheese Tree).

Lower Stratum – 0.5 m to 1 m with a PFC of 30% to 50%, the dominant species being *Pennisetum clandestinum* (Kikuyu), *Carex appressa, Andropogon virginicus* (Whisky Grass), *Hypochaeris radicata* (Flatweed), *Cynodon dactylon (Common Couch), Verbena bonariensis* (Purple Top), *Richardia brasiliensis* (White Eye), *Andropogon virginicus* (Whisky Grass), *Hypochaeris radicata* (Flatweed) and *Plantago lanceolata* (Ribwort).

Emergents – 0.5 m to 1 m with a PFC of 10% to 20%, the dominant species being, *Baumea articulata* (Jointed Twig-Rush), *Typha orientalis* (Typha), *Phragmites australis* (Native Rush), *Persicaria decipiens* (Spotted Knotweed), *Juncus subsecundus* (Finger Rush) and *Juncus usitatus* (Common Rush).

Aquatics – *Azolla pinnata* (Azolla) and *Myriophyllum aquaticum* (Brazilian Water Milfoil).

4.1.3 Conservation Status of Vegetation Communities

Three EEC's that are listed under the *TSC Act* occur within three delineated vegetation communities extant on the Development Estate. These three communities are listed below:

- The vegetation community delineated as LHSGIF is commensurate with 'Lower Hunter Spotted Gum – Ironbark Forest endangered ecological community in the Sydney Basin Bioregions';

- The vegetation community delineated as HLRF is commensurate with 'Hunter Lowland Redgum Forest endangered ecological community in the Sydney Basin and NSW North Coast Bioregions'; and

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

4.1.4 Regionally Significant Vegetation Communities

Newcastle City Council does not at present have any flora and fauna guidelines so the guidelines for Lake Macquarie Council were used to identify any regionally significant vegetation communities in the area.

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

- Alluvial Tall Moist Forest;
- Coastal Foothills Spotted Gum Ironbark Forest;
- Freshwater Wetland Complex; and
- Hunter Lowland Redgum Forest (Forest Redgum Forests within creeklines Payne 1998).

4.1.5 Regionally Significant Flora Species

One ROTAP listed species, *Eucalyptus fergusonii* ssp. d*orsiventralis* (2RC) was recorded within the south of the Link Road within the HVMF and was the dominant ironbark within this community (Briggs and Leigh, 1996) within the development estate. These are as follows:-

Identification of *E. fergusonii* ssp*. dorsiventralis* was difficult in the northern portion of the HVMF as the species appears to hybridise with other ironbarks possibly *Eucalyptus paniculata.* This hybridisation occurred on the ridge within the north eastern portion of the site, whereas the trees which were located on the south-facing slopes show strong characters of wings on the capsules and elongated peduncle of *E. fergusonii* ssp*. dorsiventralis.*

Newcastle City Council does not at present have any flora and fauna guidelines hence to ensure a holistic assessment the guidelines for Lake Macquarie Council were used to identify any regionally significant flora in the area. Lake Macquarie Flora and Fauna Guidelines (2001) contain a list of regionally significant flora species and both *Eucalyptus grandis* (Flooded Gum) and *Eucalyptus fergusonii* subsp. *dorsiventralis* are listed as being regionally significant. *Eucalyptus grandis* occurs in the ATMF to the north and Minmi and to the west of Fletcher within the Development Estate.

Tetratheca juncea is listed as regionally significant within the Lake Macquarie flora and fauna guidelines. This species was located within to the south of the Link Road in the CPSBAW community. This significance of this species is discussed further in Section 4.1.8 as *T. juncea* is listed as vulnerable on both state and federal threatened species legislation.

An additional flora species of *Scutellaria mollis* (Soft Skullcap) was identified within the HVMF to the south of the Link Road. This species is not listed as regionally significant within the guidelines however this record is a range extension as previously this species has only been recorded chiefly south from Colo River, with possible sightings from the North Coast (Harden 1993).

4.1.6 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 10 km (DECC Wildlife Atlas 2007) of the site (Refer to Figure 4-4):

- *Angophora inopina* (Chamhaven Apple)*;*
- *Callistemon linearifolius* (Netted Bottle Brush);
- *Eucalyptus parramattensis* ssp. *decadens;*
- *Grevillea parviflora ssp parviflora* (Little-flower Grevillea);
- *Melaleuca biconvexa* (Biconvex Paperbark);
- *Rutidosis heterogama* (Heath Wrinklewort);
- *Syzygium paniculatum* (Magenta Lilly Pilly); and
- *Tetratheca juncea* (Black-eyed Susan).

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

- *Acacia bynoeana;*
- *Arthropteris palisotii;*
- *Caladenia tessellata* (Thick Lip Spider Orchid);
- *Cryptostylis hunteriana* (Leafless Tongue Orchid)*;*
- *Dendrobium melaleucaphilum* (Spider Orchid);
- *Diuris praecox* (Rough Double Tail);
- *Eucalyptus glaucina* (Slaty Red Gum)*;*
- *Melaleuca biconvexa* (Biconvex Paperbark);
- *Microtis angusii;* and
- *Zannichellia palustris.*

WARNING
No part of this plan should be used for critica design dimensions. Confirmation of critical positions should be obtained from Harper Somers O' Sullivan Pty Ltd.

LEGEND

- Development Estate
- Conservation Estates

THREATENED FLORA SPECIES

- *Acacia bynoeana*
- *Angophora inopina*
- *Callistemon linearifolius*
- *Eucalyptus parramattensis subsp. decadens*
- *Grevillea parviflora subsp. parviflora*
- *Rutidosis heterogama*
- *Syzygium paniculatum*
- *Tetratheca juncea*
- *Zannichellia palustris*

0 2 4km

TITLE: Figure 4-4
NPWS Atlas Flora Records
Minmi - Link Road

CLIENT: Coal & Allied Operations Pty Ltd

PLANNING SURVEYING ECOLOGY

HARPER SOMERS O'SULLIVAN

SCALE: 1: 95000 at A3 Size
DRAWN: D. Landenberger
APPROVED: M. Doherty
DATUM: MGA Zone 56 (GDA 94)
DATE: 10/3/2008
LAYOUT REF: J:\JOBS\24k\24530 Hunter Valley\Drafting\Ecology\Northern Lands\ALL WORKSPACES\MinmiLink Road\24530 Fig 4-3 NPWS Atlas Flora Records A-A3
CONTOUR INTERVAL: N/A
JOB REF: 24530-2

241 DENISON STREET BROADMEADOW PO BOX 428 HAMILTON NSW 2303
T: 02 4961 6500 F: 02 4961 6794 E: survey@hso.com.au W:www.hso.com.au ABN 11 093 343 858

4.1.7 Threatened Flora Species with Potential to Occur

Of the species identified during the desktop search, the following 14 threatened flora species have potential habitat within the Minmi-Link Road Development Estate:

- *Acacia bynoeana* – Sub-optimal habitat within disturbed areas under the electricity easements. However this species preferred habitat is open woodland on sandy soils. This species closest record is within the Lake Macquarie SCA to the south west of the site;

- *Caladenia tessellata* – Potential habitat within the dry sclerophyll forests within the development estate;

- *Callistemon linearifolius* – A small shrub that has potential habitat within the drainage lines and the Lower Hunter Spotted Gum Ironbark vegetation community within the development estate;

- *Cryptostylis hunteriana* – Cryptic orchid mostly found in Scribbly Gum Woodland habitat; however this species has been recorded at Freeman's Waterhole within CPSBAW (Bell, 2001). No other *Cryptostylis sp.* have been recorded within the Development Estate within this vegetation community and it is considered highly unlikely that this species will occur;

- *Dendrobium melaleucaphilum* – Epiphytic orchid mostly found on *Melaleuca styphelioides*, habitat within the ATMF on the site;

- *Diuris praecox* – cryptic orchid with potential habitat within the LHSGIF vegetation community within the site;

- *Eucalyptus glaucina* – a tree, with potential habitat within the HLRF vegetation community within the site;

- *Grevillea parviflora* subsp. *parviflora* – a shrub, potential habitat within the LHSGIF vegetation community within the Development Estate;

- *Melaleuca biconvexa* – Shrub to small tree found in low-lying swampy areas, marginal habitat within the wet sclerophyll vegetation communities within the site;

- *Microtis angusii* – Cryptic orchid found in disturbed sites in Sydney. A species which is considered to have affinities to this species but remains undescribed was located at Chain Valley Bay near Wyong on the Central Coast. Thus, it is considered that this undescribed species may have sub-optimal habitat within the disturbed sites within the site;

- *Rutidosis heterogama* – A small shrub, potential habitat within the LHSGIF vegetation community within the site;

- *Syzygium paniculatum* – Shrub to small tree found in rainforests or riparian vegetation, potential habitat within the wet sclerophyll vegetation communities within the site;

- *Tetratheca juncea* – a small shrub which has potential habitat within the CPSBAW within the site; and

- *Zannichellia palustris* – an aquatic species which has sub-optimal habitat within the Freshwater Wetland Complex vegetation community.

4.1.8 Targeted Threatened Flora Species Survey Results

One threatened flora species, *Tetratheca juncea* was located within the Development Estate during surveys. Several cryptic species are known to occur within the region as discussed below.

Tetratheca juncea

A total of 10 *Tetratheca juncea* plant clumps were located during the targeted surveys in August 2007 within the Development Estate (Figure 4-5 shows the distribution). Additional searches were undertaken in November 2007 to relocate this small population and possibly map further individuals but these plants could not be located again. At least 352 plant clumps have been identified within the Conservation Estates. Furthermore it is estimated that 256 ha of habitat within the Conservation Estates remains to be surveyed. Thus, it is considered that the population within the Conservation Estates will be significantly larger in size than the population within the Development Estate. Large populations of 25,000 plant clumps have been located within the Wallarah Peninsula by Conacher Travers (2007). Of these, over 9,900 plant clumps have been conserved within Wallarah National Park, with more plant clumps to be retained within the bush parks within the Murrays Beach development estates.

The work of Payne (2000) states that all sub-populations of 100 plant clumps or more are of very high conservation significance, however, at the time the whole population of *Tetratheca juncea* was estimated to be only 10,000. This figure is an underestimation of the entire population throughout its range, but due to the cryptic nature of this species and the lack of extensive surveys undertaken at the time a conservative approach was taken. However, numerous surveys since this time have discovered numbers far in excess of this figure in the region. Whilst the total number of specimens of the species has not been determined, it is clear that it is at least in the order of hundreds of thousands, if not more. All of the conservation goals outlined in Payne (2000) have been met and exceeded.

Table 4-1 is a summary of the numbers of known *Tetratheca juncea* plant clumps in the region and these numbers are considered an underestimation of the total amount within conservation reserves as each NPWS record has been assumed to be one specimen, which is clearly not the case. These numbers are as such an underestimation of the population within the region, and are only useful from a species distribution viewpoint.

Some of the elements of the life-cycle of *Tetratheca juncea* have recently been discovered although much of the ecology is still unknown. However, as this species is an outcrosser (ie cannot self pollinate) and utilises buzz pollination (Gross *et al.,* 2003; Driscoll 2003) this type of reproduction leads to low fruit set. Buzz pollinators are highly specialized and require specific habitat requirements and this has been hypothesised as one of the reasons for the species decline and fragmentation (Gross *et al.,* 2003). As the population within the Link Road Minmi Development Estate is small, the habitat contains other species which utilise buzz pollination (e.g. *Hibbertia* sp*. and Dianella* sp.) and this habitat may form an east-west corridor for the pollinator. The Conservation Estates provide large areas of intact good quality

habitat for the buzz pollinator of *Tetratheca juncea* due to the presence of other plant species that utilise buzz pollination combined with large areas of intact habitat. Thus, it is vital that conservation of good quality habitat for the pollinator is conserved to ensure sufficient seed is set to ensure the survival of this species. Whilst the populations within the Conservation Estates have not been fully quantified, there is more potential habitat (CPSBAW) present within the Conservation Estates than the Development Estates.

Table 4-1: Known distribution of *Tetratheca juncea* within the region and known Conservation Areas

Source	Numbers of *Tetratheca juncea* plant clumps
Atlas of NSW Wildlife Records [4]	828
Awabakal Nature Reserve [2]	87
Coal & Allied Catherine Hill Bay Proposed Offset lands	7,596
Coal & Allied Gwandalan Proposed Offset lands	8,222
Coal & Allied Nords Wharf Proposed Offset lands	5,933
Coal & Allied Stockrington Proposed Offset lands	352
Glenrock Nature Reserve [2] & [4]	1220
Jillaby State Recreation Area [4]	1
Karuah Nature Reserve [4]	5
Lake Macquarie State Conservation Area [2]	29
Munmorah State Conservation Area [2]	296
Proposed Rosegroup Offset lands [3]	214
Tingira Heights Nature Reserve [4]	2
Wallarah National Park and Habitat Corridor at Murrays Beach[1]	9900
Wallaroo Nature Reserve [4]	1
Total in region	**34,686**
Total in Conservation Areas	**33,858**

[1] Data from Conacher Travers (2006)
[2] Data from Payne (2000)
[3] Data from RPSHSO (2007) and Wildthing (2003a)
[4] Atlas of NSW Wildlife Records

Diuris praecox

Targeted searches for *Diuris praecox* were conducted throughout the development estate during the flowering period for this species. No individuals of this species were located during any of the targeted searches.

Potential habitat exists for this species within CFSGIF, LHSGIF and CPSBAW vegetation communities within the site. Notably there are large areas of these communities present within the Conservation Estates.

Caladenia tessellata

This terrestrial orchid species is known to occur within sclerophyllous woodland on clay loam and sandy soils. This species was targeted during the *Diuris praecox* surveys and was not detected.

Potential habitats for *Caladenia tessellata* include dry sclerophyll forests such as Lower Hunter Spotted Gum-Ironbark Forest, Coastal Plains Smooth-barked Apple Woodland, Coastal Foothills Spotted Gum-Ironbark Forest and Hunter Valley Moist Forest (Approximately 351.9ha). However, some of the vegetation communities contain sub-optimal micro-habitat and other factors such as aspect and topography would also influence the suitability of habitat for this cryptic orchid and therefore the area of habitat may be an estimation. Notably there are large areas of these communities present within the Conservation Estates (over 2016ha).

Cryptostylis hunteriana

Targeted searches for *Cryptostylis hunteriana* were conducted throughout the development estate during the flowering period for this species. No individuals of this species were located during any of the targeted searches.

Potential habitat exists for this species within the CPSBAW vegetation community within the site. Notably there are large areas of this community present within the Conservation Estates.

Other Cryptic orchids

No threatened cryptic orchids were located during the targeted surveys within the Development Estate. A range of orchid genuses encompassing 12 species were observed within the site, including *Acianthus, Caladenia, Calochilus* and *Pterostylis*. Those threatened genuses that are considered most likely to have habitat opportunities within the Development Estate, include *Diuris* sp*.,* and *Caladenia* sp*.* Although these species cannot be entirely discounted as occurring within the development estate, large areas of potential habitat are also present within the Conservation Estates that are to be set aside for conservation.