7

The Structure Plan

7.1 Introduction

This Section of the LES has been prepared to:

- demonstrate that the site is capable and suitable to be developed for urban purposes; and
- guide future development of the site once rezoned for urban development;
- Inform the recommended zoning strategy for the site; and
- assist in Council in preparing a Development Control Plan to allow for the future development of the site.

It is not proposed to be a binding legislative framework which must be followed by developers rather a guide to demonstrate how the site can be developed once rezoned.

7.2 Local Context and Surrounding Future Development

Significant new development is not expected to occur on land nearing the site to the south, east or west. That land is already developed, constrained or not identified as a growth area in any strategic planning document. Further to the west, there is a significant amount of land mapped by LMCC as an employment investigation zone. All foreseeable significant urban development in the direct vicinity will occur on the 325ha parcel of land located on the northern side of George Booth Drive, bound by the Newcastle Link Road to the north, Cameron Park to the east and Cameron Park Drive to the west. That area is known as the Northlakes Urban Release Area, and it has a total size of approximately 325ha. The area zoned for residential development is around 207ha, which will provide for up to 4,000 dwellings.

Part of the Northlakes Urban Release Area is the Pambulong Forest Estate, which is adjacent to the Edgeworth site, separated by George Booth Drive. The Estate was originally approved for around 600 lots in 2005. Since that time, several modification applications have been approved, allowing the density of the development to increase, however the intent and general characteristics of the development remain the same. The Estate will contain the following:

- one commercial lot adjoining George booth Drive with an area of 7.2ha;
- three large, medium density residential development lots to the north and east of the commercial area, with a total area of 6.6ha;
- fifteen smaller medium density residential development lots which are proposed for small lot housing;
- around 600 standard residential lots;
- a neighbourhood park; and
- drainage reserves and a residue lot.

The commercial lot will contain the Pambulong Forest Marketplace, which is a retail centre comprising of commercial premises and shops with associated car parking and landscaping. That development was approved on 3 June 2010 and will contain the land uses indicated in **Table 7.1** below.

Table 7.1 **Pambulong Forest Marketplace**

Use	*Stage 1 (GFA)*	*Stage 2 (GFA)*
Supermarket	4,200m^2	-
Specialty Shops	2,267m^2	2,880m^2

Use	*Stage 1 (GFA)*	*Stage 2 (GFA)*
Kiosks	100m^2	50m^2
Discount Department Store	-	7,350m^2
Commercial Offices	300m^2	80m^2
Mini Major	-	1,450m^2
Total car parking spaces	288 open	401
Arcades	1,240m^2	1,853m^2
Total GFA	***8,795m^2***	***12,435m^2***
	21,230m^2	

Development of the Edgeworth urban release area will need to consider the nature of the development occuring to its north and ensure that it is complementary. Through development of the site there is an opportunity to consolidate Edgeworth as new town centre in the locality.

7.3 Urban Design Character and Form

7.3.1 Design Considerations and Guidelines

The vision for the study area has been based on the following overarching principles:

1. **Urban development should be responsive to the existing site opportunities and constraints including:**
   - existing planning, physical and environmental constraints as described previously in this LES;
   - visual significance and view potential of the existing setting;
   - need to preserve and enhance existing areas and features of high scenic amenity and ecological value wherever possible with compatible new uses;
   - implementation of buffers between potentially conflicting land uses; and
   - recognise opportunity in new development to enhance the setting of existing areas offering only minimal visual interest.

2. **Development Objectives**
   - need to establish a minimum area of development to ensure financial viability of the release area;
   - identify uses that optimise the urban development potential of the site without compromising the environmental values and visual qualities of the setting;
   - provide an appropriate mix of residential densities and land uses depending on the opportunities and constraints within the study area;
   - provide a diverse range of public facilities and recreational opportunities that establishes a desirable community lifestyle and strong sense of identity;
   - optimise the existing natural attributes of the setting to create a unique new community that sets itself apart from other conventional developments in the area;
   - ensure adequate pedestrian and vehicular links to adjoining residential, commercial, community and education services to ensure permeability and legibility in the urban environment; and
   - identify development opportunities that respond to anticipated demographic and market demands.

3. Design Objectives

- minimise the physical and environmental impact onto the site in the provision of new public infrastructure and built form and to ensure that these elements are complimentary and integral with the natural systems;
- maintain and optimise the unique visual qualities and recreational opportunities of the setting to the benefit of the new community and outside users;
- provide a healthy and active lifestyle setting that encourages walking and other non-vehicular forms of access;
- provide optimal connectivity between uses within the site and surrounding areas;
- promote built form and an urban design character that is complimentary with the natural and rural context of the site;
- create a strong sense of legibility within and between precincts;
- create a sense of place where local residents are empowered by their own community. Building an urban setting that encourages social interaction while ensuring areas of privacy;
- creating an environment that offers a high sense of public safety through the principles of crime prevention through environmental/urban design; and
- optimising water management systems that are complimentary with the visual and recreation objectives.

7.3.2 The Structure Plan

Based on the overarching principles set out above, the Structure Plan establishes a variety of land uses for the site including environmental conservation, open space, low density to medium density residential development and mixed use. The Structure Plan is shown as **Illustration 7.1** and outlines the preferred development strategy that has informed the preparation of the LEP. Although the Structure Plan is based on the opportunities and constraint mapping undertaken as part of **Section 4**, it does not exclude all identified constrained land from future urban development. The Structure Plan seeks to ensure that, while sufficient land is maintained for ecological, drainage and open space purposes, the most efficient use of the land in terms of its future development is achieved.

The development footprint is approximately 46.7ha, which represents 49% of the total site area. This reflects the need to retain a large proportion of the site for purposes other than urban development because of the various environmental, visual, engineering, servicing and planning constraints outlined earlier in this report. The suggested function, size and character of the uses within the Structure Plan are described below.

7.3.3 Development Areas

The Structure Plan includes three types of development areas, which are identified as follows:

Low Density Residential: low density precincts at the periphery of the developable area of the site;

Medium Density Residential: medium density precinct near the George Booth Drive entrance to the developable area of the site; and

Mixed Use: employment/residential precinct providing for mix of offices, low impact light industrial uses and residential uses, located at the visually exposed and acoustically affected areas of the site.

The development within each area should be designed to complement the other areas. This could be achieved through a site specific development control plan and building design guidelines. Development within the areas should be designed to optimise their local setting attributes such as attractive bushland views while complimenting and protecting other more sensitive visual and physical site features such as heritage items, drainage lines, remnant vegetation and ridgelines.

A description of the suggested urban design and visual character for each area as well as the possible range of community facilities for the site is provided below. It should be noted that these are suggested urban design concepts which could be considered in the preparation of a comprehensive Development Control Plan for the site.

Each area will need to incorporate appropriate buffers between land that is to remain rural and the proposed new urban interface. Location and size of these buffers will need to be considered at the Development Application stage.

Information shown is for illustrative purposes only

Drawn by: RE Reviewed by: MVE Date:December 2010
Source of base data: Lake Macquarie City Council

North

0 100

GeoLINK environmental management and design

LES: George Booth Drive, Edgeworth
1062856

Structure Plan

Illustration 7.1

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Low Density Residential Area
Development within this area would be limited to low density residential, including some small lots, incorporating dwellings of up to two storeys. The Low Density Residential Area is located on the periphery of the developable portion of the site, with remnant bushland adjoining it on the western and southern sides.

The street environment of this neighbourhood should have a strong urban character. The smaller lot sizes could result in reduced building setbacks from street boundaries and tighter external spaces at the rear and sides of buildings. The neighbourhood should have a legible and interconnected system of streets and footpaths that aim to provide safe access for residents while encouraging walking and cycle activities. The walk and cycle network would need to have a high level of functionality and connectivity, to encourage residents to use this form of transport to access George Booth Drive and the Pambulong Forest Marketplace. Residents would need to have easy access to the large areas of open space located through the middle of the site. The street pattern would incorporate a series of interconnected roads, with minimal cul-de-sacs. .

Possible community facilities and services include small local parks of open grassland, perimeter planting and a seating niche and walkways and bike paths.

Plate 7.1 Indicative Residential Character for the Low Density Residential Area

Medium Density Residential Area
This medium density residential area is located in a prominent position but set back from George Booth Drive to avoid noise impacts. Residents of this area will be within easy walking distance of George Booth Drive and the Pambulong Forest Marketplace, making it ideal for a more intensive urban environment. The area will incorporate a mixture of detached dwellings and multi-unit dwellings of up to two storeys occupying smaller lot sizes to generate a relatively large residential population. This will assist address the lack of development potential and associated population base elsewhere in the study area due to environmental constraints. Given the proximity to the Pambulong Forest Marketplace, seniors living or a retirement village may also be appropriate in this area.

The street environment of this neighbourhood should have a stronger urban character than the other residential precincts. The smaller lot sizes could result in reduced building setbacks from street boundaries and tighter external spaces at the rear and sides of buildings. As with the Low Density Residential Area residents should benefit from close proximity and easy access to areas of open space. Like all residential areas within the site, this neighbourhood will contain carefully conserved significant trees that will provide enduring visual amenity.

The neighbourhood should have a legible and interconnected system of streets and footpaths that aim to provide safe access for residents while encouraging walking and cycle activities. The recommended street pattern would be designed to ensure a high level of connectivity for motorists, pedestrians and cyclists.

Possible community facilities and services:

- A small, neighbourhood precinct including a convenience store and park facilities;
- passive recreation areas; and
- walkways and bike paths.

Plate 7.2 Indicative Residential Character for the Medium Density Residential Area

Mixed Use Area

The mixed use area is located along George Booth Drive in the North of the study area which is both visually exposed and subject to acoustic impacts from traffic. The precinct will be seen straight away when entering the site and is within easy walking distance of George Booth Drive and the Pambulong Forest Marketplace. This makes it possible for tenants to access the precinct via public transport. Buildings will have a maximum height of two storeys and will be designed to complement the nearby residential precincts. As suggested by the name, buildings will have a range of uses including commercial, light industrial and residential.

The Mixed Use Area will provide flexibility in the type of uses permissible which will cater for changing trends in business mix and the need for identification of smaller parcels of urban light industrial land to meet the demand of mixed residential/light trade and knowledge based industry. This type of precinct would cater for people involved in industries such as media and digital content industries, film, television, music, design, publishing, computer games, advertising, architecture and the arts. The mixed use zone would allow people working in these types of industries to set up their practice/operations in this locality whilst also living onsite or close to their place of business.

The built form will be relatively dense, and will achieve a high level of visual amenity through contemporary design and the retention of significant trees. Again, the street network will be highly legible and interconnected, providing for ease of movement for motorists, cyclists and pedestrians.

Plate 7.3 Indicative Character of the Mixed Use Area

7.3.4 Community Open Space and Environmental Conservation Areas

In order to maintain and enhance the visual and environmental values of the existing setting, a large section of the study area should be excluded from development. These excluded areas should be retained as environmental protection which should surround and infiltrate development areas, dominating their visual character and creating attractive settings for residents while protecting the site's natural and aesthetic amenity for the benefit of the wider community. Cycle paths should be created through this environmental protection area to enable connectivity to the existing residential community to the south.

Regeneration and vegetation management throughout the environmental protection area is also encouraged to overcome the effects of past destructive practices. This should aim to provide improved habitat for native fauna.

A 50 m wide vegetated buffer should remain and be enhanced where necessary along both sides of the transmission lines. This buffer will improve the visual amenity of the site from the residential and industrial precincts and will provide additional environmental value. The transmission line easement will be utilised for passive community open space and will incorporate bike paths and some play equipment.

Included within the low and medium density precincts there should be community open spaces, made up of small pockets of existing remnant native vegetation.

It is recommended that the community open spaces incorporate a network of pedestrian and bicycle paths to enhance recreational opportunities of the residents and to create strong connections between the various

precincts and to the Pambulong Forest Marketplace. The paths should be designed and located to optimise the diversity of visual experiences offered by the site and to incorporate rest areas and interpretive signs to enhance the recreational experience for users.

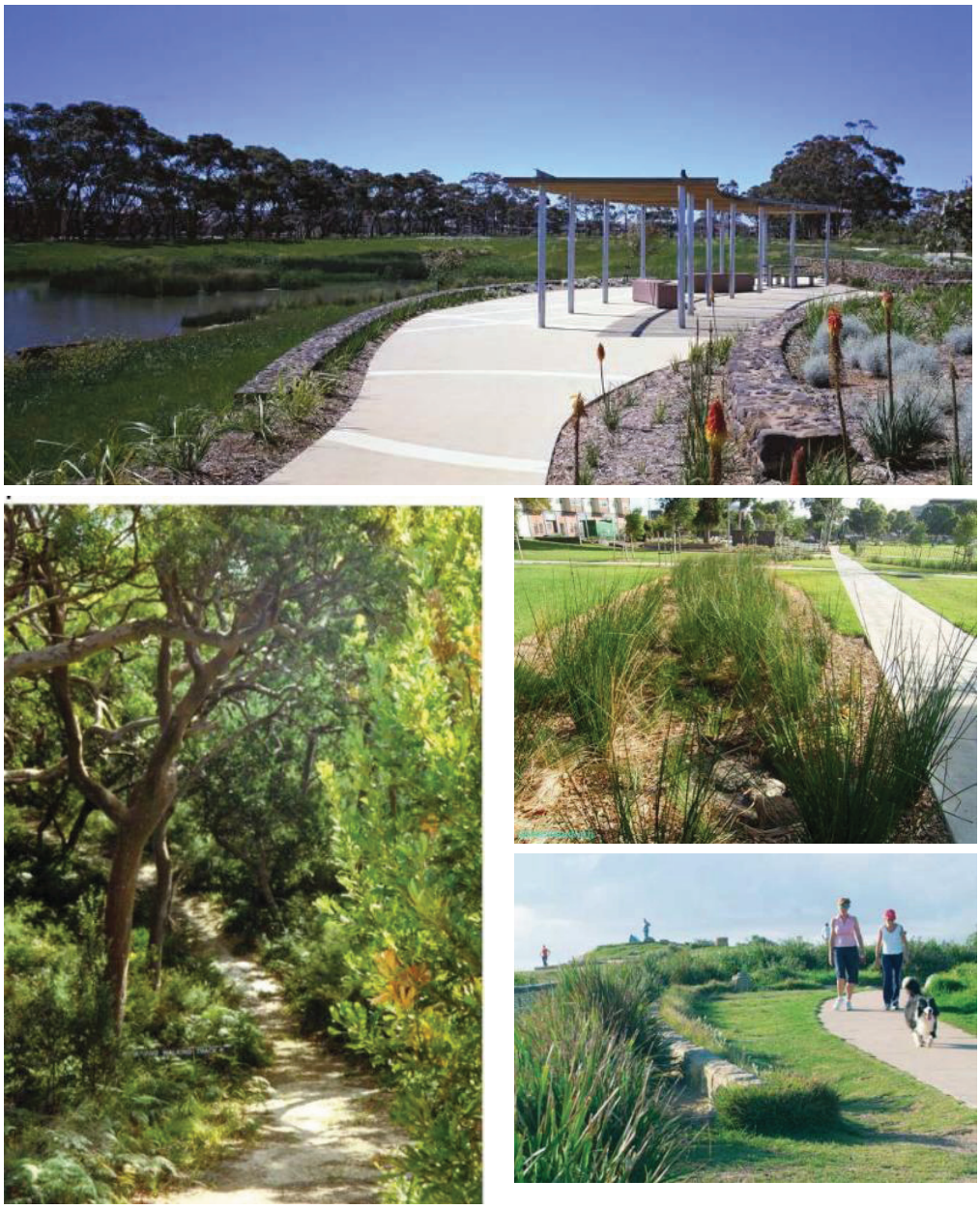


Plate 7.4 Indicative Community Open Space Areas

7.4 Servicing Plan

7.4.1 Stormwater Management Plan

An indicative stormwater management plan has been developed to achieve the general objectives outlined previously in **Section 3.5.3**:

- ensure no increase in peak flow rates from the site;
- treatment of stormwater flows from the developed portions of the site to achieve contemporary water quality objectives (indicative values for minimum reductions in pollutant loads are: 80% reduction in total suspended solids; 60% reduction in total phosphorus; and 45% reduction in total nitrogen);
- incorporation of other general Water Sensitive Urban Design (WSUD) objectives including protecting riparian vegetation and integrating stormwater management measures with community open space to improve the scenic and recreational amenity.

The purpose of developing a stormwater management plan in this study is to identify appropriate areas of the site for stormwater detention and treatment and provide an indication of the type of best practice management features relevant to the site and an indicative sizing of these features to achieve the above objectives.

The stormwater management plan is based on dividing the development area into six stormwater catchments. Recommended best practice management features for each catchment are shown in **Illustration 7.2**. The recommended features are described below for each stormwater catchment. Estimates of stormwater flows and pollutants are detailed further below. The estimates of detention volume requirements are based on hand calculations of peak flow rates for existing conditions and post-development conditions for 1, 2, 5, 10, 20, 50 and 100 year average recurrence intervals (ARI) events. The detention volume shown in the tables in the following sub-sections is the maximum volume required to detain flow rates to existing conditions for the various ARI events. The MUSIC model was used to quantify the pollutant loads and removal efficiencies provided by the stormwater treatment measures. Parameters used in the MUSIC modelling are based on the recent Water By Design MUSIC Modelling Guidelines (Water By Design, 2010).

7.4.1.1 Stormwater Catchment No.1 – Low-Density Residential Adjacent to Government Road

This portion of the site is approximately 1.7ha in area and drains to the west towards an ill-defined watercourse that drains south-west to Slatey Creek. This portion of the site is relatively flat with slopes of approximately 2% making it amenable to the use of:

- grassed / vegetated roadside swales for treatment and carriage of flows; and
- end-of-line treatment / detention measures such as bioretention basins and wetlands.

An indicative sizing of an end-of-line bioretention basin to treat the catchment is:

- 500m² surface area with 0.5m extended detention depth; and
- 300m² filter area with 0.5m filter depth with underdrains.

The treatment effectiveness of the above measure achieves contemporary water quality objectives as shown in **Table 7.2**. Additional at-source controls such as rainwater tanks specifically designed for detention and in-line measures such as grassed / vegetated roadside swales would enable the size of the end-of-line treatment / detention measure to be reduced while still achieving contemporary water quality objectives.

Table 7.2 **Stormwater Runoff and Pollutant Loads - Catchment No.1**

Parameter	*Pollutant Loads / Flows from Development Area*	*Pollutant Loads / Flows following Treatment / Detention*	*Percentage Reduction in Pollutant Loads / Flows (%)*
Annual Flow (ML/yr)	10.2	9.43	7.3
Total Suspended Solids (kg/yr)	2,130	85.1	96
Total Phosphorus (kg/yr)	4.37	0.639	85
Total Nitrogen (kg/yr)	21.2	10.5	51
Gross Pollutants (kg/yr)	317	0	100
Peak Flow Rate (m^3/s)	0.26	0.46	220 m^3 storage

Information shown is for illustrative purposes only

Drawn by: RE Reviewed by: MVE Date: December 2010
Source of base data: Lake Macquarie City Council

Steep slopes unsuitable for swale drainage and optimal sizing of in-line measures. End-of-line treatment / detention measures such as bioretention basins are recommended in the flat area adjoining Government Road

Bioretention basin as end-of-line treatment / detention measure in the existing depression

Grassed / vegetated roadside swales for treatment and carriage of flows

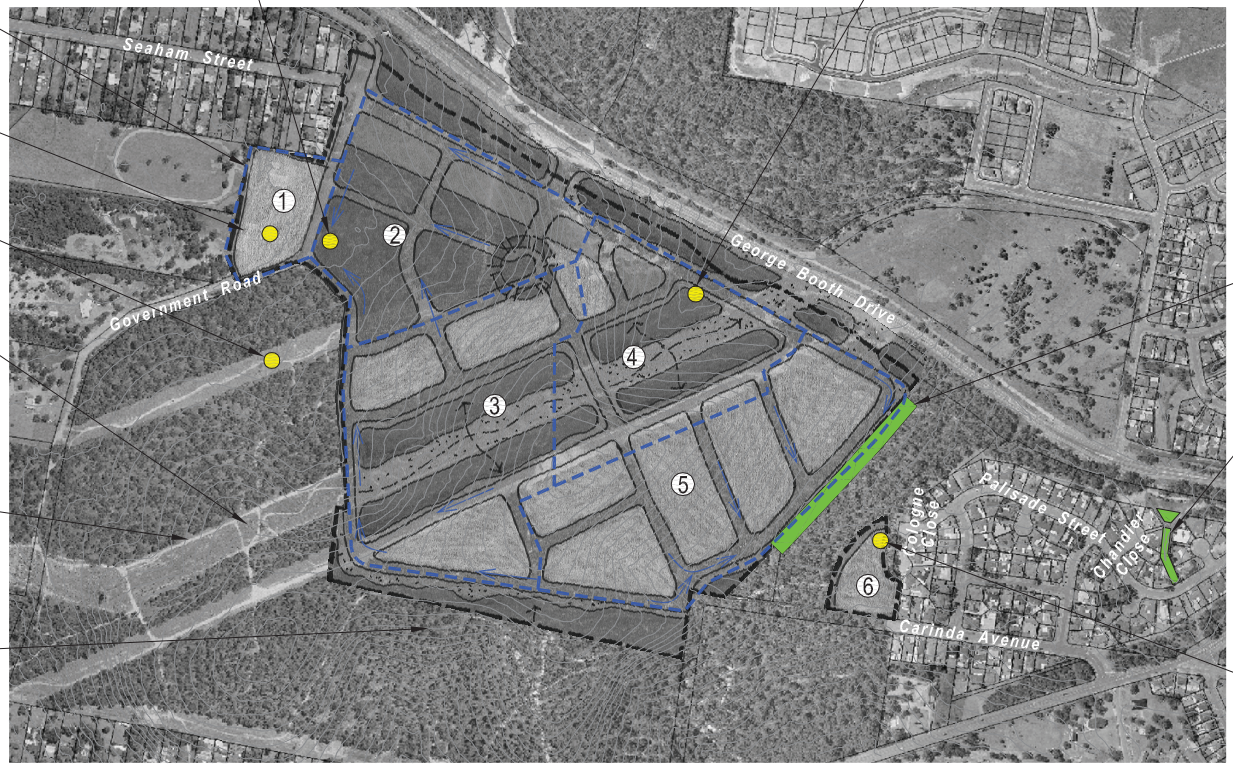
End-of-line treatment / detention measures such as bioretention basins and wetlands

Bioretention basin as end-of-line treatment / detention measure in the cleared powerline corridor

Any unsealed roadways not required for access purposes along the power line corridors to be revegetated with appropriate groundcover vegetation

Any unsealed roadways required for access purposes along the power line corridors to have appropriate drainage and sediment control measures implemented to minimise erosion and capture sediment runoff

Grassed / vegetated roadside swales for some of the perimeter roads where the longitudinal slope is less than 4%



A linear bioretention basin or bioretention swale aligned with the contours on the downslope side of the perimeter road

Alternative for Catchment No.6: Retrofit existing basin near Chandler Close to increase the treatment and detention capacity or compensatory works such as replacing the concrete dish drain with a vegetated swale along the main drainage easement entering the basin

Direct runoff into a bioretention basin prior to discharge into the street drainage system


Bioretention basin


Grassed / vegetated roadside swale


Grassed / vegetated median swale


Grassed / vegetated roadside swales

LEGEND

① Stormwater catchment number
Stormwater catchment boundary
Indicative flow path

North

0 150

GeoLINK

LES: George Booth Drive, Edgeworth
1062857

Stormwater Management Plan

Illustration 7.2

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7.4.1.2 Stormwater Catchment No.2 – Medium-Density Residential and Mixed Use Adjacent to Government Road

This portion of the site is approximately 8.8ha in area and also drains to the west towards an ill-defined watercourse that drains south-west to Slatey Creek. Slopes on this portion of the site range from approximately 10% (relatively steep) in the upper portion to approximately 1% adjacent to Government Road. The steep slopes over most of this area are generally unsuitable to swale drainage and optimal sizing on in-line measures. Therefore end-of-line treatment / detention measures such as bioretention basins are recommended in the flat area adjoining Government Road as shown in **Illustration 7.2**.

An indicative sizing of an end-of-line bioretention basin to treat the catchment is:

- 2,200m² surface area with 0.5m extended detention depth; and
- 1,500m² filter area with 0.5m filter depth with underdrains.

The treatment effectiveness of the above measure achieves contemporary water quality objectives as shown in **Table 7.3**. At-source controls such as rainwater tanks would enable the size of the bioretention basin to be reduced while still achieving contemporary water quality objectives.

Table 7.3 **Stormwater Runoff and Pollutant Loads - Catchment No.2**

Parameter	*Pollutant Loads / Flows from Development Area*	*Pollutant Loads / Flows following Treatment / Detention*	*Percentage Reduction in Pollutant Loads / Flows*
Annual Flow (ML/yr)	59.6	55.8	6.3
Total Suspended Solids (kg/yr)	13,400	539	96
Total Phosphorus (kg/yr)	26.4	4	85
Total Nitrogen (kg/yr)	121	61.6	49
Gross Pollutants (kg/yr)	1,820	0	100
Peak Flow Rate (m³/s)	1.65	3.16	1,100m³ storage

7.4.1.3 Stormwater Catchment No.3 – Low Density Residential Near Ridgeline

This portion of the site is approximately 12.8ha in area however 4.6ha of this area comprises the powerline easements and vegetated buffers. The remaining 8.2ha is nominated for low density residential development. Catchment No.3 is located upslope of Catchment No.2 with the drainage generally flowing to the same location as Catchment No.2. Catchment No.3 has been separated from the downslope catchment due to the opportunity to direct flows to a constructed wetland or bioretention basin in the cleared powerline corridor located in the north-west corner of Catchment No.3. Draining flows to this location is recommended on the basis of:

- making use of a cleared and relatively flat portion of the site outside the nominated development area that does not have any significant ecological value;
- providing the dual benefit of vegetating a portion of this cleared area while providing stormwater treatment to the development area; and
- removing flows from Catchment No.2 and thereby maximising the developable area of this catchment by reducing the treatment area requirements.

Outflows from constructed wetland or bioretention basin would flow north-west along an existing gully towards Government Road and then west towards the ill-defined watercourse that drains south-west to Slatey Creek.

Slopes in Catchment No.3 range from approximately 5% to 10%. Potential treatment measures shown in **Illustration 7.2** include:

- grassed / vegetated roadside swales for some of the perimeter roads where the longitudinal slope is less than 4%;

- a grassed / vegetated swale to carry flows from the downstream end of the catchment to the end-of-line treatment / detention measure in the cleared powerline corridor; and
- a bioretention basin as end-of-line treatment / detention measure in the cleared powerline corridor. A constructed wetland is not considered optimal due to the limited flat area.

An indicative sizing of an end-of-line bioretention basin to treat the catchment is:
- 2,000m² surface area with 0.5m extended detention depth; and
- 1,400m² filter area with 0.5m filter depth with underdrains.

The treatment effectiveness of the above measure achieves contemporary water quality objectives as shown in **Table 7.4**. At-source controls such as rainwater tanks would enable the size of the bioretention basin to be reduced while still achieving contemporary water quality objectives.

Table 7.4 **Stormwater Runoff and Pollutant Loads - Catchment No.3**

Parameter	*Pollutant Loads / Flows from Development Area*	*Pollutant Loads / Flows following Treatment / Detention*	*Percentage Reduction in Pollutant Loads / Flows*
Annual Flow (ML/yr)	52.9	49.4	6.6
Total Suspended Solids (kg/yr)	11,200	394	97
Total Phosphorus (kg/yr)	22.6	3.5	85
Total Nitrogen (kg/yr)	113	55.2	51
Gross Pollutants (kg/yr)	1,630	0	100
Peak Flow Rate (m³/s)	1.54	2.95	1,000m³ storage

7.4.1.4 Stormwater Catchment No.4 – Low-Density Residential and Mixed Use near Former Quarry Site

This portion of the site is approximately 8.3ha in area however 3.9ha of this area comprises the powerline easements and vegetated buffers. The remaining 4.4ha is nominated for low-density residential and mixed use development. The catchment drains to the north-east through a culvert beneath George Booth Drive eventually flowing into Cocked Hat Creek.

Slopes on this portion of the site range are approximately 10% (relatively steep) which are generally unsuitable to swale drainage and optimal sizing on in-line measures. Recommended treatment measures include:
- on-site detention measures to address the additional runoff associated with the higher percentage impervious area of mixed use developments. This will minimise the size of end-of-line detention / treatment measures;
- a bioretention basin as end-of-line treatment / detention measure in the existing depressions upstream of the culvert beneath George Booth Drive shown in **Illustration 7.2**. A constructed wetland is not considered optimal due to the limited flat area.

An indicative sizing of an end-of-line bioretention basin to treat the catchment is:
- assuming all detention volume is to be provided in the bioretention basin:
  - 1,600m² surface area with 0.5m extended detention depth; and
  - 200m² filter area with 0.5m filter depth with underdrains.
- assuming on-site detention provides approximately 60% of total volume requirement:
  - 700m² surface area with 0.5m extended detention depth; and
  - 500m² filter area with 0.5m filter depth with underdrains.

Table 7.5 **Stormwater Runoff and Pollutant Loads - Catchment No.4**

Parameter	*Pollutant Loads / Flows from Development Area*	*Pollutant Loads / Flows following Treatment / Detention*	*Percentage Reduction in Pollutant Loads / Flows*
Assuming all detention volume is to be provided in the bioretention basin			
Annual Flow (ML/yr)	41.5	41	1.2
Total Suspended Solids (kg/yr)	5910	428	93
Total Phosphorus (kg/yr)	14.8	3.08	79
Total Nitrogen (kg/yr)	99.4	52.7	47
Gross Pollutants (kg/yr)	1110	0	100
Peak Flow Rate (m^3/s)	0.852	1.96	800 m^3 storage
Assuming on-site detention provides approximately 60% of total volume requirement[1]			
Annual Flow (ML/yr)	41.5	40.2	3
Total Suspended Solids (kg/yr)	5910	693	88
Total Phosphorus (kg/yr)	14.8	3.38	77
Total Nitrogen (kg/yr)	99.4	53.9	46
Gross Pollutants (kg/yr)	1110	0	100
Peak Flow Rate (m^3/s)	0.852	1.96	350 m^3 storage in bioretention basin 450 m^3 on-site detention

Note: 1. On-site detention was not modelled in determining pollutant load reductions

7.4.1.5 Stormwater Catchment No.5 – Low-Density Residential in North-Eastern Portion

This portion of the site is approximately 10.6ha in area comprising low-density residential development. The catchment drains to the north-east through a culvert beneath George Booth Drive eventually flowing into Cocked Hat Creek.

Slopes on this portion of the site range are relatively steep ranging from approximately 10% to 15%. These steep slopes are generally unsuitable to swale drainage and optimal sizing on in-line measures. Recommended treatment measures include a linear bioretention basin or bioretention swale aligned with the contours on the downslope side of the perimeter road as shown in **Illustration 7.2**. A constructed wetland is not considered optimal due to the limited flat area.

An indicative sizing of an end-of-line bioretention basin to treat the catchment is:

- 1,800m^2 surface area with 0.5m extended detention depth; and
- 1,500m^2 filter area with 0.5m filter depth with underdrains.

Table 7.6 **Stormwater Runoff and Pollutant Loads - Catchment No.5 Low-Density Residential Area**

Parameter	*Pollutant Loads / Flows from Development Area*	*Pollutant Loads / Flows following Treatment / Detention*	*Percentage Reduction in Pollutant Loads / Flows*
Annual Flow (ML/yr)	63.4	59.7	5.9
Total Suspended Solids (kg/yr)	13,500	681	95
Total Phosphorus (kg/yr)	26.7	4.81	82
Total Nitrogen (kg/yr)	129.0	69.2	46
Gross Pollutants (kg/yr)	1,980	0	100
Peak Flow Rate (m^3/s)	2.0	3.5	1,100m^3 storage

7.4.1.6 Stormwater Catchment No.6 – Low-Density Residential in Eastern Portion

This portion of the site is approximately 1.1ha in area and is located partly on a ridgeline. The majority of the site drains north to either the gully to the north-west of the site or into the street drainage system of Cologne Close / Palisade Street. The drainage ultimately flows to the north-east through a culvert beneath George Booth Drive eventually flowing into Cocked Hat Creek. Slopes on the site are in the order of 5%.

The site adjoins Cologne Close and it is likely that all lots on the site would drain into the existing street drainage system. It is assumed the street drainage system flows to the existing basin located immediately north-east of Chandler Close prior to flowing through the culvert beneath George Booth Drive. The additional pollutants and flows into this system from development of Stormwater Catchment No.6 are not considered significant. However, if treatment and detention of flows from the site are required then two options are available:

- Direct runoff into a treatment and detention measures at the development site prior to discharge into the street drainage system (a bioretention basin would be the most applicable measure); or
- Retrofit the existing basin near Chandler Close to increase the treatment and detention capacity to accommodate the additional loads from the site or other compensatory works such as replacing the concrete dish drain with a vegetated swale along the main drainage easement entering the basin.

Assuming that a bioretention basin is constructed at the development site, the indicative size is:

- 200m² surface area with 0.5m extended detention depth; and
- 150m² filter area with 0.5m filter depth with underdrains.

The treatment effectiveness of the above measure is shown in **Table 7.7**.

Table 7.7 **Stormwater Runoff and Pollutant Loads - Catchment No.6**

Parameter	*Pollutant Loads / Flows from Development Area*	*Pollutant Loads / Flows following Treatment / Detention*	*Percentage Reduction in Pollutant Loads / Flows*
Annual Flow (ML/yr)	6.58	6.21	5.7
Total Suspended Solids (kg/yr)	1510	106	93
Total Phosphorus (kg/yr)	2.79	0.536	81
Total Nitrogen (kg/yr)	13.6	7.44	45
Gross Pollutants (kg/yr)	205	0	100
Peak Flow Rate (m³/s)	0.27	0.48	75m³ storage

7.4.2 Water Supply

The proposed water supply strategy is discussed in **Section 3.9.1**.

7.4.3 Sewerage Strategy

The proposed water supply strategy is discussed in **Section 3.9.2**.

7.5 Apportionment of Additional Infrastructure and Servicing Costs

7.5.1 Options Assessment

- The current local development contribution system for **NSW has recently undergone considerable reform and this reform is still ongoing. At present there are generally three ways in which Councils can levy contributions. These are:**a contribution levied under Section 94 under an adopted Developer Contribution Plan(s);

- a fixed development consent levy levied under Section 94A under an adopted Developer Contribution Plan(s);
- a contribution levied under a voluntary Planning Agreement between a Planning Authority and person.

The subject site is made up of 5 lots owned by different parties. The majority of the study area is contained within Lot 88 DP 755262 and Lot 107 DP100048 which are owned by Hammersmith Management P/L. Part lots 6 and 7 DP4647 are smaller parcels of land and owned by private land owners. Lot 17 DP 849003 (old tram line) is owned by the State Transit Authority. The fact that site is held in a number of different ownerships makes it more complex to equitably levy contributions.

It is likely that most of the infrastructure costs will involve works on Lot 88 DP 755262 and Lot 107 DP100048 which are owned by Hammersmith Management P/L. This works could include:

- opens space;
- community services;
- transport facilities – road works, traffic management and pedestrian and cycle facilities; and
- stormwater.

Given that it is likely that Council will require the developer Lot 88 DP 755262 and Lot 107 DP100048 of to construct most if not all of all required infrastructure it would be up to Council to ensure that the owners of Part Lots 6 and 7 DP4647 equitably contribute to the cost of provision of this infrastructure. Note it is unlikely that Lot 17 DP 849003 (old tram line owned by State Transit Authority) will have any significant development potential.

It is therefore considered that the fairest way to achieve equitable contribution would be via way of a Voluntary Planning Agreement. It is therefore recommended that Council enter into discussions with all property owners that have development potential determine the feasibility of preparing a voluntary planning agreement that ensures an equitable distribution of infrastructures costs for the study area. This could be achieved by estimating development yield based on size of land and zoning.

If such an agreement cannot be reached a Section 94 Developer Contribution Plan would need to be prepared in order to equitably levy infrastructure costs over the study area.

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8

Land Use and Zone Options

8.1 Main Influencing Factors

Based on the findings of this LES and associated specialist studies and relevant legislation applying to the site and its context, the primary factors influencing land use options are:

- flora;
- fauna habitat;
- wildlife corridors;
- bushfire;
- soils, slope and geotechnical;
- noise;
- visual amenity;
- existing and future transport corridors;
- traffic and access;
- water supply;
- sewer supply; and
- heritage;

The above factors have been previously identified and described in **Section 2** and **Section 3** of this LES. **Illustration 4.1** identifies the opportunities and constraints that influence the future urban development of the site.

In addition to the above factors it should also be noted that Council's Integrated Planning Department staff, the Proponent and representatives from the Department of Environment, Climate Change and Water have had a series of meetings to discuss an appropriate development footprint for the site. A number of development scenarios were discussed. GeoLINK received correspondence form LMCC dated 6 April 2010 (refer **Appendix K**) requesting it to finalise the LES taking into consideration 3 development scenarios. These scenarios have been considered in determining an appropriate development footprint for urban development**.**

8.2 Potential Land Use Options

The subject site is currently zoned 10 Investigation under the Lake Macquarie Local Environmental Plan 2004. This is a transitional zone requiring that the site be further investigated to determine an appropriate zone(s). The identified environmental constraints that exist within the site limit future land use options for the site. These options are discussed below.

The site is identified as a future urban area in the LHRS 2006 and needed to assist Lake Macquarie City Council in meeting its housing targets to meet the increasing demand for housing within the LGA. The site is located in proximity to existing and approved future residential areas and is adjacent to the strategically identified and approved Pambulong Commercial and Retail Area. The environmental assessment carried out as part of **Section 3** of this LES indicates that, aside from ecological impacts, there is no significant impediment to rezoning the site for urban purposes. This is subject to necessary mitigation measures being implemented as part of preparation and assessment of any future development application for the site.

The site has significant ecological value in terms of its existing vegetation and its potential use by fauna species. It also contains threatened species of flora and fauna as well as Endangered Ecological Communities (EEC's). Therefore zoning the entire site to accommodate urban development is not recommended as it would have an unacceptable impact on local biodiversity and on the ecology of the site. However, given the site's proximity to existing and future residential, retail and commercial development, the need to provide for the increasing demand for residential lands within the LGA and its strategic identification as a residential investigation area in the Newcastle/Lake Macquarie Western Planning Strategy, it is considered that rezoning part of the site for urban development is ecologically sustainable if suitable offsets are in place to compensate for loss of

biodiversity. These offsets must ensure the long-term improvement of biodiversity conservation in the locality and must provide legal protection of land to ensure security of management actions.

8.3 Potential Zones for the Site

8.3.1 Proposed Development Footprint

There are a number of options under Lake Macquarie Local Environmental Plan 2004 (LMLEP 2004) for zoning the proposed development footprint to accommodate urban development. A discussion on each of the possible zones is provided below.

8.3.1.1 Residential Development

There are two specific residential zones contained within Lake Macquarie Local Environmental Plan 2004. These are the 2(1) Residential Zone and 2(2) Residential (Urban Living) Zone.

Zone 2 (1) Residential Zone
The objectives of this zone are:

- permit development of neighbourhoods of low-density housing;
- provide for general stores, community service activities or development that includes home businesses whilst maintaining and enhancing the residential amenity of the surrounding area;
- ensure that housing development respects the character of surrounding development and is of good quality design; and
- provide for sustainable water cycle management.

This zone generally caters for low density residential development as well as uses that are compatible with low density residential development.

Zone 2 (2) Residential (Urban Living) Zone
The objectives of this zone are:

- provide for medium and high density housing;
- encourage development of good quality design within the zone;
- provide an environment where people can live and work in home businesses and professional services whilst maintaining the residential amenity of the surrounding area;
- provide residents with good access to a range of urban services and facilities;
- encourage amalgamation of existing lots to facilitate well designed medium and high density development; and
- provide for sustainable water cycle management.

This zone caters for medium to high density residential development and generally should be in proximity to urban centres that have a range of urban services and facilities.

The subject site is adjacent to land zoned 2(1) Residential some of which has previously been developed and is adjacent to the Pambulong Forest Marketplace. The site has also been identified for residential investigation within the Newcastle- Lake Macquarie Western Corridor Planning Strategy. It is therefore considered that both of the residential zones would be appropriate for different parts of the site.

The Zone 2 (2) Residential (Urban Living) Zone is considered most appropriate for section of the site that is directly opposite the approved Pambulong Forest Marketplace retail and commercial centre as is it will provide higher density housing within easy walking distance to the new commercial/retail centre and therefore reduce and also complement the land across George Booth Drive that is also zoned Zone 2 (2) Residential (Urban Living) Zone.

The remainder of the land within the development footprint could be zoned 2(1) Residential provided that there are no other more suitable zones (refer to discussion below).

8.3.1.2 Commercial Development

There are three business zones contained in the LMLEP 2004. These are 3(1) Urban Centre (Core) Zone, 3(1) Urban Centre (Support) Zone and Zone B4 Mixed Use Zone.

Zone 3 (1) Urban Centre (Core) Zone
The objectives of this zone are to:

- provide land for commercial, retail, recreational and housing uses in a central location;
- generate viable employment and economic activity;
- create urban centres for safe and vibrant social, cultural and community activity;
- create public spaces that are accessible, welcome all people and are a central focus for the community; and
- provide for sustainable water cycle management.

Zone 3 (2) Urban Centre (Support) Zone
The objectives of this zone are to:

- provide land for development that supports the viability of Urban Centre (Core) zoned land;
- encourage good quality design within the zone;
- provide land for mixed use development comprising residential uses in combination with commercial and retail uses, professional services and home based businesses;
- provide for sustainable water cycle management.

Zone B 4 Mixed Use Zone
The objectives of this zone are to:

- to provide for a mixture of compatible land uses;
- to integrate suitable business, office, residential, retail and other development in accessible locations so as to maximise public transport patronage and encourage walking and cycling;
- to enable development that complements and enhances the core retail function and trading performance of the local area within the regional retail hierarchy;

The Pambulong Forest Marketplace retail and commercial centre directly north of the site has been zoned Zone 3 (1) Urban Centre (Core) and its use has received development consent from Council. The economic assessment in relation to this local environmental study has highlighted that limited demand exists in the locality for land zoned for commercial or retail purposes given the approval of the Pambulong retail/commercial centre and other existing developments in the locality. It is therefore considered that both Zone 3 (1) Urban Centre (Core) Zone and Zone 3 (2) Urban Centre (Support) Zone are not the most suitable zones for the subject site.

The Zone B 4 Mixed Use Zone is a relatively new zone within LMLEP 2004 and provides some flexibility in the type of uses permissible within land designated with this zone. It is considered that this zone could be suitable for the provision of employment lands within the site which would complement the Pambulong Retail Commercial Area. Council Industrial Land Study and the Economic Impact Assessment for this LES indicates that there is a need for provision of land to cater for changing trends in business mix and the need for identification of smaller parcels of urban industrial land to meet the demand of mixed residential/light trade and knowledge based industry. This type of precinct would cater for people involved in industries such as media and digital content industries, film, television, music, design, publishing, computer games, advertising, architecture and the arts. The mixed use zone would allow people working in these types of industries to set up their practice/operations in this locality whilst also living onsite or close to their place of business. The advantages of this are the potential for reducing traffic, congestion, vehicle trips, greenhouse gases and fuel consumption. These factors strongly support the inclusion of a mixed use zoning within the site.

8.3.1.3 Industrial Development

There are three different industrial zones in the LEP. These are 4 (1) Industrial (Core) Zone, 4 (2) Industrial (General) Zone and 4 (3) Industrial (Urban Services) Zone. A summary of the objectives of each objective is incorporated below.

Zone 4 (1) Industrial (Core) Zone
The objectives of this zone are to:

- provide land for a wide range of employment-generating industries, including manufacturing, processing, assembly, storage and distribution uses, and
- provide land for a range of industrial uses that, because of their nature, require large areas of land or separation from more intensive forms of employment generating industries, and
- ensure that industries are designed and located so as not to cause unacceptable environmental harm or adversely affect the amenity of the environment, including residential neighbourhoods, and
- provide for sustainable water cycle management.

Zone 4 (2) Industrial (General) Zone
The objectives of this zone are to:

- provide land for light industries that can service surrounding community needs and provide local employment opportunities, and
- enable ancillary retail/commercial uses, in conjunction with an approved development, providing it will not undermine the retail function and general amenity of existing and future urban centres, and
- ensure that development is well designed, has minimal adverse impact on the environment and integrates with the urban environment, and
- provide opportunities for high technology industries, scientific research and development, or similar activities, and
- provide for sustainable water cycle management

Zone 4 (3) Industrial (Urban Services) Zone
The objectives of this zone are to:

- provide land for light industries that can service surrounding community needs and provide local employment opportunities, and
- provide land for the wholesale or retail sale of bulky goods, and
- provide land for research and development, and for applied technology, that can service surrounding community needs and provide employment opportunities, and
- support the role of existing and future urban centres while not undermining the retail and commercial functions and general amenity of these centres, and
- ensure that development is well designed, has minimal adverse impact on the environment and integrates with the urban environment, and
- provide for sustainable water cycle management.

These zones were all given consideration as part of this environmental study for the proposed development footprint. A mix of uses within the development footprint is considered beneficial for a number of reasons including improved urban design outcomes, support for the Pambulong Commercial/Retail Area, increased employment options. It is considered however that this mix of uses could be delivered more effectively through the B 4 Mixed Use Zone (refer to previous discussion on this zone). It is also considered that locating industrial uses in proximity to residential development can create land use conflict. It is therefore considered that none of the three industrial zones are suitable for the site. In addition to this the Newcastle Lake Macquarie Western Corridor Planning Strategy has identified other land in the locality that will be investigated for the provision of employment lands.

8.3.2 Areas of Environmental Protection

Due to the significance of the flora and fauna throughout the southern portion of the site, this area should be given an environmental conversation zoning. There are two Environmental Zones within LMLEP 2004. The two zones and their objectives area outlined below.

Zone 7 (1) Conservation (Primary) Zone
The objectives of this zone are to:

- provide and conserve land having ecological, scientific, geological, educational, faunal, floristic or aesthetic values, and
- preserve and enhance areas of significant vegetation and habitat to promote the regeneration of ecosystems and eradication of invasive species that compete with native flora and fauna, and
- conserve, enhance and manage corridors to facilitate species movement, dispersal and interchange of genetic material, and
- exclude activities which would prejudice the ongoing conservation or rehabilitation of land, and
- encourage activities that meet conservation objectives, and
- protect land within this zone from impacts from development on adjoining zones, and
- provide for sustainable water cycle management.

Zone 7 (2) Conservation (Secondary) Zone
The objectives of this zone are to:

- protect, conserve and enhance land that is environmentally important, and
- protect, manage and enhance corridors to facilitate species movement, dispersal and interchange of genetic material, and
- enable development where it can be demonstrated that the development will not compromise the ecological, hydrological, scenic or scientific attributes of the land or adjacent land in Zone 7 (1), and
- ensure that development proposals result in rehabilitation and conservation of environmentally important land, and
- provide for sustainable water cycle management.

The conservation zone that affords the most protection to the environmental attributes of a particular site is the Zone 7 (1) Conservation (Primary) Zone as it contains less permissible uses and stronger objectives than the Zone 7 (2) Conservation (Secondary) Zone. Given the presence of Ecologically Endangered Communities and threatened flora and fauna species within the site and the need to ensure an east-west biodiversity corridor is retained, it is considered that the Zone 7(1) Conservation (Primary) Zone is the most appropriate zone for this part of the site.

8.4 Recommended Zones for the Site

As outlined in **Section 7** the Structure Plan identifies a development footprint within the study area. This footprint has been derived as a result of the analysis of the constraints and opportunities relating to the site and also as a result of negotiations between Council, DECCW and the proponent. Whilst this footprint has ecological constraints, social and economic considerations dictate that development of this land should proceed. . The following zones are considered most appropriate to facilitate the development of the proposed development footprint identified in the Structure Plan:

LR This is proposed to be a low density precinct. The most appropriate zone for this area is considered to be the 2(1) Residential Zone [Zone 2(1)].

MR This is proposed to be developed as a medium density precinct due to its proximity to the Pambulong Forest Marketplace.

MU This precinct should be developed as a Mixed Use area due to its visually and acoustically exposed location and its proximity to the Pambulong Forest Marketplace. The most appropriate zone for this area is considered to be the Zone B 4 Mixed Use Zone.
Any future DCP for the MU precinct should provide for the entirety of the area to be developed as mixed use.

Generally, B4 Mixed Use zoning in the vicinity of the Pambulong town centre is considered a desirable inclusion for the future zoning of the site. However it may be more suitable for this type of mixed use zone to be located to

the north of the subject site adjacent to the Pambulong Town Centre making mixed use development more accessible as it can be integrated with the emerging town centre.

8.5 Recommended Zones under the Standard Instrument

Lake Macquarie City Council is currently preparing its city wide LEP in accordance with the Standard Instrument (Local Environmental Plans) Order 2006. This has not yet been completed however Council have stated that as far as possible, the new LEP will be a conversion of the current LM LEP 2004 to fit within the Standard Instrument requirements. This means that for most properties in the City, although the name of the land use zone may change, there will be little or no difference to the nature of development that can be carried out on the land. **Table 8.1** shows how the zones in the current LEP may be converted to the new zones when Council adopts its new Standard LEP pursuant to the Standard Instrument (Local Environmental Plans) Order 2006. It should be noted that the particular zone chosen will depend on how Council prepares and adopts the Standard Instrument—Principal Local Environmental Plan.

Table 8.1 **Suggested Zones Pursuant to Standard LEP Template**

Recommended Zone under current LEP	***Standard LEP***	***Comments***
Zone 2 (1) Residential Zone	R 2 Low Density Residential	In the current draft version of the LM LEP 2011, Council has generally adopted the approach of converting Zone 2 (1) Residential Zone to R 2 Low Density Residential
Zone 2 (2) Residential (Urban Living) Zone	R3 Medium Density Residential	Council have not adopted the R4 High Density Residential Zone in the Draft LM LEP 2011 and the R3 Medium Density is considered the most appropriate zone for to provide for the type of preferred development in this locality.
Zone B 4 Mixed Use Zone	B4 Mixed Use	This is a very similar zone to what is in the standard template and is a logical conversion.
Zone 7 (1) Conservation (Primary) Zone	E2 Environmental Conservation	The E2 Environmental Conservation zone is the only suitable option to convert the Zone 7 (1) Conservation (Primary) Zone to.

Recommendations

9.1 Recommendations

It is recommended that the draft LEP for the site amend the Lake Macquarie LEP 2004 by way of a map amendment as shown in **Illustration 9.1**.

It is further recommended that appropriate offsets are determined in consultation with Department of Environment, Climate Change and Water and implemented to counterbalance loss of vegetation and impacts on biodiversity.

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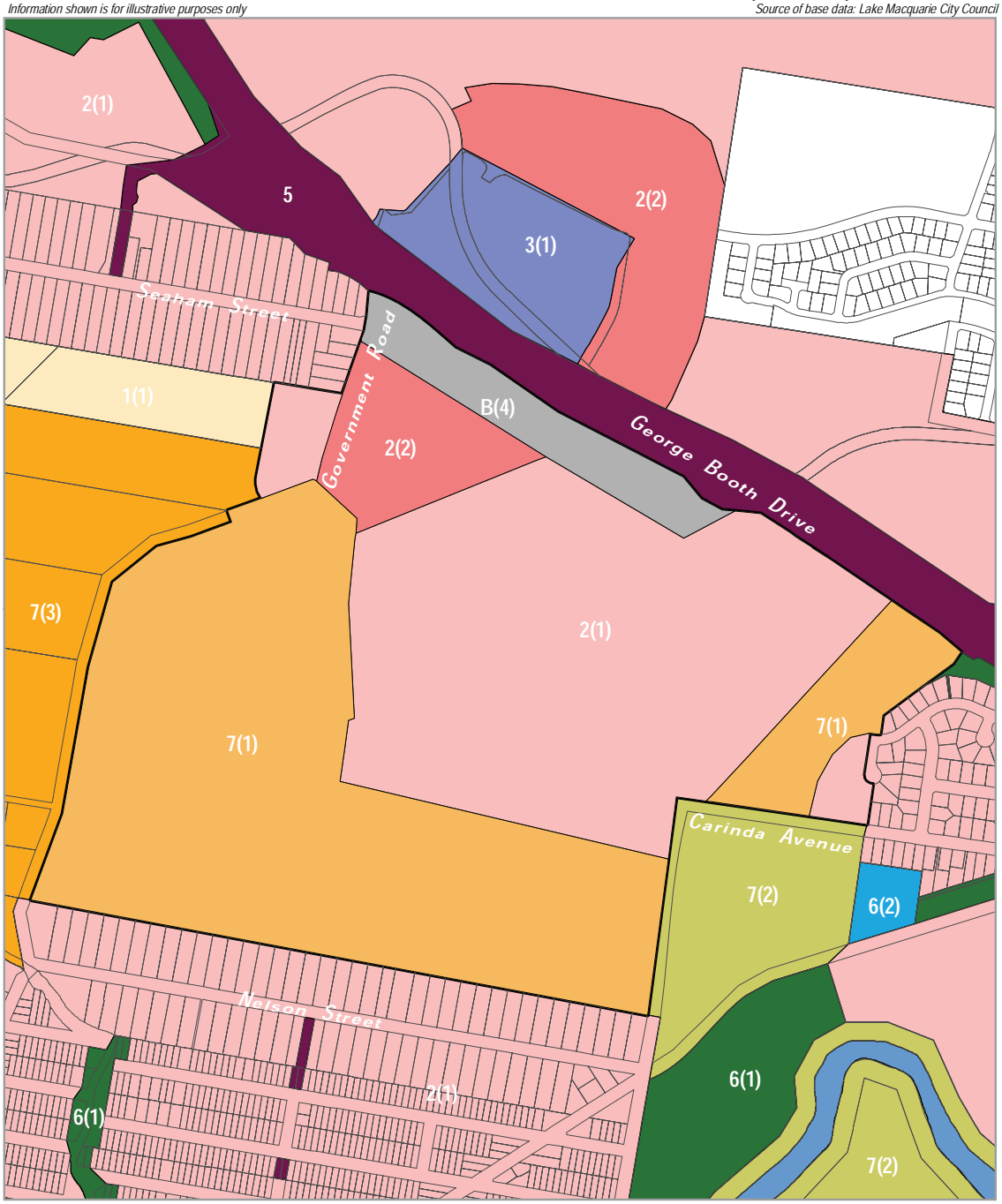
Information shown is for illustrative purposes only

Drawn by: RE Reviewed by: MVE Date: December 2010
Source of base data: Lake Macquarie City Council



LEGEND

- Site boundary
- 1(1) Rural Production
- 2(1) Residential
- 2(2) Residential (Urban Living)
- 3(1) Urban Centre
- 5 Infrastructure
- 6(1) Open Space
- 6(2) Tourism and Recreation
- 7(1) Conservation (Primary)
- 7(2) Conservation (Secondary)
- 7(3) Conservation (General)
- 10(d) Investigation Zone
- 11 Lake and Waterways
- B(4) Mixed Use
- Deferred Matter

0 200

North

Recommended Zoning

GeoLINK environmental management and design

LES: George Booth Drive, Edgeworth
1062848

Illustration 9.1

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Project Team

The project team members included:

Simon Waterworth
Senior Planner / Principal

Veronica Silver
Ecologist/Planner/Senior Associate

Megan Jamieson
Planner

Tim Ruge
Environmental Engineer

Garry Murray
Senior Landscape Architect / Associate

Ali McCallum
Environmental Scientist

Richard Elliot
Landscape Designer/illustrator

Jacob Sickinger
Planner

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Copyright and Usage

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Appendix A

Consultation Responses

The following are the responses received from:

- Response from Department of Environment and Conservation NSW;
- Response from Department of Natural Resources NSW;
- Response from Department of Primary Industries NSW;
- Response from Energy Australia;
- Response from Heritage Council of NSW;
- Response from Hunter New England NSW Health;
- Response from Hunter Water;
- Response from NSW Rural Fire Service;
- Response from Mine Subsidence Board;
- Response from the Ministry for Transport; and
- Response from the RTA

Your reference : F2005/01846
Our reference : DOC07/2076, FIL06/921
Contact : Karen Thumm, 4908 6829

Mr B Bell
General Manager
Lake Macquarie City Council
PO Box 1906
HUNTER REGIONAL MAIL CENTRE NSW 2310

30 JAN 2007

Attention: Ms Angel Troke

Dear Mr Bell

SECTION 34A AND SECTION 62 CONSULTATION – DRAFT AMENDMENT TO LAKE MACQUAIRE LOCAL ENVIRONMENT PLAN 2004 IN RESPECT OF GEORGE BOOTH DRIVE, EDGEWORTH

I refer to your letter of 17 January 2007 seeking comments from the Department of Environment and Conservation (DEC) on the above matter.

The DEC notes that this area was identified in the Lower Hunter Regional Strategy as a renewal corridor for the provision of opportunities for economic renewal and/or housing renewal and intensification.

Prior to finalising the LES for this area, it is recommended that Council be satisfied that:

- Any potential landuse conflicts associated with air, noise and odour impacts are adequately addressed, particularly in relation to premises scheduled under the *Protection of the Environment Operations Act 1997*.

- The proposed rezoning, wherever possible, minimises the impacts on areas of native vegetation, by concentrating urban and industrial uses to the most degraded parts of the land. We recommend consideration of threatened or regionally significant flora and fauna species, populations and ecological communities. It is noted that threatened species, including *Tetratheca juncea*, Squirrel Glider, Little Bent-wing Bat, Grey-headed Flying Fox, Eastern Freetail-Bat and Greater Broad-nosed Bat have been recorded either on site or near the site. The DEC recommends that the proposal attempts to avoid impacts on these species or mitigates for any impacts. Wherever the retention of habitat is not possible, we suggest that offsets are provided either on-site or off-site in order to retain an "improve or maintain" biodiversity outcome for the proposal.

- The proposed LES adequately considers the relevant threatened species provisions of the *Environmental Planning and Assessment Act 1979*, State Environmental Planning Policy

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ABN 30 841 387 271
www.environment.nsw.gov.au

(SEPP) 44 - Koala Habitat Protection, SEPP 71 - Coastal Protection and the *Native Vegetation Act 2003*.

- Important corridor functions have been retained. It is noted that the proposal footprint includes a wildlife corridor (100 m or more) along the southern edge (as identified by Lake Macquarie LGA Native Vegetation and Corridors Map, 2003). It would appear that this land could also be enhanced to function as a link in a north-south direction.

- In preparing the LES, an appropriate level of Aboriginal cultural heritage assessment has been undertaken, and that the proposed LES is not likely to impact on areas of cultural significance to the Aboriginal community. Also, it is important that the views of Aboriginal community groups be sought and fully considered in regard to the preparation of the LES.

- Potential direct and indirect impacts on DEC estate, wilderness areas, wild rivers and recognised areas of high conservation value have been adequately considered and avoided, ameliorated or compensated as appropriate.

- Given the nature of the proposed changes in landuse it is imperative that any areas of contamination on the site are identified and managed in accordance with the *Contaminated Land Management Act 1997*.

- Stormwater emanating from the area must be managed in a sustainable manner to prevent any impacts on the adjacent rivers, wetlands or estuaries.

Your attention is also drawn to the Commonwealth legislation, the *Environment Protection and Biodiversity Conservation Act 1999*. If the proposed LES affects any species requiring consideration under this legislation then consultation may be required from the Department of Environment and Heritage.

If you have any enquiries concerning this advice, please contact Dr Karen Thumm, Conservation Planning Officer, on 4908 6829.

Yours sincerely

RICHARD BATH
Acting Head Planning, Hunter
North East Branch
Environment Protection and Regulation

NSW Government
DEPARTMENT OF NATURAL RESOURCES

Your Ref: F2005/01846
Our Ref: ER7204

19 February 2007

General Manager
Lake Macquarie City Council
Box 1906
Hunter Region Mail Centre NSW 2310

Attention: Strategic Planner

Dear Sir/Madam

S 62 CONSULTATION; DRAFT AMENDMENT LAKE MACQUARIE LEP 2004
GEORGE BOOTH DRIVE EDGEWORTH

I refer to Council's letter of 16 January 2007 concerning the above proposal. The proposed amendment has been reviewed with regard to potential natural resource values and issues. Relevant issues identified are the possibility that groundwater dependent ecosystems may be present; the site's large amount of intact vegetation, its important connectivity role in that area and its proximity to Cockle Creek.

DNR recommends consideration of the following matters before finalising any rezoning for this site:

- Development be confined to disturbed and cleared areas, and areas where vegetation is in low condition.
- The proposed urban development design account for the proximity to Cockle Creek on the south eastern boundary. Appropriate water sensitive urban design principles should be applied to the urban development to manage drainage towards Cockle Creek.
- Buffer strips associated with managing drainage from the hill slopes along the western and eastern boundaries should be used to maximise connectivity with the remaining intact vegetation.
- The presence of potential groundwater dependent ecosystems should be investigated.

Should there be any further enquiry in this matter, please contact me on (02) 4904 2538.

Yours sincerely

Jeff Hunt
Senior Natural Resource Planner
Hunter Region

NSW DEPARTMENT OF
PRIMARY INDUSTRIES

Angel Troke
Integrated Planning Department
Lake Macquarie Council
PO Box 1906
Hunter Region Mail Centre
NSW 2310

Our ref: 07/729
Your ref: F2005/01846

Dear Angel,

SECTION 62 CONSULTATION – DRAFT AMENDMENT TO LAKE MACQUARIE LOCAL ENVIRONMENTAL PLAN 2004 FOR GEORGE BOOTH DRIVE, EDGEWORTH

Thank you for your letter of 16th January 2007 concerning the above draft amendment. This is a coordinated Department of Primary Industries response that reflects the views of the Mineral Resources Division. There are no issues relevant to the interests of the Agriculture and Forestries Divisions nor Forests NSW. The Department apologises for the lateness of this response.

The subject area lies within the Lake Macquarie Mine Subsidence District and is covered by Consolidated Coal Lease (CCL) 725 which is part of the West Wallsend Colliery owned by Oceanic Coal Ltd. The area is also located within Petroleum Exploration Licence (PEL) 267 held by Sydney Gas Operations Pty Ltd. The area is underlain by a potential coal resource and mine workings.

Any future development would need to comply with Mine Subsidence Board guidelines.

For further information please contact Leslie Wiles, Acting Manager Coal Advice and Resource Assessment Teams, 02 4931 6555.

Yours sincerely,

Cameron Ricketts
Team Leader, Land Use
19th February 2007

Mineral Resources NSW

PO Box 344 Hunter Region Mail Centre NSW 2310
516 High Street Maitland NSW 2320

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Tel: 02 4931 6666
Fax: 02 4931 6790

Reference: JP48/2007-50/7
Telephone: (02) 4951 9312
Facsimile: (02) 4951 9988
Email: jpritchard@energy.com.au

EnergyAustralia™

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Address all mail to
PO Box 487
Newcastle NSW 2300
Australia

13 February 2007

Lake Macquarie City Council
Box 1906
HUNTER REGION MAIL CENTRE
NSW 2310

Att: Angel Troke

Section 62 Consultation – Draft Amendment to Lake Macquarie Local Environmental Plan 2004 for George Booth Dr Edgeworth

I refer to your letter reference F2005/01846 dated 16 January 2007 regarding the above matter.

EnergyAustralia has three existing Transmission Lines within the boundaries of this draft amendment to the Local Environmental Plan. These include two 132kV Transmission Lines which are an essential part of the Newcastle/Lake Macquarie electricity supply. Please find attached a plan from EnergyAustralia's GIS System showing the location of these transmission lines.

EnergyAustralia's Network Division advises that 24 hour access to these lines is to be maintained at all times. EnergyAustralia also has strict regulations as to the construction of buildings and the like within the easement. All requests to encroach within the easement must be approved by EnergyAustralia's Network Division.

If you require any further information please contact EnergyAustralia's Property Officer, Jenny Pritchard on telephone 49519312.

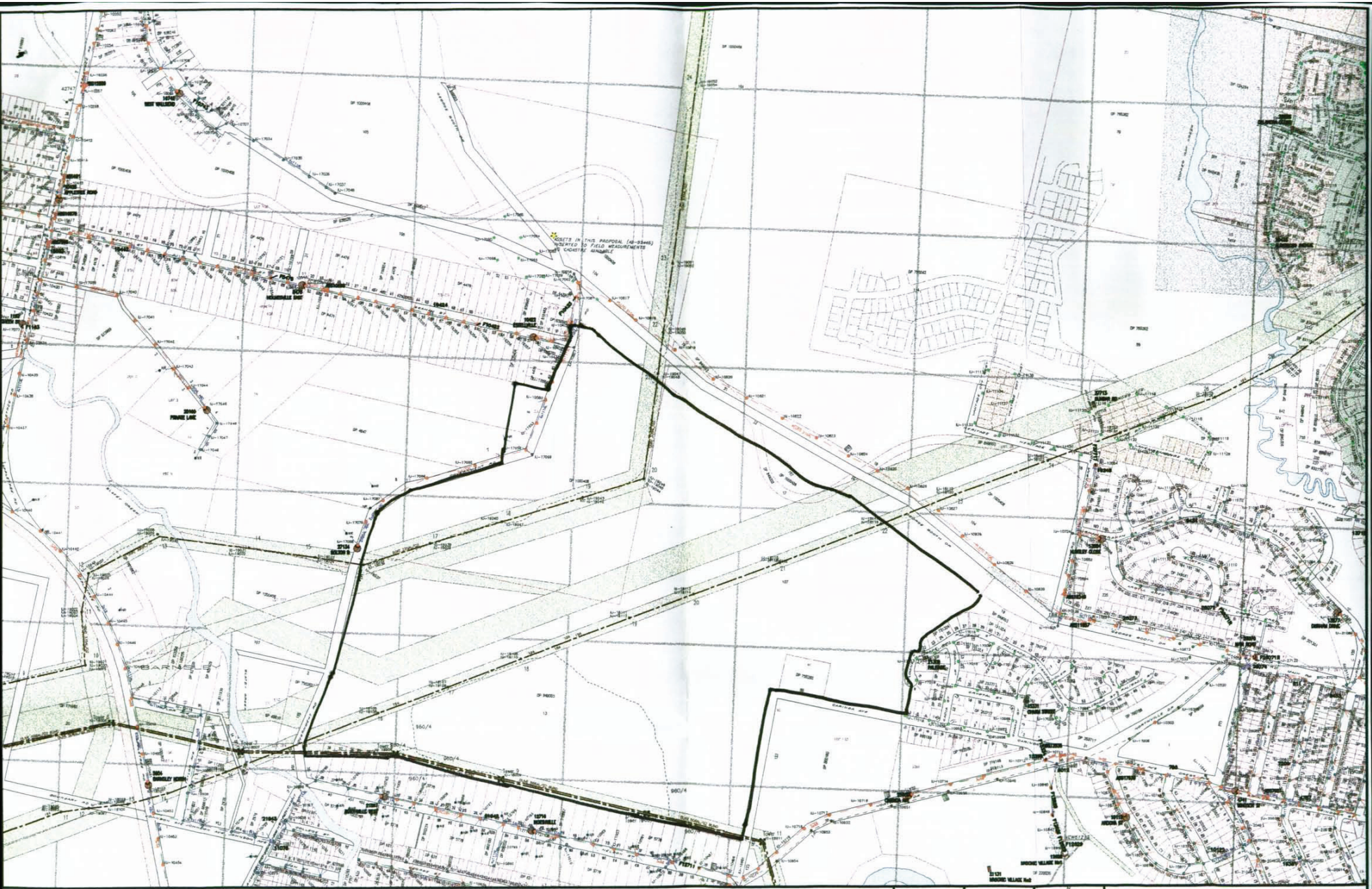
Your assistance in this matter is appreciated.

Yours faithfully,

Jenny Pritchard
Property Officer – Network Easements & Leases

Enc. Plans

Partner



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A3 Plain Border plot

PLAN FORM 3 — To be used in conjunction with Plan Form 2

WARNING: CREASING OR FOLDING WILL LEAD TO REJECTION

DP1000408

Registered 22-9-1999

This is sheet 4 of my plan in 4 sheets dated 21ST DECEMBER, 1998

Stephen Lawler

Surveyor registered under Surveyors Act 1929

This is sheet 4 of the plan of 4 sheets covered by my Certificate No. 09/2021 of 20/09/2021

General Manager/authorised person

For use where space is insufficient in any panel on Plan Form 2.

The Common Seal of The Broken Hill Proprietary Company Limited was hereunto affixed by authority of the Board of Directors:

R J McNEILLY

R W Taylor

(B) – PROPOSED EASEMENT FOR ELECTRICITY TRANSMISSION LINE AND ACCESS THERETO VAR. WIDTH (DP 646525)

(C) – EASEMENT FOR ELECTRICITY TRANSMISSION LINE AND ACCESS THERETO 15 WIDE AND VAR. (DP 646525) NOTD. IN GOV. GAZ. No.102 OF 17-9-1993

(E) – K453732 EASEMENT FOR TRANSMISSION LINE 45.72 WIDE (7734 3070)

(F) – J181471 – EASEMENT FOR TRANSMISSION LINE 30.48 WIDE (DP 106524)

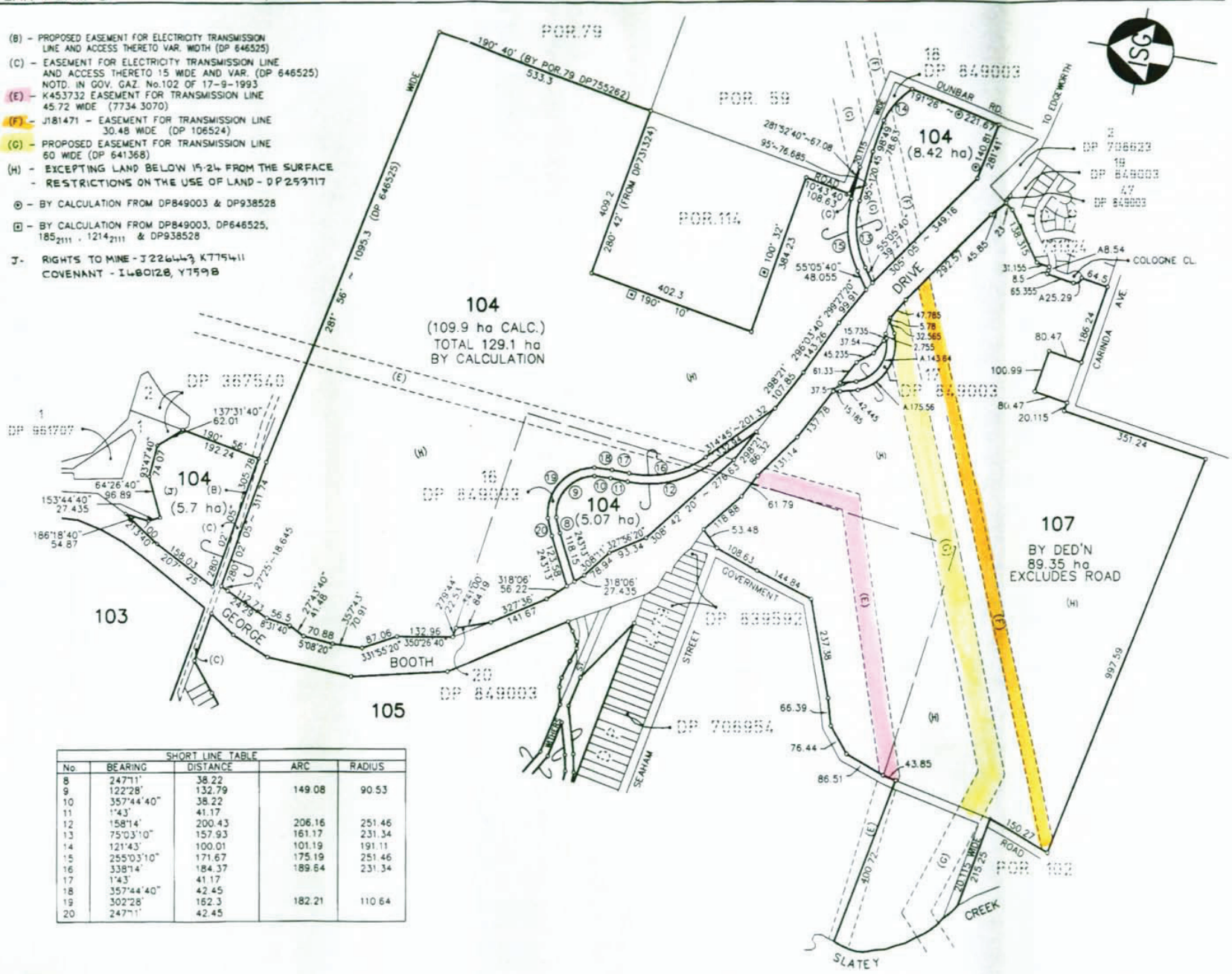
(G) – PROPOSED EASEMENT FOR TRANSMISSION LINE 60 WIDE (DP 641368)

(H) – EXCEPTING LAND BELOW 15.24 FROM THE SURFACE – RESTRICTIONS ON THE USE OF LAND – DP253717

⊙ – BY CALCULATION FROM DP849003 & DP938528

⊡ – BY CALCULATION FROM DP849003, DP646525, 185_{2111} . 1214_{2111} & DP938528

J– RIGHTS TO MINE – J226443, K775411
COVENANT – I480128, Y7598



SHORT LINE TABLE

No.	BEARING	DISTANCE	ARC	RADIUS
8	247°11'	38.22		
9	122°28'	132.79	149.08	90.53
10	357°44'40"	38.22		
11	1°43'	41.17		
12	158°14'	200.43	206.16	251.46
13	75°03'10"	157.93	161.17	231.34
14	121°43'	100.01	101.19	191.11
15	255°03'10"	171.67	175.19	251.46
16	338°14'	184.37	189.64	231.34
17	1°43'	41.17		
18	357°44'40"	42.45		
19	302°28'	162.3	182.21	110.64
20	247°11'	42.45		

Plan Drawing only to appear in this space

Reduction Ratio 1 : 6000

SURVEYOR'S REFERENCE 17624

Department of Lands

LAND AND PROPERTY INFORMATION NEW SOUTH WALES - TITLE SEARCH

FOLIO: 107/1000408

SEARCH DATE	TIME	EDITION NO	DATE
13/2/2007	12:01 PM	4	24/10/2002

LAND

LOT 107 IN DEPOSITED PLAN 1000408
AT ESTEVILLE
LOCAL GOVERNMENT AREA: LAKE MACQUARIE
PARISH OF TERALBA COUNTY OF NORTHUMBERLAND
TITLE DIAGRAM: DP1000408

FIRST SCHEDULE

HAMMERSMITH MANAGEMENT PTY LTD (T 6523380)

SECOND SCHEDULE (9 NOTIFICATIONS)

1. RESERVATIONS AND CONDITIONS IN THE CROWN GRANT(S)
2. EXCEPTING LAND BELOW A DEPTH FROM THE SURFACE OF 15.24 METRES
3. J181471 EASEMENT FOR TRANSMISSION LINE AFFECTING THE PART OF THE LAND ABOVE DESCRIBED SHOWN SO BURDENED IN THE TITLE DIAGRAM
   7404104 EASEMENT NOW VESTED IN ENERGYAUSTRALIA
4. J226443 K775411 RIGHTS TO MINE
5. K453732 EASEMENT FOR TRANSMISSION LINE AFFECTING THE PART OF THE LAND ABOVE DESCRIBED SHOWN SO BURDENED IN THE TITLE DIAGRAM
   O268489 SHORTLAND ELECTRICITY IS NOW THE REGISTERED PROPRIETOR OF THE EASEMENT
   7404104 EASEMENT NOW VESTED IN ENERGYAUSTRALIA
6. O287784 COVENANT
7. Y7598 COVENANT AFFECTING THE PART SHOWN SO BURDENED IN THE TITLE DIAGRAM.
8. 5720554 EASEMENT FOR TRANSMISSION LINE 60 METRES WIDE AFFECTING THE SITE DESIGNATED (G) IN THE TITLE DIAGRAM
9. 8923448 MORTGAGE TO NATIONAL AUSTRALIA BANK LIMITED

NOTATIONS

UNREGISTERED DEALINGS: NIL

*** END OF SEARCH ***

ena:new-pritchardj PRINTED ON 13/2/2007

Heritage Council of New South Wales

3 Marist Place
Parramatta NSW 2150
Locked Bag 5020
Parramatta NSW 2124
DX 8225 PARRAMATTA

Telephone: 61 2 9873 8500
Facsimile: 61 2 9873 8599
heritageoffice@heritage.nsw.gov.au
www.heritage.nsw.gov.au

Contact: Ian Grant
Telephone: 02-9873 8562
Ian.grant@heritage.nsw.gov.au
File: H98/00082
Our Ref: HRL 44105
Your Ref: F2005/01846

The General Manager
Lake Macquarie City Council
Box 106
Hunter Region Mail Centre NSW 2310
Attention: Ms. A. Troke

Dear Sir/Madam

Re: Draft Amendment to Lake Macquarie Local Environmental Plan 2004 for George Booth Drive, Edgeworth– s.62 Consultation

Thank you for referring the above mentioned draft Local Environmental Plan (LEP) to the Heritage Office for comment. The draft LEP was received on 19th January 2007. The draft Plan and supporting information have been reviewed and the following advice is provided under the provisions of Section 63 of the Environmental Planning and Assessment Act.

It is noted that the draft LEP intends to rezone:

1. Land south of George Booth Drive, Edgeworth (Lot 88 DP 755362, Lot 107 DP 100048, Part Lots 6 and 7 DP 4647 and Lot 17 DP 849003) from Zone 10 Investigation, to accommodate urban development and conservation.
2. Land north of George Booth Drive Cameron Park (land associated with Pambulong Town Centre-Part Lot 1001 DP 1092785) from zones 2(1) Residential and 2(2) Residential (Urban Living) to 3(1) Urban Centre (Core) Zone.

Section 84(1) of the NSW Heritage Act requires that any local environmental plan that will apply to land on which an item of environmental heritage is situated must contain provisions to facilitate the conservation of the building, work, relic, place or precinct.

As the draft Plan will result in the conservation of items that have been assessed as having Local heritage significance, no objection is raised to the content and intent of the draft LEP.

The current Lake Macquarie LEP 2004, contains appropriate provisions in this regard. As these provisions will need to be considered for any proposed development and/or change of use of the subject site(s), it is unnecessary for any further heritage provisions to be included as part of the preparation of the draft LEP. Accordingly, no objection is raised to the draft Plan on this basis.

It is noted that the West Wallsend Steam Tram Line, is not on the State Heritage Register. However, as this item is of highest-level significance to the history of development of the city and as there are increasing pressures for development adjacent to it, it is considered imperative that Council requires all future development

applications for proposed development adjacent to the item, to be accompanied by a Statement of heritage Impact.

It would be appreciated if Council would consider the above comments and incorporate them into the draft Plan. There is no need to return the draft LEP to the Heritage Office for comment.

I trust these comments are of assistance. If you require any additional information please contact Ian Grant on (02) 9873 8562 or 0439 496749.

Yours faithfully

19/02/07

Vincent Sicari
Manager
Conservation Team
Heritage Office
Department of Planning

Hunter New England Population Health

Direct Contact Details
Phone: (02) 4924 6206 Fax: (02) 4924 6490
Email: kelly.main@hnehealth.nsw.gov.au

HUNTER NEW ENGLAND
NSW HEALTH

31 January 2007

Angel Troke
Strategic Planner
Integrated Planning Department
Lake Macquarie City Council
Box 1906, Hunter Region Mail Centre
NSW 2310

via email: council@lakemac.nsw.gov.au

Dear Angel Troke

SECTION 62 CONSULTATION - DRAFT AMENDMENT TO LAKE MACQUARIE LOCAL ENVIRONMENT PLAN 2004 FOR GEORGE BOOTH DRIVE, EDGEWORTH

Thankyou for referring the above mentioned LEP to Hunter New England Population Health for comment as part of the consultation process.

The Environmental Health program has reviewed the LEP specifications and has also conducted a site inspection. We would recommend that the following issues being considered in the specifications and be addressed prior to future development:

1. A mosquito risk assessment should be included in the flora and fauna assessment or in the assessment of the terrain features to ensure any potential mosquito breeding sites are identified. A mosquito management plan should also be developed if constructed wetlands are proposed in the urban development with consideration of best practice design. This is to prevent both nuisance biting mosquitoes and disease transmitting mosquitoes to the local population.

2. Assessment of the slope, soils and geotechnical characteristics should be used to inform subdivision block size and capability for on site disposal of waste water.

3. The Social Impact assessment should also include potential local employment opportunities particularly with the proposed development of a local township.

4. It would be expected that the incorporation of best practice design principles includes energy and water saving strategies such as rainwater tanks and grey water re-use and appropriate approval and monitoring process are in place to prevent risks to both public health and environment contamination.

Hunter New England Area Health Service
Hunter New England Population Health
ABN 24 500 842 605

Locked Bag 10
Wallsend NSW 2287
Phone (02) 4924 6477 Fax (02) 4924 6490
Email PHEnquiries@hnehealth.nsw.gov.au
www.hnehealth.nsw.gov.au/hneph

5. Foot paths and cycle ways are important for both encouraging an active lifestyle and reducing the impact on the environment from increased vehicle use. Best practice design should ensure that people are connected via foot paths and cycle ways to services, employment, the proposed township, to recreational parks/facilities, schools, neighbouring developments and to public transport. The traffic and transport analysis should also consider the public transport availability and if services will be available to new developments.

If you have any questions please feel free to contact me on the above numbers.

Yours sincerely

Ms Kelly Main
Environmental Health Manager
Hunter New England Population Health
Hunter New England Area Health Service

Hunter New England Population Health

Direct Contact Details
Phone: (02) 4924 6206 Fax: (02) 4924 6490
Email: kelly.main@hnehealth.nsw.gov.au

HUNTER NEW ENGLAND
NSW HEALTH

31 January 2007

Angel Troke
Strategic Planner
Integrated Planning Department
Lake Macquarie City Council
Box 1906, Hunter Region Mail Centre
NSW 2310

via email: council@lakemac.nsw.gov.au

Dear Angel Troke

SECTION 62 CONSULTATION - DRAFT AMENDMENT TO LAKE MACQUARIE LOCAL ENVIRONMENT PLAN 2004 FOR NEWPORT ROAD, AVONDALE COLLEGE, CENTRAL ROAD AND HIGHLAND AVENUE, COORANBONG.

Thankyou for referring the above mentioned LEP to Hunter New England Population Health for comment as part of the consultation process.

The Environmental Health program has reviewed the LEP specifications and has also conducted a site inspection. We would recommend that the following issues being considered in the specifications and be addressed prior to future development:

1. A mosquito risk assessment should be included in the flora and fauna assessment or in the assessment of the terrain features to ensure any potential mosquito breeding sites are identified across all 3 sites. Particularly as the area adjoins Dora Creek. A mosquito management plan should also be developed if constructed wetlands are proposed in the urban development with consideration of best practice design. This is important to prevent issues arising with nuisance biting mosquitoes and disease transmitting mosquitoes to the local population.

2. The assessment should also ensure the impact of future development on the water quality of Sandy Creek is considered. Rural zoning must ensure that there is minimal impact on the water quality of Sandy creek particularly from waste water run off or from hobby farming practices.

3. The infrastructure assessment needs to consider subdivision lot sizes in relation to the provision of sewerage or on-site disposal systems for the proposed 6 rural living lots. If lot sizes require an on-site disposal system the assessment must include the soil capability to provide long term and sustainable sewerage disposal in accordance with Council's installation and approval requirements.

Hunter New England Area Health Service
Hunter New England Population Health
ABN 24 500 842 605

Locked Bag 10
Wallsend NSW 2287
Phone (02) 4924 6477 Fax (02) 4924 6490
Email PHEnquiries@hnehealth.nsw.gov.au
www.hnehealth.nsw.gov.au/hneph

4. The assessment should also consider water and sewerage availability for the proposed student accommodation and auditorium. Any proposed water re-use scheme must undergo approval from the relevant authorities.

5. The Social Impact assessment should also include potential local employment opportunities particularly with the proposed increase in student population.

6. It would be expected that the incorporation of best practice design principles include energy and water saving strategies such as rainwater tanks and grey water re-use and appropriate approval and monitoring process are in place to prevent risks to both public health and environment contamination.

7. Foot paths and cycle ways are important for both encouraging an active lifestyle and reducing the impact on the environment from increased vehicle use. Best practice design should ensure that people and the community is connected via foot paths and cycle ways to services, employment, student accommodation, to recreational parks/facilities, schools, neighbouring developments and to public transport. The traffic and transport analysis should also consider the public transport availability particularly on days and at times when students would be expected to arrive and leave the accommodation.

If you have any questions please feel free to contact me on the above numbers. Please ensure that the LEP includes referral and comments from Council's Environmental Health Unit.

It would be greatly appreciated and would improve the timeliness of comments from Hunter New England Health if future consultation papers could be sent either by email attention to:

david.durrheim@hnehealth.nsw.gov.au

or mailed to:

Dr. David Durrheim
Director Health Protection
Hunter New England Population Health
Hunter New England Area Health Services
Locked Bag 10
Wallsend NSW 2287

Yours sincerely

Ms Kelly Main
Environmental Health Manager
Hunter New England Population Health
Hunter New England Area Health Service

HUNTER WATER CORPORATION . PO BOX 5171 HRMC NSW 2310 . TEL 1300 657 657
36 HONEYSUCKLE DRIVE NEWCASTLE . ABN 46 228 513 446 . HUNTERWATER.COM.AU

15 March 2007

Ref: 2007-92

Angel Troke
Lake Macquarie City Council
PO BOX 1906
Hunter Region Mail Centre NSW 2310

Dear Ms Troke

RE SECTION 62 CONSULTATION – DRAFT AMENDMENT TO LAKE MACQUARIE LOCAL ENVIRONMENT PLAN 2004 FOR LAND NORTH AND SOUTH OF GEORGE BOOTH DRIVE, EDGEWORTH

Lot 88 DP 755262, Lot 107 DP 100048, Pt Lots 6 & 7 DP 4647, Lot 17 DP 849003 and Pt Lot 1001 DP 1092785

Thank you for your letter of 16 January 2007 regarding the proposed draft amendment to the Lake Macquarie LEP 2004 for land north and south of George Booth Drive, Cameron Park. Hunter Water values the opportunity to comment on the draft amendment and accordingly offers the following preliminary assessment with respect to providing water and sewer services to the subject land:

Wastewater Transportation

A wastewater transportation servicing strategy for this area was prepared in 2003, which included potential rezoning of the two sites to the north of George Booth Drive as part of the large Pambulong Forest development. However, only partial redevelopment of the large site south of George Booth Drive was identified in this strategy.

However, based on the latest rezoning information provided by Council, the loadings and servicing options for the subject sites will need to be reviewed as part of the next Edgeworth Servicing Strategy to be carried out by Hunter Water. This study is planned for completion by mid 2008 at which time Hunter Water's capital works program will be updated based on the study findings.

It is likely that servicing of the two sites north of George Booth Drive can be carried out in line with the recommendations of the 2003 Edgeworth Servicing Strategy for the Pambulong Forest development. The requirement for any system upgrades will need to be assessed at the time of development.

Servicing of the large site south of George Booth Drive will be complex and the developer will need to prepare a sewer servicing strategy for this site as part of the Section 50 process. The sewer systems to which this area drains generally have limited capacity to accept additional flows, however upgrades in these catchments are planning from 2010 onwards.

Water Supply

The sites are located in the South Wallsend system and have frontage to trunk mains in George Booth Drive. A water servicing strategy for this system is currently being finalised. Future development assumed for the subject sites was similar to that described above for the Wastewater Transportation Servicing Strategy. However, based on the assumed demands

in the Servicing Strategy, the South Wallsend system performs generally well and has some capacity to cater for future growth.

A revised Servicing Strategy for the South Wallsend Water Supply System is planned to be completed in 2010 and Council's latest rezoning information will be used to prepare the study.

It should be noted that HWC is currently reviewing recycled water opportunities in its area of operations and due to the size of the development and it's location close to the Edgeworth WWTW, this site has been identified for possible reuse. A recycled water scheme in this area would involve construction of a recycled water treatment plant at the Edgeworth WWTW which could be provided as part of the Edgeworth WWTW upgrade.

General

Please find attached plans showing the location of existing water and sewer mains in this area.

It is a requirement of Hunter Water that application for a Section 50 "Notice of Requirements" be made for specific development proposals. Hunter Water would then formally assess the development, determine system capacity and nominate actual connection points to water and sewer. The Notice of Requirements would also nominate a number of actions to be completed by the developer. Completion of all actions in the Notice of Requirements triggers release of the Section 50 Compliance Certificate for the development.

The completion of Hunter Water's requirements (usually works and payment of fees) is best achieved prior to issue of Construction Certificate by Council or private certifier for other associated construction works.

To this end Hunter Water requests that Council continue to include appropriate wording in its development consent conditions to reflect our needs.

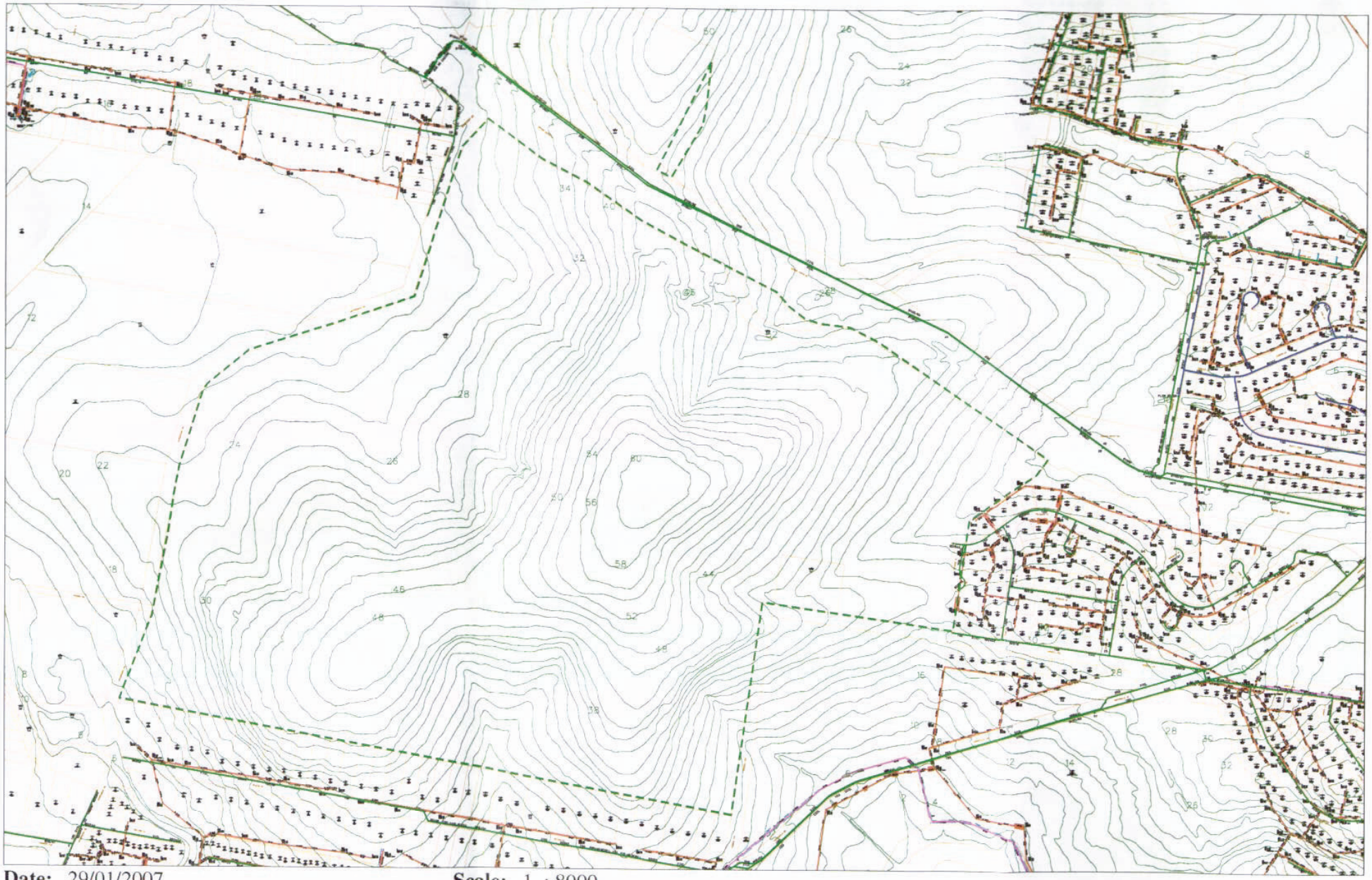
Our Development Services team is available at short notice to discuss with Council or the development community their water and sewer servicing needs and I would encourage open communication between all stakeholders.

Should you require further clarification or assistance please contact the enquiries officer listed below.

Yours faithfully

Brett Lewis
Manager Development Services

Enquiries: Peter Smith
Tel: 1300-657-657
Fax: (02) 4979-9711
Your Ref: F2004/01846



Date: 29/01/2007 **Scale:** 1 : 8000

Notes: Various Lots, George Booth Drive, Edgeworth

HWC

2007-92

All communications to be addressed to:

Head Office
NSW Rural Fire Service
Locked Mail Bag 17
Granville NSW 2142

Telephone: (02) 8741 5555

Head Office
NSW Rural Fire Service
15 Carter Street
Homebush Bay NSW 2127

Facsimile: (02) 8741 5550

The General Manager
Lake Macquarie Council
Box 1906
Hunter Region Mail Centre NSW 2310

Your Ref: F2006/01846
Our Ref: LEP/0075
A07/0076 MH

Attention: Angel Troke

27 March 2007

Dear Sir/ Madam,

Re: Draft Amendment to Lake Macquarie Local Environmental Plan 2004 for George Booth Drive, Edgeworth - Rezoning.

I refer to your letter dated 16 January 2007 seeking our advice in accordance with Section 62 of the *Environmental Planning & Assessment Act 1979* for the above Local Environmental Plan (LEP).

The NSW Rural Fire Service (RFS) notes that the subject area is identified as bush fire prone on the Lake Macquarie Bush Fire Prone Land map. As a result, future residential or Special Fire Protection Purpose Developments will be subject to the requirements of Section 79BA of the *Environmental Planning and Assessment Act 1979* and Section 100B of the *Rural Fires Act 1997*,

Based upon an assessment of the plans and documentation received for the proposal, the RFS advises that the requirements of *Planning for Bushfire Protection 2006* are to be considered in the planning stages of any development. Therefore, a bushfire threat assessment should be prepared that addresses the requirements of *Planning for Bushfire Protection 2006.*

It is advised that in the preparation of the LEP, Council consider compliance with *Planning for Bushfire Protection 2006* and the requirements of the Minister for Planning's Section 117 Direction 19 – Planning for Bushfire Protection.

For any enquiries regarding this correspondence please contact Mark Hawkins.

Yours sincerely

Lew Short
Manager, Development Control Services

All communications to be addressed to:

Head Office
NSW Rural Fire Service
Locked Mail Bag 17
Granville NSW 2142

Telephone: (02) 8741 5555

Head Office
NSW Rural Fire Service
15 Carter Street
Homebush Bay NSW 2127

Facsimile: (02) 8741 5550

The General Manager
Lake Macquarie Council
Box 1906
Hunter Region Mail Centre NSW 2310

Your Ref: F2005/01846
Our Ref: LEP/0075
A07/0342 JC

Attention: Angel Troke

18 May 2007

Dear Sir/ Madam,

Re: Draft Amendment to Lake Macquarie Local Environmental Plan 2004 for George Booth Drive, Edgeworth - Rezoning.

I refer to your letter dated 4 April 2007 seeking our advice in accordance with Section 62 of the *Environmental Planning & Assessment Act 1979* for the above Local Environmental Plan (LEP).

It is noted that the NSW Rural Fire Service (RFS) has already provided advice in our response dated 27 March 2007 and raises no additional considerations in relation to bushfire matters for the above rezoning proposal.

In addition the RFS advises that comments provided in our response dated 27 March 2007 are to apply in preparation of the Local Environmental Study for the above site.

For any enquiries regarding this correspondence please contact Jaclyn Cowen on 8741 5444.

Yours sincerely

Nika Fomin
Co-ordinator, Development Control Services

In reply please send to: Newcastle District Office

Our reference: FN07-01541L1

Your reference: F2005/01846

Contact: Paul Gray (02) 4908 4300

General Manager
LMCC
BOX 1906
HRMC NSW 2310

22 January 2007

Dear Sir or Madam

REZONING APPLICATION NO TENQ07-01010L1
LOT 107 DP 1000408 LOT 88 DP 755262 PART LOTS 6 AND 7 DP4647
LOT 17 DP 849003 PART LOT 1001 DP 1092785 GEORGE BOOTH
DRIVE EDGEWORTH

The Mine Subsidence Board has no objections to the proposed rezoning as described in your letter of 16th January 2007 and accompanying plan.

The applicant should be advised to seek the Board's approval for any proposed subdivision or the erection of improvements at the appropriate time.

Yours faithfully

Paul Gray
Acting District Manager

MINE SUBSIDENCE BOARD

HEAD OFFICE:
PO Box 488G
Newcastle 2300
Telephone: (02) 4908 4395
Facsimile: (02) 4929 1032

NEWCASTLE:
NSW Government Offices
117 Bull Street
Newcastle West 2302
PO Box 488G
Newcastle 2300
Telephone: (02) 4908 4300
Facsimile: (02) 4929 1032
DX 4322 Newcastle West

SPEERS POINT:
143 Main Road
Speers Point 2284
PO Box 9 Boolaroo 2284
Telephone: (02) 4950 8088
Facsimile: (02) 4950 8101
DX 7820 Newcastle

WYONG:
Suite 3 Feldwin Court
30 Hely Street
Wyong 2259
PO Box 157 Wyong 2259
Telephone: (02) 4352 1646
Facsimile: (02) 4352 1757
DX 7317 Wyong

SINGLETON:
Coal Services Building
1 Civic Avenue
Singleton 2330
PO Box 524 Singleton 2330
Telephone: (02) 6572 4344
Facsimile: (02) 6572 4504

PICTON:
100 Argyle Street
Picton 2571
PO Box 40 Picton 2571
Telephone: (02) 4677 1967
Facsimile: (02) 4677 2040
DX 26053 Picton

EMAIL:
mail@minesub.nsw.gov.au

WEBSITE:
www.minesub.nsw.gov.au

MINISTRY OF TRANSPORT

Level 19, 227 Elizabeth Street Sydney 2000
GPO Box 1620 Sydney 2001

Telephone 9268 2800 Facsimile 9268 2900
Internet www.transport.nsw.gov.au

ABN 25 765 807 817

Ms Angel Troke
Strategic Planner
Lake Macquarie City Council
Box 1906
HUNTER REGION MAIL CENTRE NSW 2310

Your ref:F2005/01846
Our ref: TP07/00682

Dear Ms Troke,

SECTION 62 CONSULTATION
LAKE MACQUARIE LOCAL ENVIRONMENTAL PLAN 2004
DRAFT AMENDMENT FOR GEORGE BOOTH DRIVE, EDGEWORTH

I refer to your letter dated 16 January 2007 in relation to the Lake Macquarie Local Environmental Plan (LEP) 2004 Draft Amendment for George Booth Drive, Edgeworth. The Ministry of Transport has reviewed the document and wishes to present the following comments.

The Ministry of Transport's primary focus is to ensure that the provisions identified within the draft LEP amendment support the implementation of the Lower Hunter Regional Strategy and are consistent with the objectives of Section 117 Direction #17 - Integrating Land Use and Transport. Taking both initiatives into account, our objectives are to:

- improve access to housing, jobs and services by walking, cycling and public transport;
- increase the choice of available public transport and reducing dependence on cars;
- reduce the number of trips and distances travelled by car; and
- support the efficient and viable operation of public transport services.

The Lower Hunter Regional Strategy (Department of Planning, 2006) has been prepared to provide the basis for sub-regional planning on the Lower Hunter. Lake Macquarie Council is located within the boundaries this sub-region. A number of actions identified in the document in relation to transport are relevant to the identified lands in the draft LEP amendment, including:

- implementation of the recommendations from the Review of Bus Services in NSW that relate to the Lower Hunter, including implementing the

- strategic bus corridors for the Newcastle region;
- the identification of Glendale as an emerging major regional centre, which is in close proximity to the identified lands in the draft LEP amendment;
- the identification of renewal corridors, including the corridor along Main Road between Glendale and Edgeworth, to support the viability of public transport operations; and
- ensure that the planning and design of new release areas is based on the Neighbourhood Planning Principles, which encourage land use design that supports walking, cycling and the introduction of public transport networks that link frequent buses into the rail system.

The commentary provided by Lake Macquarie Council in relation to the traffic and transport analysis specification, developed as part of the Local Environmental Study to be prepared in association with the draft LEP amendment, is noted. The Ministry supports the draft rezoning of the lands from the current Zone 10 Investigation, Residential 2(1) Zone and Residential 2(2) Zone to accommodate urban development, conservation and 3(1) Urban Centre Zone. It is important that future development proposals for the site not only meet NSW Government land use planning targets identified for the local government area but also maximise the use of existing and proposed public transport, walking and cycling infrastructure. This requires a consistent commitment and ongoing discussions between Lake Macquarie Council, landholders and the Ministry of Transport.

The service planning guidelines developed by the Ministry (Ministry of Transport, 2005) support a maximum walking distance of 400 metres to a bus or rail route during the daytime and 800 metres to a bus or rail route during the night. The lands identified in the draft LEP amendment are within a 400 metre walking distance to existing bus services (Routes 265, 266 and 267) that are currently operated by Sugar Valley Bus Service along Northville Drive in Edgeworth. These bus services provides linkages to local shops and community facilities at Glendale, Cardiff, University of Newcastle and Newcastle CBD. The suburb of Cardiff also has direct rail services to major centres on the Central Coast and Sydney. It is important that the use of these public transport services is encouraged by Lake Macquarie Council to minimise the number of car trips generated by the development of the lands covered by the draft LEP amendment.

The re-routing of these bus service or potential bus services may be an opportunity to maximise the use of public transport on the identified lands in the draft LEP amendment. The determination of undertaking this option will depend on the demand likely to be generated by the proposed subdivision and the implications for service delivery times. It is important that any interest in exploring these options should be discussed at the earliest possible stage with the Ministry. The feasibility of these options will require Council to ensure that the subdivision has road layouts that support appropriate geometric configuration for buses, as well as the installation and maintenance of appropriate road-side bus stop infrastructure.

The lands identified under the draft LEP amendment fall within the Newcastle bus contract area. A strategic corridor is planned for this contract area linking Toronto, Glendale, Broadmeadow and Newcastle CBD. A review of bus services in this area is planned within the next three years. This review will facilitate the location and frequency of the strategic bus corridor, as well as district and local bus routes. This review, which is undertaken by the Ministry of Transport and the bus operator for the contract area, is another opportunity to identify potential options that can better service the lands identified in the draft LEP amendment.

Finally, I draw your attention to the following documents which are of relevance to this planning task:

- State Plan (NSW Government, 2006);
- Section 117 Direction #17 - Integrating Land Use and Transport (Department of Planning, 2005);
- Draft State Environmental Planning Policy (SEPP) No 66;
- Planning Guidelines for Walking and Cycling (NSW Government, 2004);
- Service Planning Guidelines (Ministry of Transport, 2005);
- Best Practice Guidelines for NSW Public Transport Signage and Information Displays, (Transport NSW, 2002); and
- Disability Standards for Accessible Public Transport (Commonwealth Legislation, 2002).

If you would like to discuss this further, please contact Juliet Grant, Manager Transport Planning on 9268 2241 or email juliet.grant@transport.nsw.gov.au

Yours sincerely

Lyall Kennedy

Lyall Kennedy
Director Transport Planning

252RZ25;1
07/15
Natasha Waeger

RTA

RECEIVED
20 FEB 2007
LAKE MACQUARIE CITY COUNCIL

The General Manager
Lake Macquarie City Council
DX7869
NEWCASTLE

Attention: Ms Angel Troke

SECTION 62 CONSULTATION – DRAFT AMENDMENT TO LAKE MACQUARIE LOCAL ENVIRONMENTAL PLAN 2004 FOR GEORGE BOOTH DRIVE, EDGEWORTH (F2005/1846)

Dear Ms Troke

I refer to your letter dated 16 January 2007 (Your reference: F2005/1846) requesting issues to be taken into account when preparing a Local Environmental Study (LES) and draft amendment Local Environmental Plan (LEP) for the subject area.

The RTA's primary interests are in the road network, traffic and broader transport issues, particularly in relation to the efficiency and safety of the classified road system, the security of property assets and the integration of land use and transport.

In accordance with the *Roads Act 1993*, the RTA has powers in relation to road works, traffic control facilities, connections to roads and other works on the classified road network. As George Booth Drive (MR527) is a classified State road, RTA concurrence is required for connections to the roads with Council consent, under section 138 of the Act. George Booth Drive is declared a Controlled Access Road (CAR) and direct access across the common boundary of this road and the subject area is restricted. Council is the roads authority for all public roads in the area.

The RTA's requirements for the preparation of the LES and draft LEP primarily relate to traffic generation to / from the site. In this regard the following guidelines would apply:

- DIPNR (Department of Infrastructure, Planning and Natural Resources) EIS Guidelines
  - *Roads and Related Facilities* (Transportation and Traffic Issues)
- Roads and Traffic Authority's *Guide to Traffic Generating Developments*
- EPA's *Environmental Criteria for Road Traffic Noise*

The RTA's primary interests in relation to the road network are to:

- Maintain an efficient and safe road system (includes *SEPP 11* considerations).

- Facilitate the integration of land use and transport (includes consideration of the intent of draft *SEPP 66*).

- Maintain the integrity and security of the road network, property and assets.

The RTA expects that the LES would include preparation of a traffic study, in accordance with the RTA's *Guide to Traffic Generating Developments*, and shall include (but not limited to) the following:

- Identify all relevant vehicular traffic routes and intersection for access to / from the subject areas

- Current traffic counts for all of the above traffic routes and intersections

- The anticipated vehicular traffic generated from the proposed rezoning and other developments / rezoning in the area.

- Consideration of the traffic impact on the existing intersections and the capacity of George Booth Drive to safely and efficiently cater for the additional vehicular traffic generated.

- The ultimate/staged traffic generation from within the area over the time of the development, and the associated staged/ultimate road and transport infrastructure requirements.

- Traffic analysis of existing and any future intersection, using SIDRA or similar traffic model, including;
  - Current traffic counts and traffic growth projects for the life of the project
  - 95th percentile back of queue lengths
  - Delays and level of service on all legs
  - Use of SIDRA or similar traffic model

- Subject to the outcomes of the above traffic study, the RTA may require that additional route modelling be undertaken.

The proponent should be made aware that a signalised intersection is proposed on George Booth Drive in this vicinity to provide access to the North Lakes development area. The proposed development area should connect to that intersection.

The RTA would require that a Section 94 Contributions Plan be completed or a Deed Containing Agreement (DCA) be entered into to cover the cost of any additional road and transport infrastructure related to the future development of the area. The plans/agreements should be in place prior to any approval being granted.

Aside from the comments above, the following issues are raised in relation to this rezoning proposal:

- State Environmental Planning Policy (SEPP) No. 11 – Traffic Generating Developments may apply to subsequent development of the subject area. Therefore any issues as required under this SEPP should be addressed accordingly in the master plan and development stage.

- Council should ensure that the applicants are aware of the potential for road traffic noise to impact on any future development of the area. In this regard, the applicant, not the RTA, is responsible for providing noise attenuation measures in accordance with the Environmental Protection Authority's Environmental Criteria for Road Traffic Noise, should the applicant seek assistance at a later date.

The RTA will hold an objection to the proposed rezoning under section 62 of the *Environmental Planning and Assessment Act, 1979* until the above issues are addressed by Council, to the satisfaction of the RTA, prior to the adoption of the LEP amendment.

Continued consultation on this matter would be appreciated to ensure that both the RTA and Council's interests are included, particularly in relation to provision of traffic and transport infrastructure upgrades.

For more information please contact me on (02) 4924 0240.

Yours sincerely

Dave Young
Manager, Land Use Development
Hunter Operations & Engineering Services

14 February 2007

Appendix B

Ecological Assessment

The following are:

- Vegetation Assessment;
- Fauna Assessment; and
- Survey of Large Forest Owl Habitat Trees.

Vegetation Assessment:

Lot 88 DP755262 & Lot 107 DP100048, George Booth Drive, Edgeworth.

Lake Macquarie LGA

Report to

GeoLINK &

Lake Macquarie City Council

August 2010

Stephen A.J. Bell

Eastcoast Flora Survey
PO Box 216
Kotara Fair NSW 2289

Vegetation Assessment: Lot 88 DP755262 & Lot 107 DP100048, George Booth Drive, Edgeworth. Lake Macquarie LGA

August 2010

Stephen A. J. Bell
Eastcoast Flora Survey,
PO Box 216,
Kotara Fair NSW 2289

EXECUTIVE SUMMARY

A vegetation survey, classification and mapping project of lands comprising the Edgeworth LES in northern Lake Macquarie was carried out during 2008. These lands (Lot 88 DP755262 & Lot 107 DP100048 off George Booth Drive) occupy 96ha of near-coastal land, and have been identified in Lake Macquarie Council's Lifestyle2020 project as potentially forming part of the proposed Pambulong Forest town centre. Apart from four powerline easements and numerous tracks and trails, the site retains extensive stands of native vegetation.

A targeted sampling methodology using eighteen 0.04ha survey plots was performed on the vegetation of the site. Classification of collected data was undertaken with *Primer* v6, using hierarchical clustering and ordination techniques and defining vegetation communities at 51% similarity (0.49 dissimilarity). There was strong congruence between the cluster analysis and 2-dimensional non-metric multidimensional scaling. This classification was also informed by a regional data analysis, which showed each defined community to be robust. Mapping of vegetation communities incorporated the resultant clusters with aerial photographic interpretation and extensive ground truthing.

The Edgeworth LES study area supports over 173 native plant taxa across five vegetation communities. Two of these taxa are currently listed on the Commonwealth *EPBC Act 1999* or the NSW *TSC Act 1995* (*Callistemon linearifolius* and *Tetratheca juncea*), and one is nationally rare (*Eucalyptus fergusonii* subsp*. fergusonii*). The vegetation communities present are all various forms of open forest. In the most part, community definition allowed reasonable comparisons with regional vegetation classifications recently undertaken in the Lower Hunter and Central Coast bioregion, and consequently statements of conservation significance for each community have been made. Two Endangered Ecological Communities, as listed in the NSW *TSC Act 1995*, occur within the Edgeworth LES study area (Lower Hunter Spotted Gum – Ironbark Forest, Swamp Sclerophyll Forest on Coastal Floodplains), which collectively occupy 51.35 or 54% of the total study area.

A potential development area has been proposed, which would allow development of 47.7 ha (~50%) of the total 96 ha area. This would entail the loss of 11 plants of *Tetratheca juncea* (Vulnerable), 22 ha of Lower Hunter Spotted Gum-Ironbark Forest EEC, and one stand of *Eucalyptus fergusonii* subsp. *fergusonii* (rare). Retained lands would conserve 29 ha of Lower Hunter Spotted Gum-Ironbark Forest EEC, 0.18 ha of Swamp Sclerophyll Forest on Coastal Floodplains, one population of *Callistemon linearifolius* (Vulnerable, 2 plants), and one stand of *Eucalyptus fergusonii* subsp. *fergusonii* (rare). Impact assessments under the EPBC Act 1999 and the TSC Act 1995 concluded with little or no significant impact for these losses.

Document cover shows (from top) *Ramaria* sp., *Thysanotus tuberosus* subsp. *tuberosus*, *Poa affinis* and *Arthropodium minus*, all present in the study area © S. Bell.

This document may be cited as:

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Table of Contents

1. INTRODUCTION

1.1 Background

In August 2005, Lake Macquarie City Council (LMCC) received a rezoning proposal for land south of Pambulong Town Centre, currently Zone 10 Investigation in Lake Macquarie Local Environmental Plan 2004 (LMLEP 2004). On 9 October 2006, Lake Macquarie City Council resolved to prepare a draft amendment to the LMLEP 2004. This aimed to rezone approximately 100ha of Zone 10 Investigation land south of George Booth Drive near Edgeworth to allow urban development and conservation, and to rezone two small sections of land north of George Booth Drive adjacent to Pambulong Town Centre to 3(1) Urban Centre (Core) Zone. The two small portions of land on the northern side of George Booth Drive were determined by Council not to form part of investigations, and are considered no further in this report.

The draft amendment aims to rezone:

- Land south of George Booth Drive, Edgeworth being Lot 88 DP 755262 , lot 107 DP 100048 and part Lots 6 & 7 DP 4647 from Zone 10 Investigation to accommodate urban development and conservation;
- George Booth Drive, Cameron Park (Land associated with Pambulong Town Centre) being part Lot 1001 DP 1092785 from zones 2(1) Residential and 2(2) Residential (Urban Living) to 3(1) Urban Centre (Core) Zone.

Council is preparing this draft plan to potentially allow urban development incorporating an appropriate balance of commerical, industrial and residential uses, and to remove inconsistencies between zone and lot boundaries for the Pambulong Town Centre on the northern side of George Booth Drive. Council determined that a Local Environmental Study (LES) was required for the Zone 10 Investigation zoned land south of George Booth Drive, because of the large scale of land involved, and potential changes in land use and issues that require attention including bushfire, flooding, traffic and flora and fauna.

The proposed rezoning will seek to reinforce and further strengthen the developing urban centre, commonly referred to as Pambulong Town Centre. It will provide for employment generating opportunities and potentially maintain existing local area amenity. The changes will support the growth of a residential precinct that will emerge in the locality. Furthermore, it will contribute to whole of city outcomes through the provision of employment generating and residential lands consistent with the Lake Macquarie LifeStyle 2020 Strategy. The rezoning of the land will be consistent with the Lower Hunter Regional Strategy (LHRS), and provide new urban development opportunities within the region and support the emerging Glendale/Cardiff centre, as identified in the LHRS.

In accordance with Section 62 of the *Environmental Planning and Assessment Act 1979*, LMCC has consulted with relevant authorities including the Department of Environment and Climate Change, NSW Rural Fire Service, Roads and Traffic Authority, Mine Subsidence Board, Department of Education and Training, Department of Natural Resources, Koompahtoo Local Aboriginal Land Council, Hunter Water Corporation, Energy Australia, Hunter-Central Rivers Catchment Management Authority, Department of Primary Industries, Department of Lands and NSW State and Regional Development.

GeoLINK Pty Ltd is preparing the LES on behalf of LMCC. *Eastcoast Flora Survey* has been contracted to undertake a full survey, classification and mapping program for the study area, including an assessment of threatened species and ecological communities. The main objectives of the flora study were to:

- collect detailed floristic information to enable a classification of the natural vegetation to be made; and
- integrate the classification into a vegetation map of the study area, incorporating extensive ground truthing to increase the accuracy of the final map; and

- undertake targeted survey for threatened plant species potentially present on the land; and
- prepare a report on the vegetation of the study area, to be incorporated into the LES.

All investigations and reporting have been undertaken by Stephen Bell, Principal of *Eastcoast Flora Survey*.

1.2 Study Area and Study Region

The study area lies approximately 2.5km west of Edgeworth, immediately north and east of Barnsley and Holmesville respectively, within the Lake Macquarie local government area (Figure 1). It occupies 96ha of mostly forested land, but with three powerline easements traversing the land in a NE-SW direction. Numerous trails and tracks run across the site, which are heavily used by local residents for trail bike riding etc.

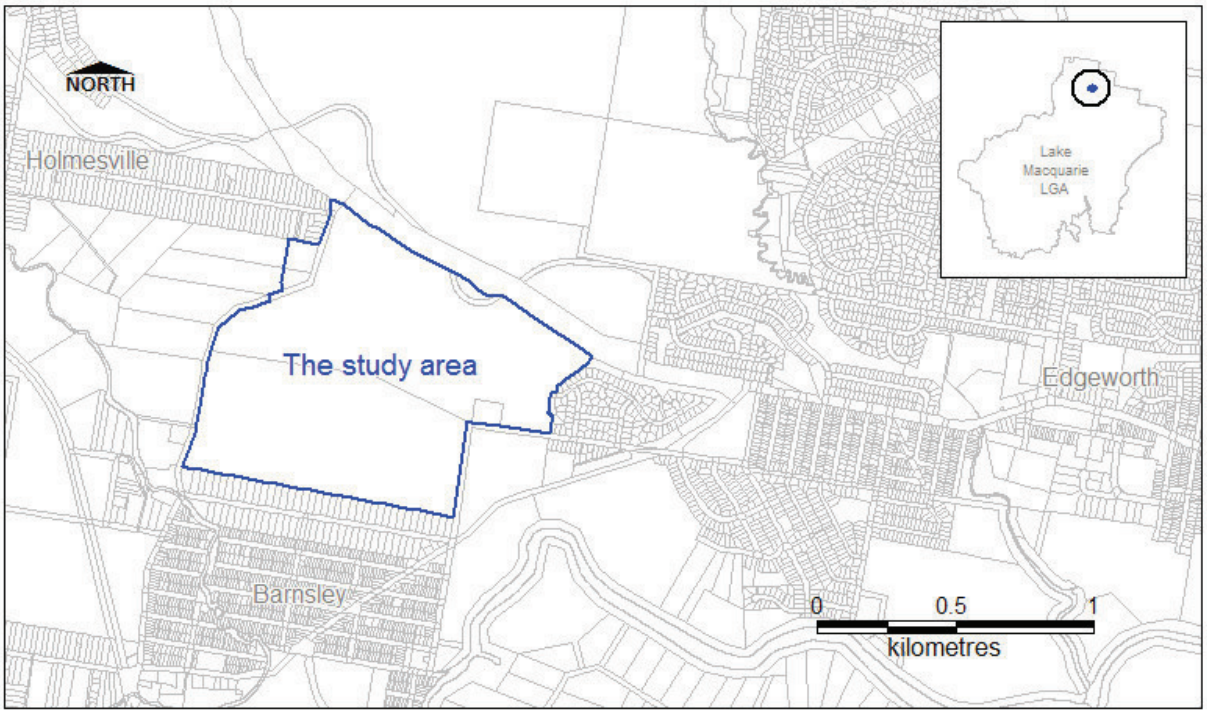

Figure 1 Location of the study area, Lake Macquarie LGA.

Bioregion – the study area lies within the Sydney Basin bioregion of Thackway and Cresswell (1995).

Geology – the entire study area falls within the Sydney geological basin, and forms part of the Newcastle Coal Measures. The dominant lithologies in this group are sandstone, conglomerate, siltstone, coal and tuff (DMR 1999). Small areas (~3.6ha) of Quaternary alluvium are mapped for the extreme western edges of the study area, although at the scale at which this mapping was completed their full extent cannot be relied upon.

Soil landscapes – almost all of the study area has been mapped as the Killingworth soil landscape, which is described as undulating to rolling hills and low hills on the Newcastle Coal Measures of the Awaba Hills region, supporting shallow to moderately deep, well to imperfectly drained yellow podzolic soils, yellow soloths, gleyed podzolic soils, and gleyed soloths on crests and hillslopes, with shallow well-drained structured loams, bleached loams and lithosols on some crests. Approximately 1.6ha on the extreme easterly

edge is mapped as the Warners Bay soil landscape, undulating to rolling low hills and rises on fine-grained sediments of the Newcastle Coal Measures, with moderately deep to deep imperfectly to poorly drained gleyed podzolic soils, moderately well-drained yellow podzolic soils and yellow soloths, with moderately deep, poorly drained structured loams in drainage lines. The south-western corner of the site also shows approximately 0.19ha of the Cockle Creek landscape, representing narrow floodplains, alluvial fan deposits and broad delta deposits, with deep, imperfectly to poorly-drained yellow soloths and yellow podzolic soils on floodplains, deep, moderately well to poorly drained yellow earths, and grey earths on delta and fan deposits, with deep imperfectly drained to well-drained yellow podzolic soils (Matthei 1995a; 1995b).

Climate – the Hunter Valley falls within a warm temperate climatic zone, with a maritime influence near the coast, and experiences warm wet summers and cool dry winters. Rainfall generally peaks in late Summer and early Autumn, although local variations due to topography are evident. Annual average rainfall ranges from 748 mm at Cessnock (24km north-west) to 1112 mm at Maryville (Newcastle, 17km east). Temperatures range from a daily average low of 17.7^{o} C in July and a high of 27.6 ^{o} C in January at Maryville; and a low of 4.2^{o} C in July and a high of 30.2 ^{o} C in January at Cessnock (Bureau of Meteorology 2008).

Botanical division – the study area lies within the North Coast botanical sub-division (Anderson 1961).

Regional vegetation modelling – modelled vegetation communities (LHCCREMS 2003) for the study area include Coastal Plains Smooth-barked Apple Woodland (Map Unit 30) across the vast majority of the site, with 0.2ha of Alluvial Tall Moist Forest (Map Unit 5) in the south-west, and 0.15ha of Coastal Sheltered Apple – Peppermint Forest (Map Unit 11) in the east.

Coastal lands - The study area *does not* form part of the NSW Coastal Zone under State Environmental Planning Policy No. 71.

Corridors - In the LMCC corridors mapping, the study area has been identified as supporting wildlife corridors in the north-west corner and along the southern boundary.

1.3 Masterplan

The current Masterplan for the site shows a range of land uses, including industrial in the south-west, seniors living in the north-west, and residential and medium-density housing in the east. However, such conceptual planning has been undertaken prior to any ecological investigations occurring, and may be expected to be modified where necessary.

1.4 Previous Studies

A number of biodiversity studies have been conducted on or in close proximity to the study area since the 1990's. No detailed study has yet been undertaken on the subject land.

Conacher-Travers (2000) – prepared a Species Impact Statement for the proposed Pambulong Forest development to the north of the site. Three vegetation communities were described for the site, as well as the discovery of more than 100 clumps of *Tetratheca juncea*.

Ecotone Ecological Consultants (2000) - carried out a vegetation survey and threatened species assessment on a small parcel of land to the south-east of the current study area, at Barnsley.

Payne (2001) – prepared a conservation management plan for *Tetratheca juncea*, on behalf of LMCC, NPWS and BHP. In summary, this plan concluded that *Tetratheca juncea* has a preference for ridgetops on south-east to south-west aspects on Munmorah Conglomerate geology and the Awaba soil landscape unit. Sub-populations are isolated and have become fragmented due to urban development, with most

possessing <25 plant clumps and only a few sub-populations exceeding 100 plant clumps. This plan also suggested the conservation of between 75 - 80% of plants contained within a population.

Bell (2001) – published information on the known population sizes and habitat of the vulnerable ground orchid *Cryptostylis hunteriana*. This species has been raised as potentially occurring within the Pambulong Forest Estate to the north of the study area.

Payne et. al. (2002) - establishes a standard methodology for the survey and counting of *Tetratheca juncea* populations. Suggests each plant clump be considered separate if the separation distance between adjacent plants exceeds 25cm.

Driscoll (2003) – published information on the pollination ecology of *Tetratheca juncea*. Flowering in this species was found to be strongest between September and January, although some flowers can often be found throughout the year. Two species of native bee were identified as collecting pollen from *Tetratheca juncea*, and the sexual reproductive process in this species appears to be pollinator-limited.

LHCCREMS (2003) – the Lower Hunter & Central Coast Regional Environmental Management Strategy. This major classification and mapping project (originally described in full in NPWS 2000) attempted to describe and map the vegetation diversity across seven LGA's in the lower Hunter Valley and Central Coast. Maps produced were the result of modelling vegetation distribution in relation to 43 environmental variables, and consequently errors and inaccuracies were expected. The classification behind the modelling was based on over 1100 detailed survey plots, and generally provided a strong basis for categorising all vegetation. This classification has been used as the basis of the current project.

Wildthing (2003) – assessment of 1.5ha of land on the northern side of George Booth Drive, and part of the proposed Pambulong Forest development. No threatened flora were recorded, although survey was conducted outside of the prime flowering period of *Tetratheca juncea*. A single native vegetation community described and mapped.

Australian Bushfire Safety & Planning (2004) – bushfire assessment for the proposed Pambulong development on the northern side of George Booth Drive. Vegetation on the site classified as Group 1 Forest and Group 2 Woodland.

Andrews Neil (2004a) – prepared a Species Impact Statement for the proposed Pambulong Forest development to the north of the site. Threatened flora and fauna species were assessed, including *Tetratheca juncea*, and three vegetation communities described for the site. No Endangered Ecological Communities identified.

Andrews Neil (2004b) - additional surveys for *Tetratheca juncea* and *Cryptostylis hunteriana* at the proposed Pambulong Forest development to the north of the site. This survey resulted in 1632 clumps of *Tetratheca juncea* (predominantly in the north of their site), 94% of which fell within the proposed conservation area. No individuals of *Cryptostylis hunteriana* were recorded.

Bellairs et. al. (2006) - published the results of a study into the seed biology of *Tetratheca juncea*. They concluded that fire management is important for promoting survival of this species, and that the soil seed bank cannot be relied upon for re-establishment of populations due to short longevity of the seed bank. Hand-collected seeds treated with fire-related stimuli may be important for re-establishing populations.

Bell (2009a) – mapped the distribution of Lower Hunter Spotted Gum – Ironbark Forest EEC within the Lake Macquarie area, incorporating a detailed data analysis confirming the presence of a Lake Macquarie/ Wyong form of this community. Summary details published in Bell (2010).

Bell & Driscoll (2010) - the mapping of native vegetation within Lake Macquarie local government area is currently underway, with Stage 2 now complete. This mapping is revising that produced by LHCCREMS (2003), broadly incorporating the classification of NPWS (2000) but extending it to cover

previously un-recognised vegetation communities. Mapping and classification utilised in the current LES project will adopt the same methods as the LGA project, and will ultimately be incorporated directly into the LGA mapping.

Searches of relevant databases and the literature have revealed eight threatened plant species and one endangered population as potentially occurring within a radius of 10km of the study area. Threatened species are as listed on the Commonwealth *EPBC Act 1999* or the NSW *TSC Act 1995*. Table 1 summarises these species, together with an initial assessment of their likelihood of occurrence based on known habitat elsewhere.

Table 1 Summary of threatened plant species previously recorded from a 10km radius of the study area. [E = Endangered; V = Vulnerable; EP = Endangered Population]

Species	EPBC Act	TSC Act	Comment
Acacia bynoeana	V	E	unlikely, habitat absent (Driscoll 2006)
Angophora inopina	V	V	unlikely, habitat absent (Hill 1997; Bell 2004)
Callistemon linearifolius	-	V	possible, habitat present
Cryptostylis hunteriana	V	V	unlikely, habitat absent (Bell 2001)
Eucalyptus camfieldii	V	V	unlikely, habitat absent (Harden 2002)
Eucalyptus parramattensis subsp. *parramattensis*	-	EP	unlikely, habitat absent (Bell 2006)
Grevillea parviflora subsp. *parviflora*	V	V	possible, habitat present
Syzygium paniculatum	V	V	unlikely, habitat absent (Payne 1991; 1997)
Tetratheca juncea	V	V	possible, habitat present

1.5 Section 62 Consultations

Issues raised in respect of native flora by relevant Government Departments as part of Section 62 consultations under the *Environmental Planning and Assessment Act 1979* include:

- minimising impacts to the most degraded sections of the land (DECC, DNR);
- *Tetratheca juncea* known on or near the site (DECC);
- consider wildlife corridors, in particular recognising corridors mapped by LMCC (DECC; DNR);
- consider potential direct and indirect impacts on DECC estate, wilderness, wild rivers and recognised areas of high conservation value (DECC);
- consideration of the Commonwealth *EPBC Act 1999* (DECC);
- potential impact on Cockle Creek, and the use of water sensitive urban design principles (DNR);
- investigate potential for groundwater dependent ecosystems (DNR).

1.6 Flora Survey Guidelines

Flora and fauna survey guidelines have been produced by several government departments in an effort to standardise the level of ecological information collected for development-related and other projects. Guidelines developed by State government agencies include York, Binns & Shields (1991), Wilson, Gott & Schofield (1997), DLWC (2000), Murray, Bell & Hoye (2002), and DECC & DPI (2005). All sets of guidelines follow essentially the same methodology, and emphasise the need to be comprehensive, diligent and scientific in approach.

Lake Macquarie City Council has also prepared guidelines (Murray & Bell 2001), which were adopted by Council in November 2001, but are currently in review. Consistent with the 2001 guidelines, a project of 100ha in size would require the following level of minimum survey effort:

- 7-10 walking transects;
- 2 survey quadrats per defined community;
- 1 additional quadrat per community > 10ha in area.

2. METHODS

Five separate but related tasks were undertaken in order to meet the objectives of this project:

- Collection of Rapid Data Points to assist classification and mapping
- Systematic flora survey to sample all observable variations
- Analysis of floristic data to classify the vegetation
- Mapping the distribution of defined vegetation communities or their variants
- Targeted survey for threatened plant species potentially present in the area

2.1 Mapping data

The collection of Rapid Data Points (RDPs) is a relatively new method of vegetation mapping for accurate spatial depiction of vegetation biodiversity. Central to this method is the recognition that variability in vegetation distribution cannot yet be predicted blindly using computer GIS programs, and that documenting what actually occurs on the ground is an essential component of producing a reliable final map. Many recent mapping programs have relied heavily on GIS capabilities to predict where certain vegetation communities occur, with often disappointing results (eg: the LHCCREMS vegetation modelling, NPWS 2000).

RDPs are essentially summaries of floristic information recorded at specific points in the field. At specific and regular locations, summaries of the vegetation are noted and waypointed in a Garmin GPS unit, and later transferred to the GIS. Information recorded includes:

- Canopy layer dominant species
- Shrub layer dominant species
- Ground layer dominant species
- Draft or field-recognised vegetation unit
- Miscellaneous notes

Initially, all trafficable paths across the study area are driven in 4WD vehicle recording RDPs. Those areas lacking extensive trail networks are then walked on foot with hand-held GPS units, recording the same information. In this way, a large dataset of summary information can be rapidly collected to use in vegetation mapping procedures. The data also proves invaluable as a ground-truthing mechanism for the final vegetation map.

This mapping method has been used recently in number of studies in recent years, most notably for the Tomago and Tomaree Sandbeds north of Newcastle (Bell & Driscoll 2006a), Watagans National Park and Jilliby State Conservation Area (Bell & Driscoll 2006b), the Cessnock-Kurri region (DECC 2008) and several smaller projects in the lower Hunter Valley. By comparison to traditional modelling methods, it offers a time-efficient and accurate alternative for producing a map of vegetation biodiversity based on real ground data. The same methods are currently in use for the mapping of vegetation within Lake Macquarie LGA on behalf of LMCC (Bell & Driscoll 2010).

2.2 Systematic Flora Survey

Systematic flora survey conducted across the study area consisted of the following steps:

1. Plot selection – Full floristic plot sampling was undertaken after a thorough reconnaissance of the study area, in areas and vegetation types considered typical of the observed variation present. This process recognises the fact that environmental stratification of an area (such as through the use of habitat surrogates like soil landscapes) does not adequately highlight certain floristic variations which may be evident in the field. Other workers have also recognised the problems of stratification in some

environments (eg: Griffith et al 2000), and this process of expert intuition is one of the central themes in the Braun-Blanquet system of plant classification (Braun-Blanquet 1928).

2. Plot Sampling - Within areas considered to be representative of the major floristic variations present, detailed survey within 0.04ha quadrats was completed. Methods used were those adopted as standard by Lake Macquarie City Council, the National Parks and Wildlife Service for national parks and nature reserves in New South Wales (Wilson, Gott & Schofield, 1997), State Forests for land under their control (York, Binns & Shields 1991), and the Department of Natural Resources for other areas (DLWC 1999). The same methods are also consistent with the large body of existing data in the region (Bell 2000; NPWS 2000). Benson (1999) provides an overview of how important consistent survey methods are for vegetation management across the State.

   Within each 0.04ha site (nominally 20 X 20m, but can be 40 X 10m in riparian zones, etc), all vascular plant species present are recorded and given a cover abundance rating, based on a modified Braun-Blanquet scale (1 to 6). Physical attributes of the site (vegetation structure, soil type, elevation, slope, aspect, physiographical position, etc) are also recorded, and photographs taken of the site for later reference. Plant specimens of unknown or significant status are collected for later identification or lodgement with the National Herbarium in Sydney. Orchid specimens were identified in the field with the aid of Bishop (2000), or digital photographs taken to assist later identification.

3. Ground Truthing - General reconnaissance undertaken as part of the mapping process (see below) validated trends observed in the floristic data. During such reconnaissance, searches for rare or threatened Australian plants were also made. Levels of disturbance and fire history of the general area could also be assessed in this manner.

2.3 Data Analysis

Taxonomic Review

Prior to data analysis, a review of plant taxonomy was undertaken for all taxa included in the final dataset to ensure consistency of nomenclature. Nomenclature according to Harden (1990a-1993; 2002) and Harden and Murray (2000) was used as the standard, except where more recent revisions have been published in recognised scientific journals and accepted by the National Herbarium of New South Wales.

Floristic Data Exploration

Floristic data was analysed using multivariate techniques to assist in classifying the vegetation present in the study area. Cluster analysis and non-metric multidimensional scaling (nMDS) on the dataset was performed using *Primer* V6 (Clarke & Gorley 2006), utilizing the group averaging strategy, the Bray-Curtis association measure and a Beta value of –0.1. The SIMPER routine was used to generate diagnostic species lists for each defined floristic group. Analysis of similarity within and between pre-defined floristic groups was undertaken with the ANOSIM routine.

Additional data analysis was also undertaken using the same methods for a larger regional dataset (the Central Coast: Newcastle, Lake Macquarie, Wyong & Gosford LGA's), to test how the derived groups for the study area related to other native vegetation in the region. A third analysis examined the relationship of vegetation dominated by Spotted Gum and Red Ironbark with similar vegetation elsewhere in the Hunter and Central Coast region. This analysis was aimed at examining the validity of attributing parts of the vegetation to proclaimed Endangered Ecological Communities, in particular the Lower Hunter Spotted Gum – Ironbark Forest (Bell in prog.).

Structural Data Exploration

Information on the structure of vegetation within each community has been calculated and averaged from data collected at each of the floristic data plots. Estimates of height and percentage cover for each of the emergent, tallest layer, mid layer, and lowest layers have been used.

2.4 Vegetation Mapping

Within Mapinfo © GIS, observable photo-patterns from digital orthorectified aerial photographs (supplied by Lake Macquarie City Council) were initially digitised on-screen to form a base map layer. Subsequent to this, each RDP collected and recorded on GPS (see Section 2.1) was attributed a map unit code reflecting the floristic classification, and overlain on the base map to code each polygon accordingly. Updating of the vegetation map layer was done progressively after each field day.

2.5 Targeted Surveys

Threatened species searches were conducted in concert with full floristic plot sampling, as well as through targeted searches in habitats known to support specific species elsewhere. Foot traverses in selected areas were made with a hand-held GPS unit (Garmin GPSmap 60CSx) and significant plant species recorded where encountered. GPS data was downloaded and imported into mapping layers on completion of each field search. Searches focused on the nine threatened entities shown in Table 1 (Section 1.3), although other potential species (eg: *Rutidosis heterogama*) were also considered.

Acacia bynoeana – any areas of open woodland on lateritic or sandstone-based soils were searched, particularly those locations where *Ptilothrix deusta* or *Xanthorrhoea latifolia* dominated the ground layer.

Angophora inopina – searches were conducted during general reconnaissance of the site, and also while collecting rapid habitat data for mapping purposes.

Callistemon linearifolius – leafy branches of *Callistemon* encountered while in the field were collected and examined to determine whether or not *Callistemon linearifolius* was present in the area, taking care to avoid sampling epicormic regrowth following fire or other disturbance. Regrowth of other closely related *Callistemon*, in particular *C. rigidus*, superficially resembles *C. linearifolius* foliage. GPS locations were recorded at those locations where *C. linearifolius* occurred.

Cryptostylis hunteriana – searches were not undertaken for this highly cryptic species unless habitat suitable for this species was present (Bell 2001). Given the geology and soil characteristics of the entire study area, it was considered unlikely that potential habitat would be present. However, all orchid species encountered during Spring surveys were recorded, since *C. hunteriana* often co-occurs with other *Cryptostylis* species.

Eucalyptus camfieldii - searches were conducted during general reconnaissance of the site, and also while collecting rapid habitat data for mapping purposes.

Eucalyptus parramattensis **subsp*. parramattensis*** – searches were conducted during general reconnaissance of the site, and also while collecting rapid habitat data for mapping purposes.

Grevillea parviflora **subsp. *parviflora*** – all Grevilleas encountered while in the field were examined and samples collected if necessary. Any specimens of *Grevillea parviflora* subsp. *parviflora* or *G. humilis* present were lodged with the National Herbarium in Sydney, and their locations logged with GPS.

Syzygium paniculatum – any areas of rainforest or mesic riparian vegetation was searched for *Syzygium paniculatum*, and their positions logged with GPS if present.

Tetratheca juncea - searches were made in suitable habitat particularly for *Tetratheca juncea*, given the pre-existing record on the northern side of George Booth Drive (outside of the current study area, approximately 150m from the study area boundary). If plants could be found flowering at that location, it would be reasonable to assume that synchronous flowering would also be occurring within the study area. Timing of targeted searches for *Tetratheca juncea* coincided with flowering of this species at other reference locations throughout Lake Macquarie, including the lower slopes of Sugarloaf SCA to the west, Morisset to

the south, and sites in Rankin Park and Mt Hutton in the east. If plants were located, the number of clumps was counted following the methodology of Payne et. al. (2001), and their locations recorded.

3. RESULTS

3.1 Mapping Data

Over 180 Rapid Data Points (RDP's; 1 point per 0.5ha of vegetated area) were collected during field reconnaissance for the current project. At each of these points, information on dominant plant species in each stratum was recorded and could be imported directly into the vegetation mapping process. All points were attributed a draft vegetation community code, which was reviewed after classification analysis of full floristic data (Section 3.3).

Figure 2 shows the distribution of RDPs across the study area, used to inform the mapping process.

Figure 2 Distribution of Rapid Data Points (RDPs) across the study area.

3.2 Floristic Survey

Survey Periods and Sampling Intensity

The majority of vegetation survey and mapping in the study area was undertaken during July-August 2008. Targeted surveys for *Tetratheca juncea* commenced on 3 September 2008 after reference populations elsewhere were flowering well. Subsequent surveys were completed on 10 September, 15 October, 28 October and 11 November 2008. Searches concentrated on potential habitat for this species, in this case the Coastal Plains Stringybark - Apple Forest and avoiding the Hinterland Spotted Gum – Red Ironbark Forest (except where the two merged). A search was also made immediately north of the study area for the pre-existing record of *Tetratheca juncea* on 11 September 2008, to determine its flowering status. Orchid

surveys were carried out at the same time as searches for *Tetratheca juncea*, with all orchids present recorded.

Figure 3 shows the routes taken on targeted *Tetratheca juncea* and orchid surveys.

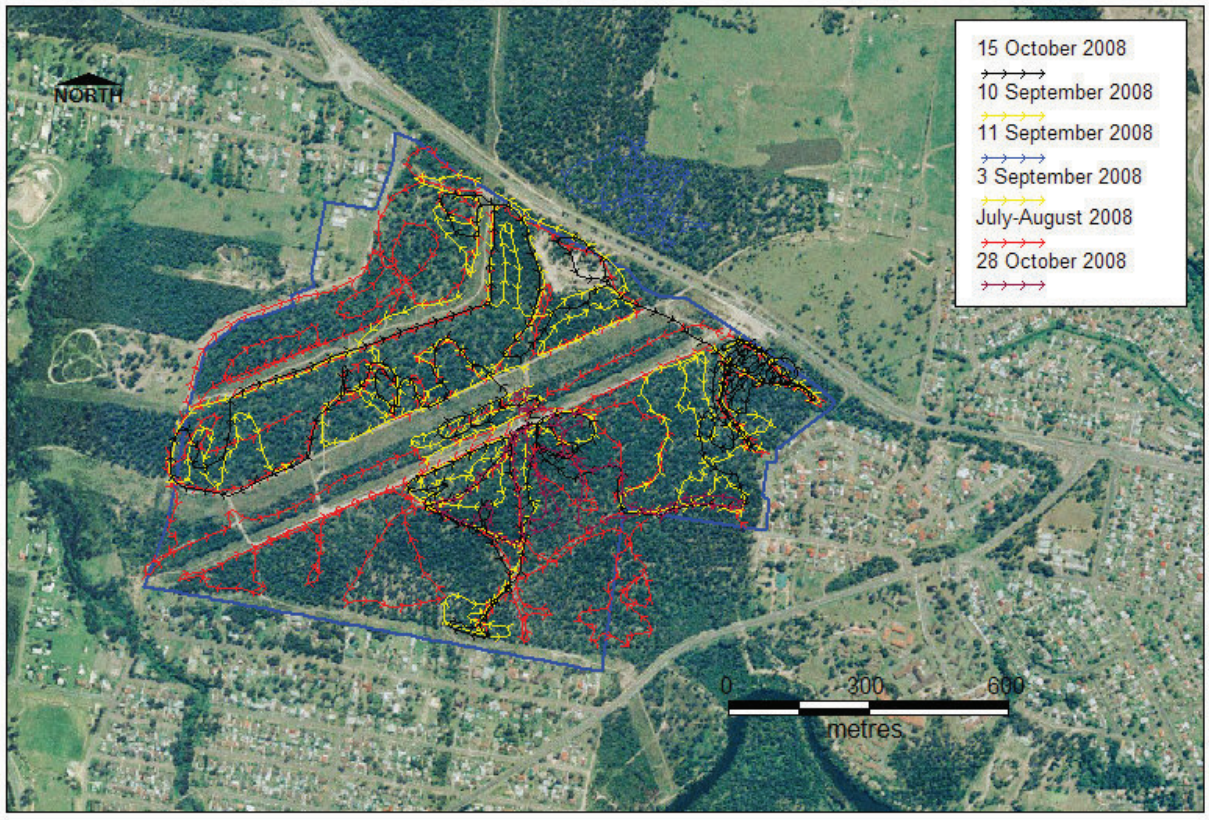

Figure 3 Routes of targeted species survey across the study area.

Floristic Diversity and Plot Sampling

A total of 188 plant taxa (including 15 weed species) were recorded through systematic plot and general traverses for the study area. The most commonly recorded species across all sampling plots were the grasses *Themeda australis, Microlaena stipoides* var. *stipoides, Entolasia stricta* and *Panicum simile*, the graminoids *Lomandra filiformis* subsp. *filiformis, Lomandra multiflora* subsp. *multiflora* and *Lomandra obliqua*, and the herb *Gonocarpus tetragynus*. *Acacia ulicifolia, Dillwynia retorta* and *Bursaria spinosa* were the most frequent shrubs, while *Eucalyptus fibrosa* was the most frequent canopy species. A full species list for the study area is included in Appendix 9.1.

Eighteen (18) full systematic survey plots have been completed across the study area (Figure 4). Given that five vegetation communities have been defined for this study (see Section 3.3), this level of sampling clearly exceeds that required for sites >50ha in size in the LMCC survey guidelines (Murray et. al. 2001). In the guidelines, study areas of this magnitude require 2 plots per community, plus an additional plot for those communities >10ha in extent. Two of the four communities defined are <0.25ha in extent, and hence sampling of more than one plot is problematic: issues of pseudo-replication can surface in communities <0.5ha in size and occurring in a single location.

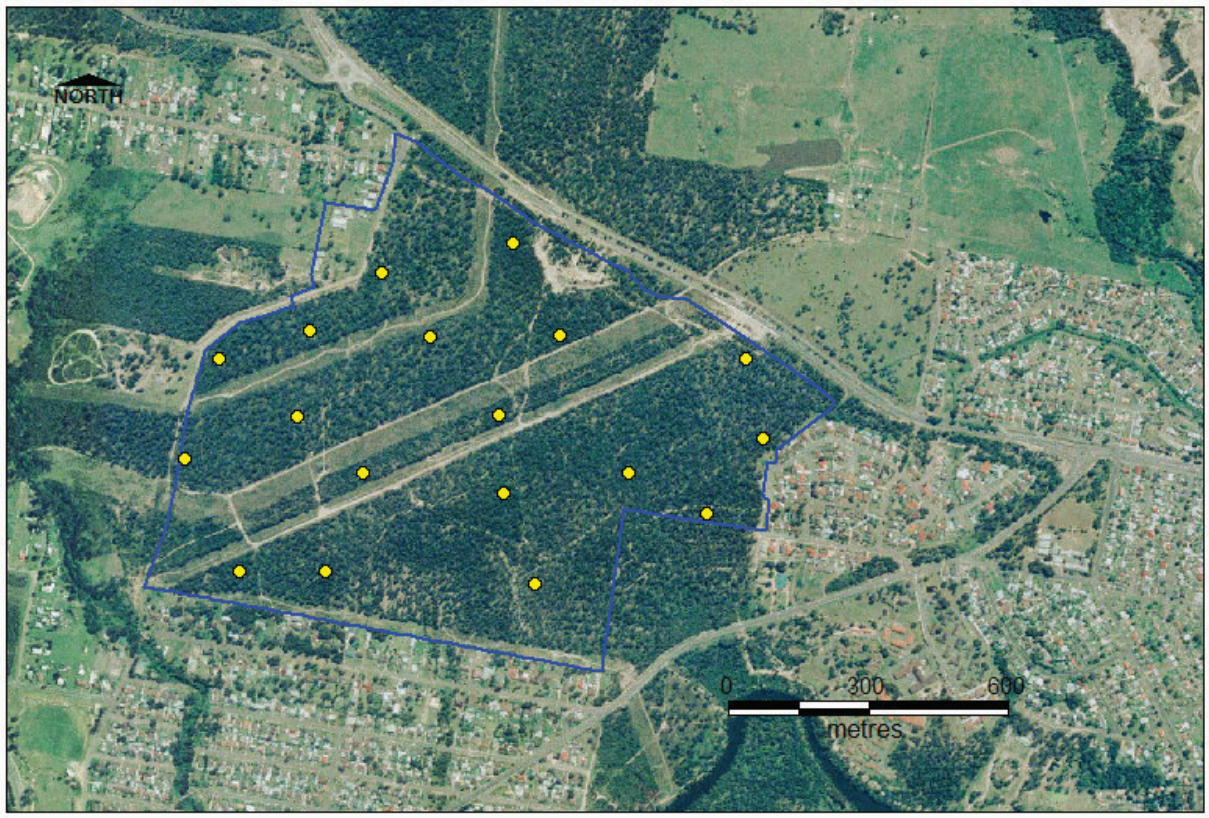

Figure 4 Distribution of full floristic survey.

3.3 Data Analysis & Community Definition

Edgeworth LES Analysis

Multivariate cluster analysis of 18 sample plots and 173 native plant taxa (using the Bray-Curtis association measure, flexible UPGMA fusion strategy, Beta –0.1) resulted in the definition of 5 floristic groups at 51% similarity, or 0.49 dissimilarity (Figure 5). This represents a fine resolution of observable floristic variation, with other classifications often limited to 20-30% similarity (0.7-0.8 dissimilarity) due to dataset size and quality. Three of the five groups have been broadly defined previously in the LHCC regional classification (NPWS 2000), but most represent new variations or sub-communities delineated for the revised classification of the Central Coast (Bell & Driscoll 2010). At five groups, the current dataset could be clearly rationalised with variations observed on the ground. Any further splitting of groups could not be consistently undertaken due to the inherent natural variation of many communities. Two communities (eg: MU's 42 and 110b) are so limited within the study area that only single plot samples could be undertaken. This situation is not ideal but cannot be avoided.

Ordination using non-metric multidimensional scaling (nMDS) strongly supported the groupings evident in the cluster analysis, with a low stress level of 0.1 and strong congruence with the cluster analysis groups (Figure 6). All defined groups are well separated in 2-dimensional space. Appendix 9.2 contains detailed profiles for each of these communities, following techniques developed for vegetation studies in NPWS estate. Modified landscapes or cleared areas are not included.

The analysis of similarity (ANOSIM) of species composition between defined groups of sample plots revealed an overall Global R value of 0.765 ($p = 0.001$). Significant differences were also evident between all defined communities in the pairwise analysis (Table 2). Comparisons from all groups returned R values at or close to

unity, indicating within group similarity to be greater than between group similarity. Low values evident for Hinterland Spotted Gum - Red Ironbark Forest (0.67 & 0.70) and Coastal Plains Stringybark - Apple Forest (0.69) suggest poorer resolution of these communities when based on floristic differences alone.

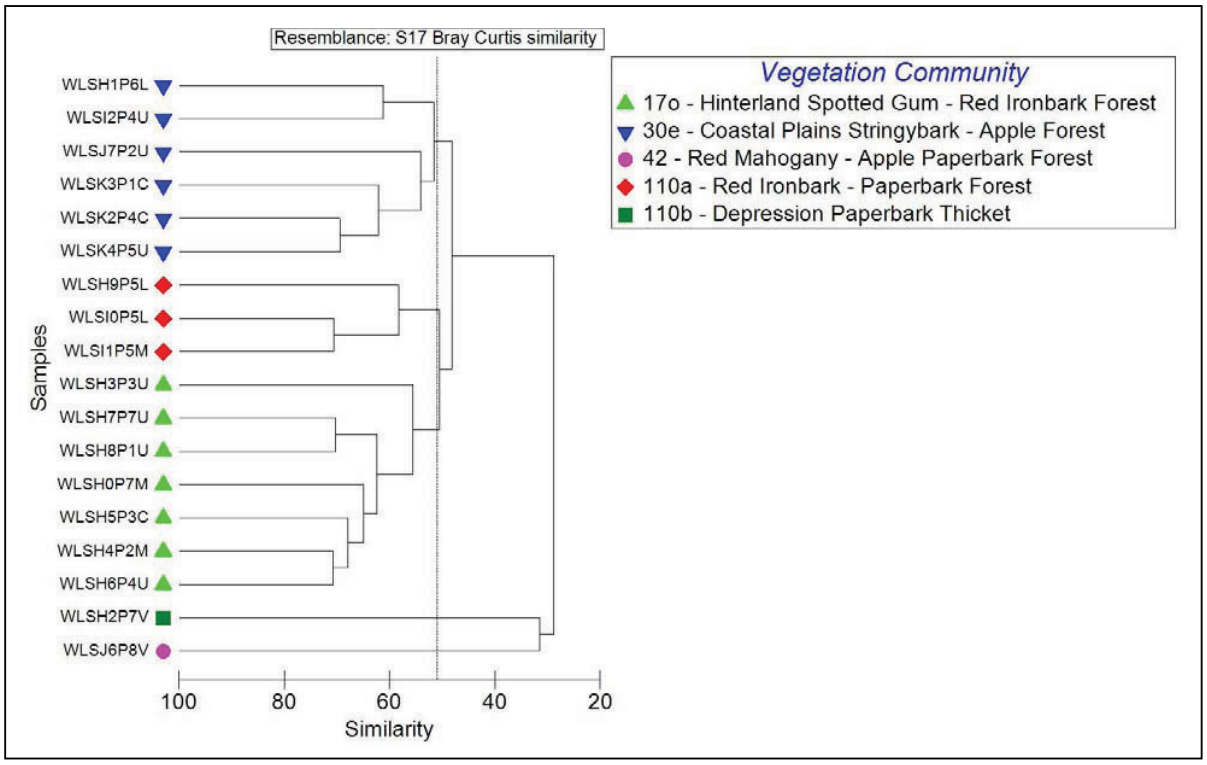

Figure 5 **Site dendrogram produced from the cluster analysis.** 5 groups at 51% similarity (dashed line), Bray-Curtis association measure, flexible UPGMA, Beta = -0.1.

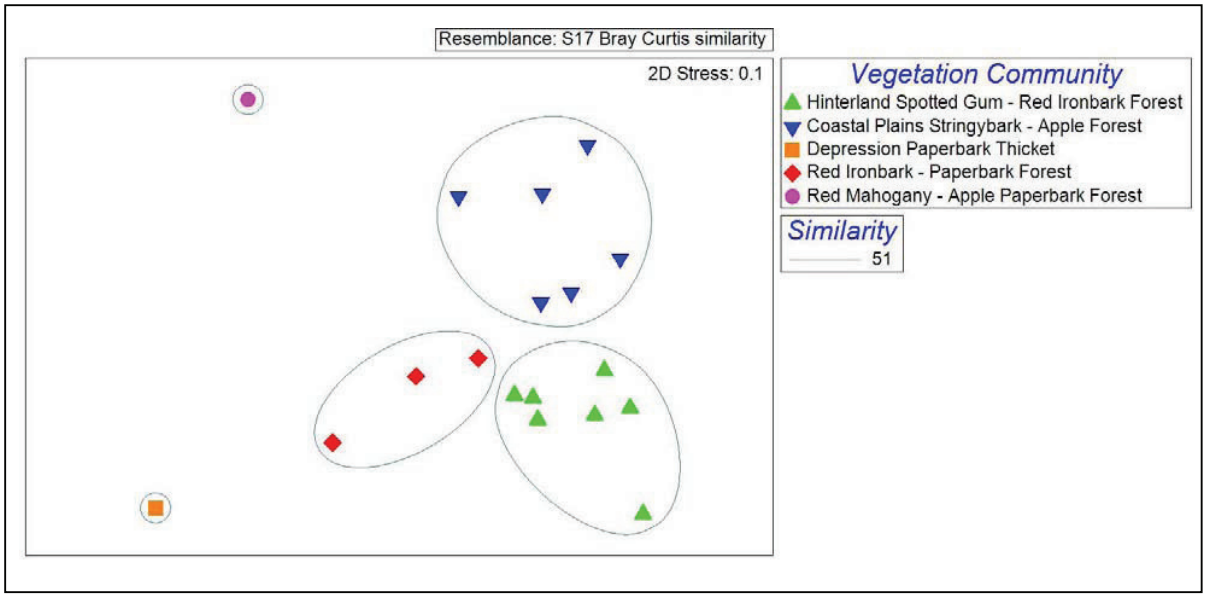

Figure 6 **Chart of 2D non-metric multidimensional scaling** (overlain with cut-points from dendrogram in Figure 5, at 51% similarity).

Table 2 ANOSIM results (Global R values) for pair-wise comparisons of *aprior* vegetation groups.

	17o: HSGRIF	30e: CPSAF	110b: DPF	110a: RIPF	42: RMAPF
17o: Hinterland Spotted Gum-Red Ironbark Forest					
30e: Coastal Plains Stringybark-Apple Forest	0.67				
110b: Depression Paperbark Forest	1	1			
110a: Red Ironbark-Paperbark Forest	0.70	0.69	1		
42: Red Mahogany-Apple Paperbark Forest	1	1	-	1	

Central Coast Analysis

Within the considerably larger Central Coast regional dataset maintained by the author (Newcastle, Lake Macquarie, Wyong, Gosford LGA's: 866 sample plots), cluster analysis confirmed the delineation of vegetation communities noted above. In most cases, the Edgeworth LES data arranged itself with other similar data elsewhere in the region, such that community groupings (clusters) became larger with the additional data available. Some exceptions to this were those cases where a community was represented only by a small number of sites, and the low frequency of similar sites elsewhere in the region meant that these sites were subsumed into larger regional groups within the dendrogram. Such site mobility is common in large datasets where small sample sizes of distinct communities are evident. On the whole, however, the larger regional analysis broadly supported the groupings evident from the Edgeworth LES analysis. In view of the size of this dataset, summary dendrograms and ordination plots are not included here.

Spotted Gum – Red Ironbark Analysis

As part of the review of the Lower Hunter Spotted Gum – Ironbark Forest EEC classification (Bell in prog.), data collected from the Edgeworth LES study area was also analysed within a regional dataset of 134 sample plots, to assist determining the significance of this vegetation. The 7 plots defining the Hinterland Spotted Gum – Red Ironbark Forest for the Edgeworth LES area grouped strongly with other plots from the Central Coast (Warnervale, Killingworth, Sugarloaf SCA) and lower Hunter Valley (Columbey NP, Seaham) within a distinct clade of the Lower Hunter Spotted Gum – Ironbark Forest group. This suggests that a more coastal form of the LHSGIF occurs on the hinterland of the Central Coast and Hunter Valley, and one which cannot be referable to any other regional vegetation community.

Defined Vegetation Communities

Table 3 summarises all floristic groupings delineated for the Edgeworth LES dataset, and the number of hectares for each. Vegetation community codes broadly equate with the regional classification established by NPWS (2000), but have been expanded by the author to accommodate newer communities and finer resolution of others, in keeping with the classification of the Lake Macquarie vegetation currently in development (Bell & Driscoll 2010). Detailed descriptions of all communities are provided in Appendix 9.2, and include those species contributing the top 90% in diversity for each community, as obtained through the SIMPER procedure in *Primer*.

3.4 Vegetation Community Map

A vegetation community map of the Edgeworth LES study area is presented as Figure 6, and incorporates information obtained from 180 RDP's and the results of the classification analysis. Detailed information on each of the communities defined can be found in Appendix 9.2. Vegetation units are consistent with the Lake Macquarie classification and mapping project currently underway (Bell & Driscoll 2010).

Table 3 Summary of vegetation units delineated for this study.

Vegetation Unit		ha	Characteristic Species
17o	Hinterland Spotted Gum – Red Ironbark Forest	38.34	**Canopy** – *Eucalyptus fibrosa, Corymbia maculata* **Mid-layer** – *Dillwynia retorta, Acacia ulicifolia, Pultenaea paleacea, Bursaria spinosa* **Ground layer** – *Joycea pallida, Themeda australis, Panicum simile, Lomandra multiflora subsp. multiflora, Lomandra obliqua, Entolasia stricta, Setaria distans*
30e	Coastal Plains Stringybark-Apple Forest	19.36	**Canopy** – *Angophora costata, Corymbia gummifera, Eucalyptus capitellata, Eucalyptus umbra* **Mid-layer** – *Dillwynia retorta, Pultenaea euchila, Bursaria spinosa* **Ground layer** – *Entolasia stricta, Joycea pallida, Themeda australis, Lomandra filiformis subsp. filiformis, Lomandra obliqua, Microlaena stipoides var. stipoides, Xanthorrhoea latifolia*
42	Red Mahogany-Apple Paperbark Forest	0.19	**Canopy** – *Eucalyptus resinifera subsp. resinifera, Angophora costata* **Mid-layer** – *Glochidion ferdinandi var. ferdinandi, Callistemon salignus, Banksia spinulosa var. collina, Leptospermum polygalifolium subsp. cistmontanum* **Ground layer** – *Gahnia clarkei, Schoenus melanostachys, Entolasia stricta, Entolasia marginata*
110a	Red Ironbark- Paperbark Forest	12.82	**Canopy** – *Eucalyptus fibrosa, Melaleuca decora* **Mid-layer** – *Melaleuca decora, Melaleuca nodosa, Bursaria spinosa, Acacia ulicifolia, Leptospermum trinervium*. **Ground layer** – *Entolasia stricta, Ptilothrix deusta, Aristida vagans, Lomandra multiflora subsp. multiflora, Microlaena stipoides var. stipoides, Themeda australis*
110b	Depression Paperbark Forest	0.26	**Canopy** – *Melaleuca decora* **Mid-layer** – *Melaleuca nodosa, Melaleuca decora, Bursaria spinosa* **Ground layer** – *Microlaena stipoides var. stipoides, Centella asiatica, Pratia purpurascens, Carex inversa, Veronica plebeia, Hydrocotyle peduncularis*

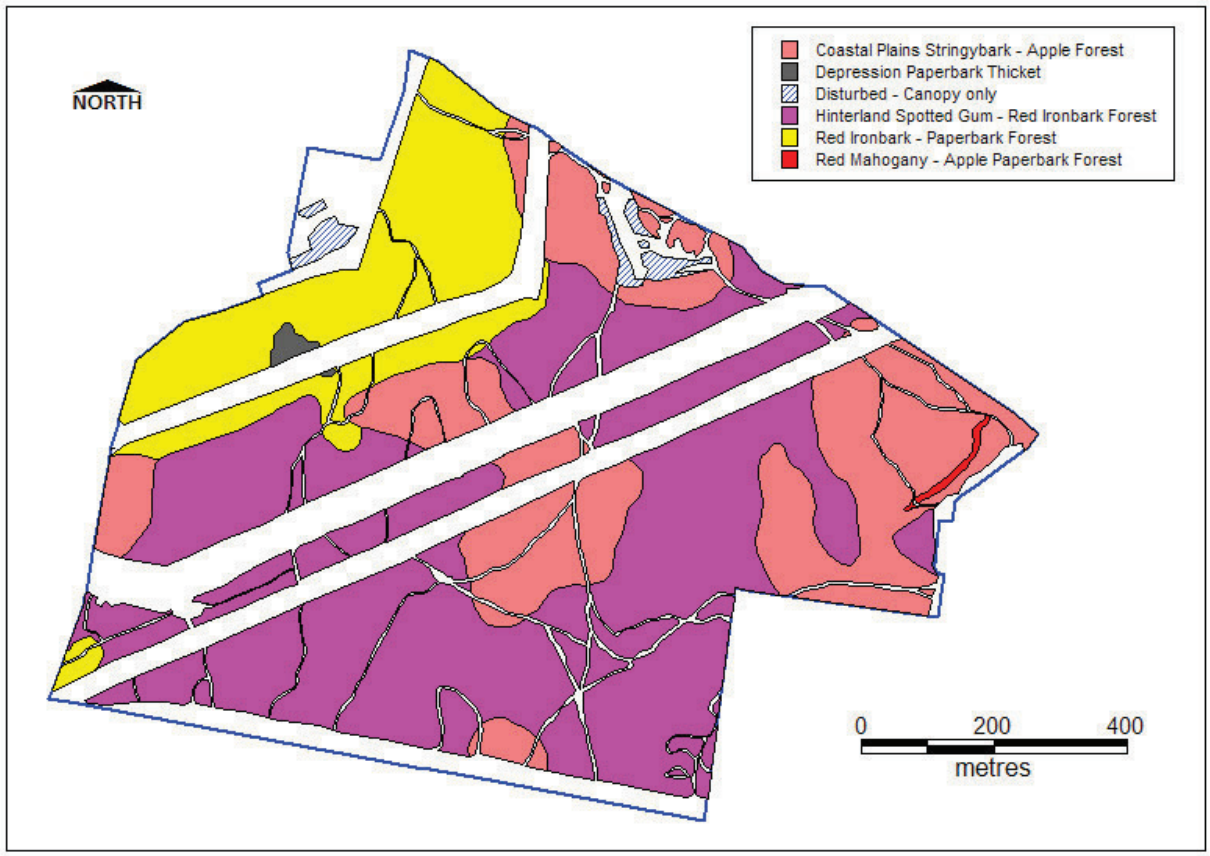

Figure 6 Vegetation map of the Edgeworth LES study area.

3.5 Significant Plant Species

Targeted searches for significant plant species resulted in the following:

- *Tetratheca juncea* — a total of 11 plant clumps in the NE corner
- *Callistemon linearifolius* — two plants found in eastern section

- *Acacia bynoeana* — no plants found
- *Angophora inopina* — no plants found
- *Cryptostylis hunteriana* — not surveyed for (unsuitable habitat)
- *Eucalyptus camfieldii* — no plants found (unsuitable habitat)
- *Eucalyptus parramattensis ssp. parramattensis* — no plants found (unsuitable habitat)
- *Grevillea parviflora* ssp. *parviflora* — no plants found
- *Syzygium paniculatum* — no plants found (unsuitable habitat)

Tetratheca juncea plants were found to be flowering on the northern side of George Booth Drive, to the immediate north of the study area, on 11 September 2008, and again on 15 October 2008. All plants there were associated with a shallow drainage line. Within the study area, plants were first noted flowering on 15 October 2008.

Two occurrences of the rare *Eucalyptus fergusonii* subsp. *fergusonii* were located towards the east of the study area, growing on sandstone-based soils. This species has a ROTAP code of 3KC-, but is well conserved

in the region in Jilliby State Conservation Area (Bell & Driscoll 2006b), Sugarloaf State Conservation Area (Bell & Driscoll in prog.) and Wallaroo Nature Reserve (Bell 2002). A small population of *Eucalyptus beyeriana* was also located in the south-east, which is of general interest as this species is uncommon in coastal environments.

Voucher specimens of *Callistemon linearifolius* and *Eucalyptus fergusonii* subsp. *fergusonii* were lodged with the National Herbarium of NSW. Further discussion on significant plant species present within the study area, including a map of their occurrences, can be found in Section 4.

4. CONSERVATION SIGNIFICANCE

Assessment of the conservation significance of the vegetation within the Edgeworth LES study area has been examined separately for vegetation communities and individual species. Vegetation communities and significant species are discussed in relation to both Commonwealth (*EPBC Act 1999*) and State (*TSC Act 1995*) threatened species legislation, as well as within a regional significance context.

Table 4 summarises the significant species and vegetation communities present within the Edgeworth LES study area.

Table 4 Summary of significant species and vegetation communities, Edgeworth LES.

Significant Species	Legal Status		Briggs & Leigh System
	EPBC Act 1999	TSC Act 1995	
Threatened			
Callistemon linearifolius	-	Vulnerable	3VC
Tetratheca juncea	Vulnerable	Vulnerable	3VCa
Rare (ROTAP)			
Eucalyptus fergusonii subsp. *fergusonii*	-	-	3KC-
Endangered Ecological Communities (TSC Act)			
Lower Hunter Spotted Gum-Ironbark Forest, Sydney Basin bioregions (LHSGIF)			
Swamp Sclerophyll Forest on Coastal Floodplains, North Coast, Sydney Basin & South-East Corner bioregions (SSFCF)			

4.1 Vegetation Communities

Commonwealth - At present, there are no Threatened Ecological Communities listed on the *Environment Protection & Biodiversity Conservation Act 1999* that apply to vegetation within the Edgeworth LES area.

State - A number of Endangered Ecological Communities, as listed in the *Threatened Species Conservation Act 1995,* may potentially occur within the Edgeworth LES study area. However, based on field investigations conducted for the current study only two are considered to be present:

- Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin bioregions (LHSGIF)
- Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions (SSFCF)

The LHSGIF is based on the regional classification undertaken by NPWS (2000), while the SSFCF relates to work completed by Keith and Scott (2005). Table 5 indicates which of the vegetation communities present in Edgeworth LES study area fall into these EECs, together with the areal extent within the study area. In most cases, final determinations stipulate which previously defined vegetation communities are encompassed by the relevant EEC, and this has been used as a guide for this assessment. Neither of these two EEC's have been previously recognised for the immediately adjacent area, including the proposed residential developments at Pambulong Estate (Conacher Travers 2003; Wildthing 2003; Andrews Neil 2004a), but both EEC's post-date these previous studies. Figure 7 shows the distribution of these communities across the site, evidently comprising a total of 51.35ha or 54% of the study area.

Table 5 NSW Endangered Ecological Community equivalents.

Endangered Ecological Community	Edgeworth LES Community	Extent (ha)
Lower Hunter Spotted Gum – Ironbark Forest	Hinterland Spotted Gum-Red Ironbark Forest (17o)	38.34
	Red Ironbark – Paperbark Forest (110a)	12.82
Swamp Sclerophyll Forest on Coastal Floodplains	Red Mahogany – Apple Paperbark Forest (42)	0.19
Total		**51.35**

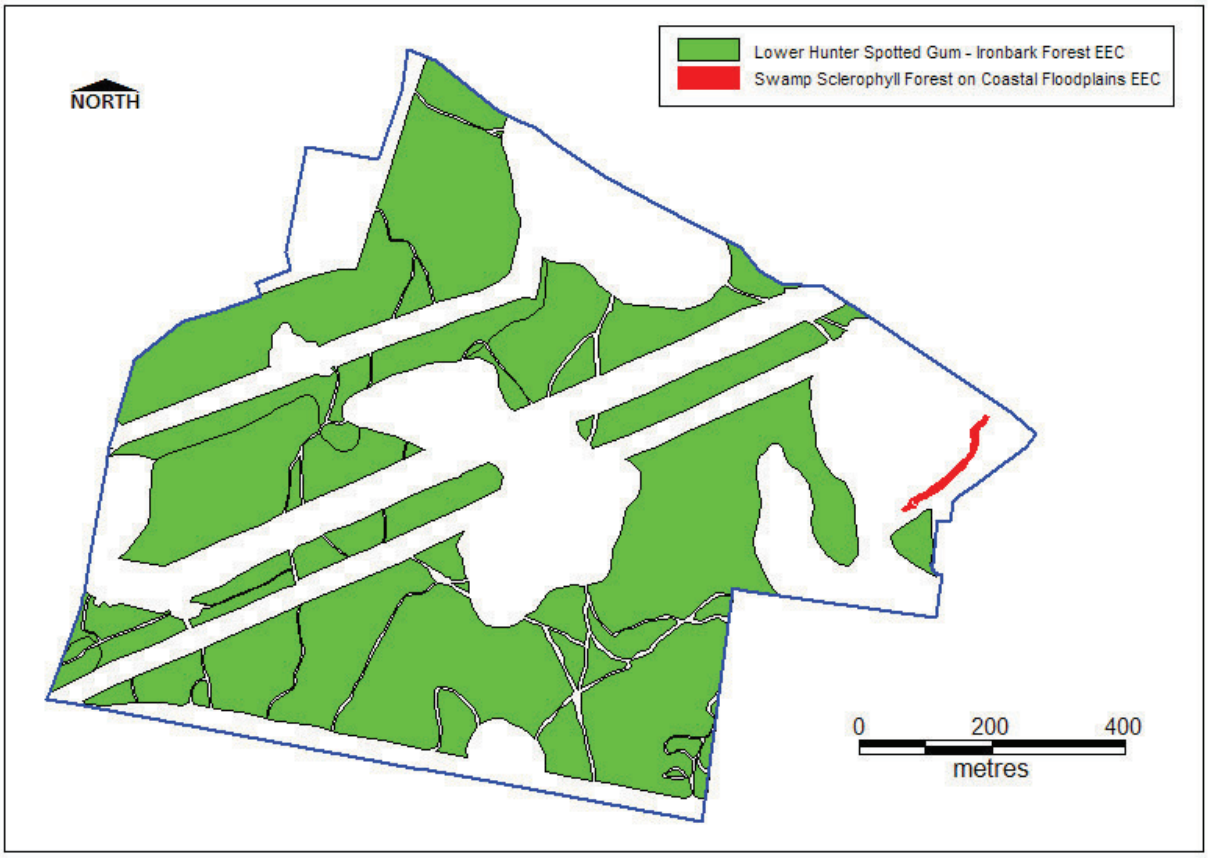

Figure 7 Distribution of EEC equivalents, Edgeworth LES.

Lower Hunter Spotted Gum – Ironbark Forest

The LHSGIF has recently been the focus of a number of studies aimed at clarifying the composition and extent of this community, and also its relationship to similar vegetation in the region. Since its determination in 2005, a range of vegetation types broadly equating to LHSGIF were surfacing within the region and it became evident that a review of the classification of Spotted Gum – Ironbark vegetation was necessary. The collection of additional plot-based data was seen as an important step in this process, to boost the number of replicates originally analysed, but also to target areas that appeared to meet the criteria listed in the final determination, but which for one reason or another were excluded. The first phase of this process was undertaken and reported on in Driscoll and Bell (2004), which re-analysed 134 floristic plots from across the region, and concluded that there was a distinct subset of plots centred around the township of Cessnock that most closely met the description in the final determination. Other Spotted Gum – Ironbark communities, most notably the Coastal Foothills Spotted Gum – Ironbark Forest and the Seaham Spotted Gum – Ironbark Forest (both from NPWS 2000), were difficult to distinguish from one another. This phase also confirmed

that, with greater quality control of data, the original broad circumscription of the LHSGIF could be improved upon considerably.

The second phase of this revision occurred during studies undertaken for the proposed Sweetwater (Huntlee) development at North Rothbury (Bell & Driscoll 2005). The principal issue here was whether or not vegetation dominated by *Eucalyptus fibrosa* and *Corymbia maculata* could be attributable to LHSGIF, or alternatively the Central Hunter Grey Box – Spotted Gum – Ironbark Forest (CHGBSGIF). Again, a re-analysis of quality-controlled plot data (192 plots) from throughout the region was undertaken, and showed that differences in ground layer vegetation distinguished the North Rothbury vegetation from that occurring around Cessnock. At this point, the 700-800mm/yr rainfall band was postulated as the location of the change from LHSGIF to CHGBSGIF.

With the addition of further plot data, the third revision of the Spotted Gum – Ironbark classification was presented in the classification of the Cessnock vegetation (DECC 2008). Again, the same trends that were evident in the first revision in 2004 remained, and were in fact strengthened by the additional data (a total of 360 plots). The 700-800m/yr rainfall band postulated as the demarcation point between the LHSGIF and the CHGBSGIF in 2005 was again confirmed. Put simply, the presence of *Eucalyptus fibrosa* and *Corymbia maculata* in the canopy, together with *Melaleuca nodosa* in the mid-storey, cannot be seen as a presumption that a particular area is LHSGIF in the strict sense. Instead, an inventory of the ground layer vegetation is required.

Most recently, additional plot data collection and analysis for various projects, including survey in Columbey National Park near Clarencetown (Bell 2009b) and in the coastal zone between Lake Macquarie and Wyong (Bell 2009, 2010), has again strengthened observed variations. Of most relevance to the current project is the emergence of a strong group of sub-coastal plots within the broader *Corymbia maculata – Eucalyptus fibrosa* sub-group of data. This group is currently referred to as the Hinterland Spotted Gum - Red Ironbark Forest, and is differentiated from other forms of the LHSGIF by the strong presence of *Joycea pallida* and *Themeda australis* in the ground layer. Likewise, vegetation dominated by *Eucalyptus fibrosa* with strong representation by *Melaleuca decora* and *Melaleuca nodosa* (the Red Ironbark – Paperbark Forest), is difficult to separate from the *Corymbia maculata – Eucalyptus fibrosa* dataset, and hence must be considered a form of LHSGIF.

Although data analysis is still in progress, it is evident that a form of LHSGIF within higher rainfall coastal sites extends from Wyong up to the Clarencetown and Seaham area. The results of these studies, essentially presenting a re-classification of Spotted Gum – Ironbark vegetation in the Hunter Valley and Central Coast, will be prepared for scientific publication in the coming year (Bell in prog.). From a broader perspective, the Lower Hunter Spotted Gum – Ironbark Forest is at present known with certainty from Werakata National Park (Bell 2004b), Werakata State Conservation Area (DECC 2008), Columbey National Park (Bell 2009b), and Sugarloaf State Conservation Area (Bell & Driscoll in prog.). However, it is unknown at this stage what the collective area of reserved vegetation is that supports this EEC.

Swamp Sclerophyll Forest on Coastal Floodplains

The final determination for SSFCF specifically mentions in paragraph 8 that "*In the lower Hunter district, this community includes 'Swamp Mahogany-Paperbark Swamp Forest' (map unit 37), Riparian Melaleuca Swamp Woodland (map unit 42) and Melaleuca Scrub (map unit 42a) of NPWS (2000)*" (NSW Scientific Committee 2005). The Red Mahogany – Apple Paperbark Forest delineated in the current study forms part of the NPWS (2000) defined Riparian Melaleuca Swamp Woodland (MU42), and hence should be considered a part of SSFCF.

Swamp Sclerophyll Forest on Coastal Floodplains is present in a number of coastal reserves, although typically occurrences are small. Known reservation includes Lake Macquarie State Conservation Area (Bell 1998b), Sugarloaf State Conservation Area (Bell & Driscoll in prog.), Wallaroo and Karuah Nature Reserves (Bell 2002) and Tilligery State Conservation Area (Bell & Driscoll 2006a).

Regional - To assist in the regional assessment of vegetation from particular areas, the Lower Hunter and Central Coast Regional Environmental Management Strategy (LHCCREMS) undertook a vegetation survey

and mapping project of the seven local government areas from Port Stephens to Gosford, and west to Cessnock. The original survey (incorporating stratified random sampling) and mapping (GIS modelling) was documented in NPWS (2000), and updated mapping was completed in 2002 (Eco Logical Australia 2002). Hunter Councils have more recently revised this mapping (McCauley et al. 2006), but defined communities are difficult to rationalise to observed ground data.

The LHCCREMS classification and mapping is of necessity broad in nature, given budget limitations and the large study area involved. However, it is an important baseline for placing a site into a regional perspective, and hence the Edgeworth LES vegetation has been assessed against this regional classification. Importantly, a review of the LHCCREMS project conducted by the CSIRO concluded that the outcomes of the study are most appropriately used in a regional or at best local government area context, rather than for local scale assessments (Nicholls, Doherty & Newsome 2002). They also state that the modelling techniques used in the production of the mapping had not been widely used and hence they could not comment on their accuracy. A more detailed classification and mapping program entailing tighter restrictions on data quality, together with targeted sampling and extensive ground truthing, is currently in progress by the author. Communities defined in the current study reflect this revised classification.

Some of the Edgeworth LES communities are floristically and structurally distinct, yet when placed within the regional LHCCREMS framework bear little resemblance to their parent community. However, based on the regional LHCCREMS classification and mapping (LHCCREMS 2003), regional clearing estimates since European Settlement are:

- *Hinterland Spotted Gum – Red Ironbark Forest* (41% extant, equivalent to Unit 17: Lower Hunter Spotted Gum – Ironbark Forest of LHCCREMS);
- *Red Ironbark – Paperbark Forest* (41% extant, broadly equivalent to Unit 17: Lower Hunter Spotted Gum – Ironbark Forest of LHCCREMS);
- *Depression Paperbark Forest* (41% extant, broadly equivalent to Unit 17: Lower Hunter Spotted Gum – Ironbark Forest of LHCCREMS);
- *Red Mahogany – Apple Paperbark Forest* (49% extant, equivalent to Unit 42: Riparian Melaleuca Swamp Woodland of LHCCREMS).
- *Coastal Plains Stringybark – Apple Forest* (67% extant, equivalent to Unit 30: Coastal Plains Smooth-barked Apple Woodland of LHCCREMS);

It is difficult to make further comment on the regional significance of the Edgeworth LES vegetation, given that the available published regional information is limited in its application (Nicholls et al 2002). However, in addition to EEC-equivalent vegetation outlined previously, and in the author's experience throughout the region, two further communities are considered to be of at least regional significance pending additional regional data:

1. **Coastal Plains Stringybark-Apple Forest** occupies limited areas in the northern parts of Lake Macquarie LGA, but it is unknown how extensive this form of Coastal Plains Smooth-barked Apple Woodland is. The base geology in these northern sections is Permian sediments, but further south these change to Triassic Narrabeen.

2. **Depression Paperbark Forest** occupies very limited gully situations in north-western Lake Macquarie and the Cessnock area, typically within a wider Spotted Gum-Ironbark landscape. Possibly protected within the LHSGIF EEC listing.

4.2 Significant Species

Two threatened and one rare plant species were recorded within the Edgeworth LES study area, including:

- *Callistemon linearifolius* (vulnerable)
- *Tetratheca juncea* (vulnerable)
- *Eucalyptus fergusonii* subsp*. fergusonii* (rare)

Figure 8 shows the location of all significant species recorded. None of these species pose a significant constraint on potential use of the land, given their small population sizes within the Edgeworth LES area and current reservation status elsewhere. *Eucalyptus beyeriana* has been included on Figure 8, as it is considered of regional significance due to its rarity in Lake Macquarie.

Callistemon linearifolius **(Myrtaceae)** TSC Act Vulnerable

Harden (2002) indicates that *Callistemon linearifolius* occurs in dry sclerophyll forest on the coast and adjacent ranges chiefly from the Georges River to the Hawkesbury River on the Central Coast. It is a large shrub 3-4m in height with linear to linear-lanceolate leaves and bearing red flowers during Spring and Summer. *Callistemon linearifolius* has been recorded in several locations in the Cessnock and Werakata NP areas (Bell 2004b; DECC 2008). In a juvenile form (such as after wildfire), it is difficult to distinguish this species from *Callistemon rigidus*, with which it co-occurs in several locations.

One small population of two plants of *Callistemon linearifolius* occurs within the Edgeworth LES area, within the Coastal Plains Stringybark-Apple Forest (Unit 30e). Other potential stands of this species were determined by the National Herbarium to be *Callistemon rigidus*.

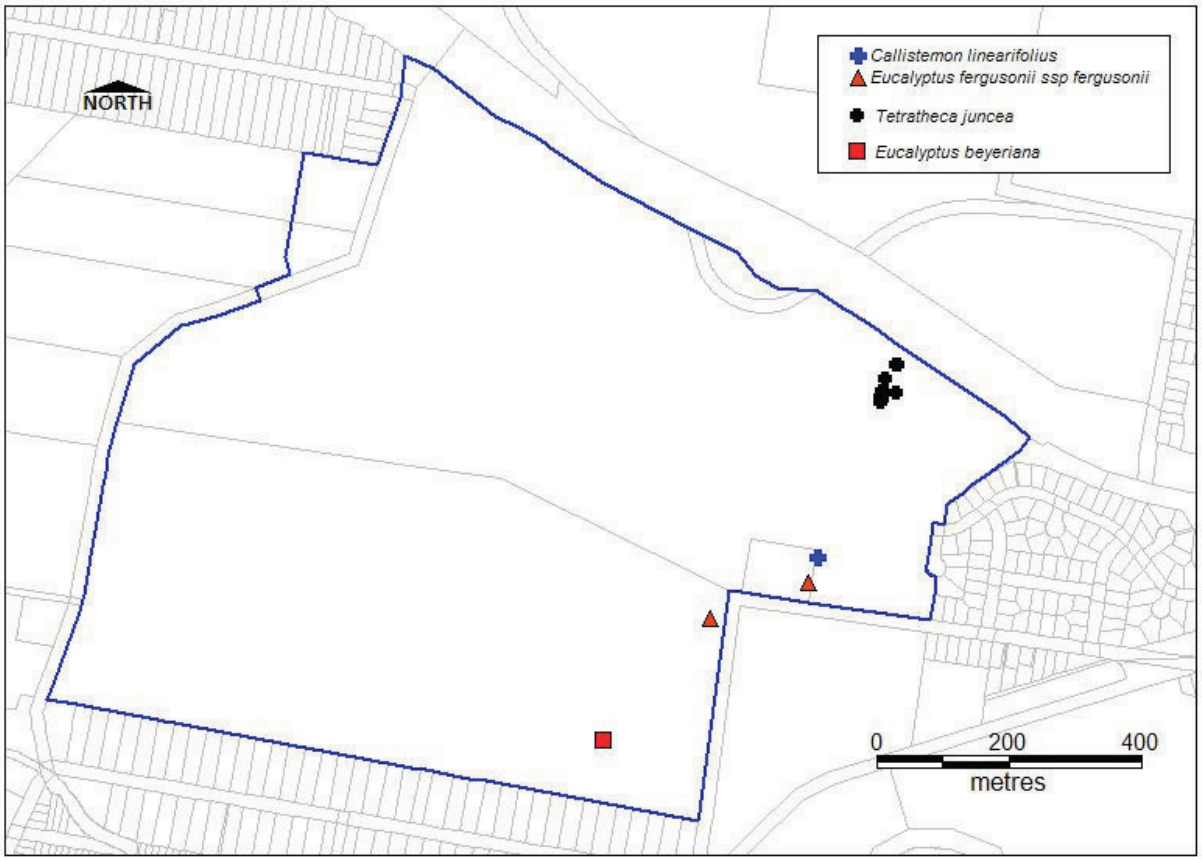

Figure 8 Significant plant taxa, Edgeworth LES.

Tetratheca juncea (Tremandracaceae) EPBC Act Vulnerable; TSC Act Vulnerable

Tetratheca juncea is widespread in the Lake Macquarie area, but its full distribution currently extends from Wyong to Bulahdelah. It occupies a range of habitats within this region, from coastal headlands to open forests, on conglomerates, sandstones and coastal sands. The distribution and habitat requirements of *Tetratheca juncea* in the Munmorah area were examined by Payne (1993), while Payne (2001) has examined several other aspects of the ecology of this species, as part of the Lake Macquarie Conservation Management Plan. Since that time, significant new research has been published on the pollination ecology of *Tetratheca juncea*, and sizeable new populations have been uncovered. Driscoll (2003) has documented the pollination process of *Tetratheca juncea* and identified several species of native bees responsible, while Bellairs et al. (2006) examined aspects of the seed biology of this species.

Eleven (11) plant clumps of *Tetratheca juncea* were located within the Edgeworth LES study area, in the north-eastern portion near George Booth Drive. All eleven occur within the Coastal Plains Stringybark-Apple Forest (Unit 30e). In the Lake Macquarie *Tetratheca juncea* conservation management plan, Payne (2001) indicates that most populations of this species comprise less than 25 plant clumps, with few populations comprising more than 100 plants. However, more recent detailed surveys at several locations within Lake Macquarie suggest that many populations exceed 100 plants. In the Morisset area, 4134 plant clumps were recorded within the Morisset structure plan area, and which are likely to have comprised a single population prior to fragmentation occurring through development (Driscoll & Bell 2008). At another site in Tingira Heights to the east, initial counts of 27 clumps ultimately resulted in more than 600 after detailed survey (Murray & Bell 2006). At Eraring Power Station in south-western Lake Macquarie, abundant populations have been reported, clearly exceeding previous estimates in the area (HLA 2004; Bell 2007). Evidently, since the production of the conservation management plan, considerably more data has become available, and more systematic and detailed surveys are revealing many populations greater than 100 plants in size.

Implications for the Edgeworth LES population are that 11 plant clumps cannot be considered of high significance, given the number of larger populations elsewhere in the City. For the north-west quadrant, Payne (2001) indicates that around 14% of total plant clumps were held in conservation at that time. With the gazettal of Sugarloaf State Conservation Area (the former Awaba and Heaton State Forests), large populations of *Tetratheca juncea* are now contained in reserve (Bell & Driscoll in prog.).

Eucalyptus fergusonii subsp. *fergusonii* (Myrtaceae) Rare 3KC-

Eucalyptus fergusonii subsp. *fergusonii* is an ironbark tree to 25m in height, growing in wetter forest on sandstone principally from Bulahdelah to Morriset (Harden 2002). It is known from extensive stands in Jilliby State Conservation Area and Watagans National Park (Bell & Driscoll 2005), Wallaroo and Karuah Nature Reserves (Bell 2002), Sugarloaf State Conservation Area (Bell & Driscoll in prog.), Glenrock State Conservation Area (Bell 1998), and Booti Booti National Park on the North Coast (Griffiths et. al. 2000).

A few trees are present within the eastern sections of the Edgeworth LES area, associated with small sandstone outcrops within the wider *Corymbia maculata – Eucalyptus fibrosa* mosaic. Although generally rare in the northern Lake Macquarie area, this species is not of high significance.

5. IMPACT ASSESSMENT

The flora investigations undertaken for the Edgeworth LES sought to identify the presence of protected and threatened species. Threatened species are those listed on Schedules One and Two of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999), and also Schedules One and Two of the NSW *Threatened Species Conservation Act 1995* (TSC Act 1995).

This assessment is required to address the potential or actual effect of any proposal impacting on these threatened species or their habitat. The assessment of potential or actual effect of a proposal under the EPBC Act 1999 requires consideration of several Matters of National Significance. In addition, the proposal also requires consideration of impact under s.5A of the NSW *Environmental Planning and Assessment Act 1979* (as amended by the *Threatened Species Conservation Act 1995*).

As a result of current flora surveys, two threatened species are present on the subject site (Table 6). Assessments for each of these species have been completed, and are presented in the following sections.

Table 6 Threatened species recorded in the study area. *Locality record* refers to the immediately surrounding area, within a 5km radius of the site.

Threatened Entity	EPBC Act 1999	TSC Act 1995	Recorded in Study Area	Locality Record
Flora				
Callistemon linearifolius	-	Vulnerable	+	
Tetratheca juncea	Vulnerable	Vulnerable	+	+
Endangered Ecological Communities				
Lower Hunter Spotted Gum-Ironbark Forest	-	Endangered	+	
Swamp Sclerophyll Forest on Coastal Floodplains	-	Endangered	+	+

5.1 Commonwealth

This Act requires the Commonwealth Environment Minister's approval for an Action that will have or is likely to have a detrimental / adverse impact(s) on a Matter of National Environmental Significance, or on Commonwealth land unless the action is exempt. Matters of National Environmental Significance currently include World Heritage properties, Ramsar Wetlands of international importance, Listed threatened species and communities, Listed migratory species, Nuclear Actions, Commonwealth marine environment, and other matters prescribed by the Regulations.

Guidelines have been prepared in order to decide whether an action is likely to have a significant impact, and if it is necessary to take into account the nature and magnitude of potential impacts. In determining the nature and magnitude of an action's impact, it is important to consider matters such as:

- all on-site and off-site impacts,
- all direct and indirect impacts,
- the frequency and duration of the action,
- the total impact which can be attributed to that action over the entire geographic area affected, and over time,
- the sensitivity of the receiving environment, and
- the degree of confidence with which the impacts of the action are known and understood.

The Act provides that the Minister must, in deciding whether an action is likely to have a significant impact on a matter of national environmental significance, take account of the precautionary principle. Accordingly, the fact that there is *a lack of scientific certainty* about the potential impacts of an action will not itself justify a decision that the action is not likely to have a significant impact on a matter of national environmental significance.

No World Heritage properties, Ramsar Wetlands, Commonwealth Marine Areas, Nuclear Actions or other matters apply to the study area.

Matters of National Environmental Significance relevant to the Edgeworth LES area include listed threatened species.

Tetratheca juncea

Criteria 1. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to lead to a long-term decrease in the size of an important population of a species.*

An "important" population is one that is necessary for a species long-term survival and recovery, and may include key source populations for breeding and dispersal, populations necessary for maintaining genetic diversity and populations near the limit of the species range.

The Lake Macquarie region represents the centre of the species distribution (excluding extinct populations in Sydney). Within the study area, 11 plant clumps were recorded, which will be destroyed as a result of development.

Criteria 2. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to reduce the area of occupancy of an important population.*

It is likely that all of the *Tetratheca juncea* plants will be destroyed through development of the subject land. However, given the substantial numbers of other plants in the northern Lake Macquarie area, including many hundreds in conservation reserve, and the fact that the population within the study area is not considered an important one, a significant impact would not be felt.

Criteria 3. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to fragment an existing important population into two or more populations.*

The study area lies on the north-eastern edge of a large vegetated area, near the major George Booth Drive. Due to its small size, the population of *Tetratheca juncea* present within the proposed development site is not considered an important population under the meaning of the Act, and hence a significant impact will not be felt. Consequently, the proposal is unlikely to fragment the existing population of plants, and is therefore not considered significant.

Criteria 4. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to adversely affect habitat critical to the survival of a species.*

No critical habitat for *Tetratheca juncea* has been declared under the *EPBC Act 1999*. *Tetratheca juncea* currently occupies a range of habitats throughout its distribution (Payne 2001; Driscoll 2003).

Criteria 5. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to disrupt the breeding cycle of an important population.*

Driscoll (2003) has documented the pollination process of *Tetratheca juncea* and identified several species of native bees responsible. Such pollinators are highly mobile and are not restricted solely to *Tetratheca* for their nourishment. Several species include *Tetratheca juncea* as only a minor component of their diet. Due to its small size, the population potentially impacted upon by the proposal is not considered an important one, and will therefore not be significantly impacted upon.

Criteria 6. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.*

All 11 plants of *Tetratheca juncea* will be removed through development. Given that no further plants were located elsewhere within the large remnant (~96ha) containing the known plants, it is possible that habitat is not ideal for this species.

Criteria 7. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat.*

There is some possibility that invasive species (eg exotic grasses) will become established within the habitat of *Tetratheca juncea*. This is most likely along roadside edges and other disturbed lands. However, intact and contiguous bushland is unlikely to be severely impacted upon by invasive weeds.

Criteria 8. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to interfere substantially with the recovery of the species.*

Tetratheca juncea occurs widely in the Lake Macquarie area, including the vicinity of the study area. The potential loss of 11 plants would not impinge on the recovery of the species. In any case, it is possible that all populations of *Tetratheca juncea* are undergoing a process of insidious delayed extinction due to pollinator limitation (sensu Driscoll 2003), although some sites support high densities of pollinators. The potential impact of interference to recovery processes is therefore considered insignificant.

Summary - The action (development of the study area) will impact on a small number of *Tetratheca juncea* plants through ground disturbance and plant removal. However, as the population has not been identified as an important population under the meaning of the Act, a significant impact on the species **will not** be felt.

5.2 State

As required under the revisions to the relevant legislation (ie: Section 94 *Threatened Species Conservation Act;* Section 5A *Environmental Planning & Assessment Act*; Section 220Z *Fisheries Management Act*), 'seven-part tests' have been completed for *Callistemon linearifolius* and *Tetratheca juncea,* and the *Lower Hunter Spotted Gum – Ironbark Forest* and *Swamp Sclerophyll Forest on Coastal Floodplains* EEC's. No Endangered Populations, as listed on the Act, are present on the site and consequently do not require impact assessment.

Callistemon linearifolius

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Clearing of the habitat supporting *Callistemon linearifolius* will unavoidably disrupt the life cycle of this species in the immediate vicinity. One area within the study area supports the species (two plants), located immediately adjacent to the proposed development. This species typically occurs sporadically within sandstone environments, mostly on the Central Coast but also towards Cessnock

and Karuah. Based on available records, the occurrence of this species on the subject site forms a disjunct local population, which may be placed at risk of extinction.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

No endangered populations of *Callistemon linearifolius* are listed in the TSC Act 1995.

(c) in the case of an endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Callistemon linearifolius is not an endangered ecological community under the meaning of the Act.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

(i) the two plants of *Callistemon linearifolius* located within the study area occur within the Coastal Plains Stringybark-Apple Forest. Assuming this vegetation type constitutes the habitat of this species locally, the proposed development will remove approximately 13.5 ha. Known plants will be retained in a vegetated buffer.

(ii) given the paucity of confirmed records of this species in the northern Lake Macquarie area, it is assumed that the two plants of *Callistemon linearifolius* are already isolated from other populations, and that further fragmentation of potential habitat through development will not occur.

(iii) Coastal Plains Stringybark-Apple Forest represents a potentially restricted form of the regional Coastal Plains Smooth-barked Apple Woodland (Unit 30 of NPWS 2000). *Callistemon linearifolius* is sporadically distributed between the Hawkesbury River, Karuah and Cessnock, across a range of habitats. Removal of habitat as part of the current proposal may impact on the local populations of this species, but it is unlikely that such an impact can be considered significant.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

No critical habitat has yet been declared for this species under Part 3 Division 1 of the Threatened Species Conservation Act 1995.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

A Recovery Plan or Threat Abatement Plan has not yet been prepared for *Callistemon linearifolius*.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Schedule 3 of the TSC Act is intended to provide a list of the "*key threatening processes*" which are regarded as of relevance to the TSC Act and its implementation. The *TSC Act 1995* defines "*threatening process*" as "*a process that threatens, or may have the capability to threaten*, *the survival or evolutionary development of species*, *populations or ecological communities*". There are several threatening processes currently listed by the NSW Scientific Committee, of which the following are relevant to the proposed development on the subject site:

- Clearing of native vegetation.

Development of the subject site will entail clearing of existing native vegetation within the site and is hence an action which constitutes, or will result in the operation of, the listed Key Threatening Process *Clearing of native vegetation*.

Summary - This Section 5A assessment concludes that the local population of *Callistemon linearifolius* is **unlikely** to be significantly impacted upon by the proposed development. The two plants present do not constitute an important population, and will be retained within a vegetated area adjacent to development.

Tetratheca juncea

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The study area supports 11 plant clumps of *Tetratheca juncea*, in the north-east of the Edgeworth LES area. It is likely that all of these plants will be destroyed through development. *Tetratheca juncea* is pollinated by at least two sonicating bees (Driscoll 2003), and based on the amount of *Tetratheca juncea* elsewhere in northern Lake Macquarie, it is evident that these bees are active in the area. The proposed development will remove all 11 plant clumps of *Tetratheca*, and the local population of plants will be placed at risk of extinction.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

No endangered populations of *Tetratheca juncea* are listed in the TSC Act 1995.

(c) in the case of an endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Tetratheca juncea is not an endangered ecological communities under the meaning of the Act.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

(i) within the current study area, *Tetratheca juncea* occurs within the Coastal Plains Stringybark-Apple Forest, of which approximately 13.5 ha will be removed through development. However, further afield this species occupies a wide range of habitats.

(ii) the proposed development will remove all 11 plants present within the study area, and will result in the loss of some potential habitat for this species. Given the already fragmented nature of the habitat within the locality, it is unlikely that further fragmentation or isolation will occur.

(iii) Coastal Plains Stringybark-Apple Forest represents a potentially restricted form of the regional Coastal Plains Smooth-barked Apple Woodland (Unit 30 of NPWS 2000). *Tetratheca juncea* is widespread between Wyong and Bulahdelah, across a range of habitats. Removal of habitat as part of the current proposal may impact on the local populations of this species, but it is unlikely that such an impact can be considered significant.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

No critical habitat has yet been declared for this species under Part 3 Division 1 of the Threatened Species Conservation Act 1995.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

A Recovery Plan or Threat Abatement Plan has not yet been prepared for *Tetratheca juncea*.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Schedule 3 of the TSC Act is intended to provide a list of the "*key threatening processes*" which are regarded as of relevance to the TSC Act and its implementation. The *TSC Act 1995* defines "*threatening process*" as "*a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities*". There are several threatening processes currently listed by the NSW Scientific Committee, of which the following are relevant to the proposed development on the subject site:

- Clearing of native vegetation.

Development of the subject site will entail clearing of existing native vegetation within the site and is hence an action which constitutes, or will result in the operation of, the listed Key Threatening Process *Clearing of native vegetation*.

Summary - This Section 5A assessment concludes that the local population of *Tetratheca juncea* is **likely** to be significantly impacted upon by the proposed development. However, the 11 plants present do not constitute an important population given the large numbers reported elsewhere in Lake Macquarie.

Lower Hunter Spotted Gum-Ironbark Forest

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Lower Hunter Spotted Gum-Ironbark Forest is not a threatened species.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Lower Hunter Spotted Gum-Ironbark Forest is not an endangered population under the TSC Act 1995.

(c) in the case of an endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

(i) approximately 22 ha (43%) of Lower Hunter Spotted Gum-Ironbark Forest will be impacted upon by the proposal, with 29 ha (57%) retained within the study area. Within the Lake Macquarie LGA, 836 ha of this EEC have been mapped (Bell 2009), while in total around 30,000 ha are known for the region (NSW Scientific Committee 2005b). It is unlikely that the proposed development will place this community at risk of extinction either regionally or within the Lake Macquarie LGA.

(ii) the proposed development will remove 22 ha of Lower Hunter Spotted Gum-Ironbark Forest, but 29 ha will be retained on-site. This, in combination with the ~800 ha of this EEC present elsewhere in Lake Macquarie, imply that the local occurrence is unlikely to be placed at risk of extinction.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

(i) 22 ha of Lower Hunter Spotted Gum-Ironbark Forest will be removed as a result of the proposal.

(ii) removal of Lower Hunter Spotted Gum-Ironbark Forest as part of the development proposal will fragment a larger remnant of this vegetation type, but further isolation than that which currently exists will not occur to any great degree.

(iii) given the extent of this EEC within the Lake Macquarie LGA, and further afield, the habitat proposed for removal will not impact on the long-term survival of the community in the locality. Larger areas of intact vegetation supporting this EEC occur to the west around West Wallsend and Killingworth (Bell 2009).

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

No critical habitat has yet been declared under Part 3 Division 1 of the Threatened Species Conservation Act 1995.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

A Recovery Plan or Threat Abatement Plan has not yet been prepared for this community.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Schedule 3 of the TSC Act is intended to provide a list of the "*key threatening processes*" which are regarded as of relevance to the TSC Act and its implementation. The *TSC Act 1995* defines "*threatening process*" as "*a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities*". There are several threatening processes currently listed by the NSW Scientific Committee, of which the following are relevant to the proposed development on the subject site:

- Clearing of native vegetation.

Development of the subject site will entail clearing of existing native vegetation within the site and is hence an action which constitutes, or will result in the operation of, the listed Key Threatening Process *Clearing of native vegetation*.

Summary - This Section 5A assessment concludes that the Lower Hunter Spotted Gum-Ironbark Forest EEC is **unlikely** to be significantly impacted upon by the proposed development. Substantial areas of the community occur to the west of the current site, although it is uncertain how secure those areas are with regard to future development or clearing.

Swamp Sclerophyll Forest on Coastal Floodplains

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Swamp Sclerophyll Forest on Coastal Floodplains is not a threatened species.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Swamp Sclerophyll Forest on Coastal Floodplains is not an endangered population under the TSC Act 1995.

(c) in the case of an endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

(i) no clearing or modification of Swamp Sclerophyll Forest on Coastal Floodplains EEC is proposed, as it will be retained within a vegetated buffer area.

(ii) no clearing or modification of Swamp Sclerophyll Forest on Coastal Floodplains EEC is proposed, hence the local occurrence is unlikely to be placed at risk of extinction.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

(i) no clearing or modification of Swamp Sclerophyll Forest on Coastal Floodplains EEC is proposed.

(ii) the single stand of Swamp Sclerophyll Forest on Coastal Floodplains is already isolated from other stands of similar vegetation due to previous developments. No further fragmentation or isolation will occur as a result of the proposed development.

(iii) no clearing or modification of Swamp Sclerophyll Forest on Coastal Floodplains EEC is proposed.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

No critical habitat has yet been declared under Part 3 Division 1 of the Threatened Species Conservation Act 1995.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

A Recovery Plan or Threat Abatement Plan has not yet been prepared for this community.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Schedule 3 of the TSC Act is intended to provide a list of the "*key threatening processes*" which are regarded as of relevance to the TSC Act and its implementation. The *TSC Act 1995* defines "*threatening process*" as "*a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities*". There are several threatening processes currently listed by the NSW Scientific Committee, of which the following are relevant to the proposed development on the subject site:

- Clearing of native vegetation.

  Development of the subject site will entail clearing of existing native vegetation within the site and is hence an action which constitutes, or will result in the operation of, the listed Key Threatening Process *Clearing of native vegetation*.

Summary - This Section 5A assessment concludes that the Swamp Sclerophyll Forest on Coastal Floodplains is **unlikely** to be significantly impacted upon by the proposed development. The single area present will be retained within a vegetated buffer area.

5.3 Summary of Impact

Table 7 summarises the results of the impact assessment for both the Commonwealth and State legislation.

Table 7 Summary of impact assessment.

Threatened Entity	EPBC Act 1999	TSC Act 1995
Flora		
Callistemon linearifolius	-	No impact
Tetratheca juncea	Not significant	Not significant
Endangered Ecological Communities		
Lower Hunter Spotted Gum-Ironbark Forest	-	Not significant
Swamp Sclerophyll Forest on Coastal Floodplains	-	No impact

6. LAND USE OPTIONS

6.1 Summary of Constraints

The native vegetation present across the 96ha of lands forming the Edgeworth LES study area comprise two Endangered Ecological Communities (EEC's), as listed on the NSW *TSC Act 1995*, together with two Vulnerable plant species (*Callistemon linearifolius, Tetratheca juncea*), and one rare plant species (*Eucalyptus fergusonii* subsp. *fergusonii*). Collectively, the two EEC's occupy 54% of the total land area and extend across most of the site (refer to Figure 9). The small population of *Tetratheca juncea* occurs towards the north-eastern boundary of the site, adjacent to George Booth Drive. Relative to other documented populations of this species, this population is of low significance. Likewise, the single location of *Callistemon linearifolius* represents a small population of two plants, and it and the *Eucalyptus fergusonii* subsp. *fergusonii* occur along the south-eastern boundary.

Figure 9 summarises the constraints on development posed by native vegetation.

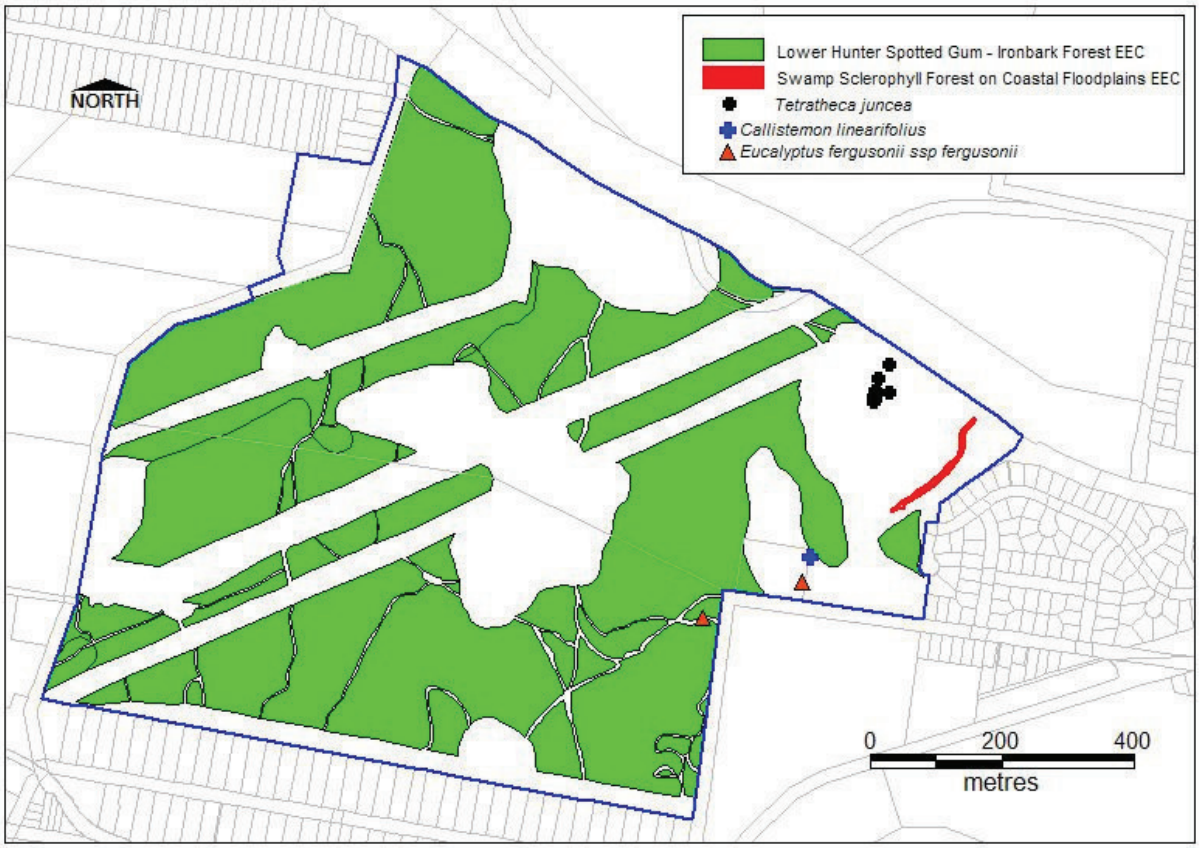

Figure 9 Summary of vegetation constraints, Edgeworth LES.

6.2 Corridors

Lake Macquarie City Council has identified wildlife corridors across the southern and western sections of the study area. Bearing in mind the approved developments as part of the Pambulong Forest estate to the north, there is in effect little scope for effective corridors in a north-south direction, without substantial plantings and rehabilitation of previously disturbed lands.

6.3 Development Options

Evidently, any development of the land within the Edgeworth LES study area will involve the loss of threatened ecological communities. This is complicated by the fact that vegetation communities recognised in this study have not been previously defined formally for the region, and consequently their perceived significance can only be intuitively determined.

The Lower Hunter Spotted Gum – Ironbark Forest, as defined in this study, comprises two distinct variants: the Hinterland Spotted Gum – Red Ironbark Forest and the Red Ironbark – Paperbark Forest. Both of these vegetation communities have been recognised in other recent studies (eg: DECC 2008), yet their full distribution is yet to be realised. Additionally, neither of these two communities are adequately conserved in the region, with only limited representation within Sugarloaf SCA (Bell & Driscoll in prog.). Concurrent and ongoing studies aim to clarify the situation in the coming year (Bell in prog.).

Figure 10 illustrates the proposed development area within the overall study area. The development area occupies approximately 47.7 ha (49.7%), and will inevitably require the removal of some Lower Hunter Spotted Gum-Ironbark Forest (22 ha), and all 11 plants of *Tetratheca juncea* (Vulnerable). However, 29 ha of this EEC will be retained, as will all of the Swamp Sclerophyll Forest on Coastal Floodplains (0.18 ha), the known population of *Callistemon linearifolius* (Vulnerable), and one of the two stands of *Eucalyptus fergusonii* subsp. *fergusonii* (rare). The perceived impacts of these losses have been dealt with in Section 5.

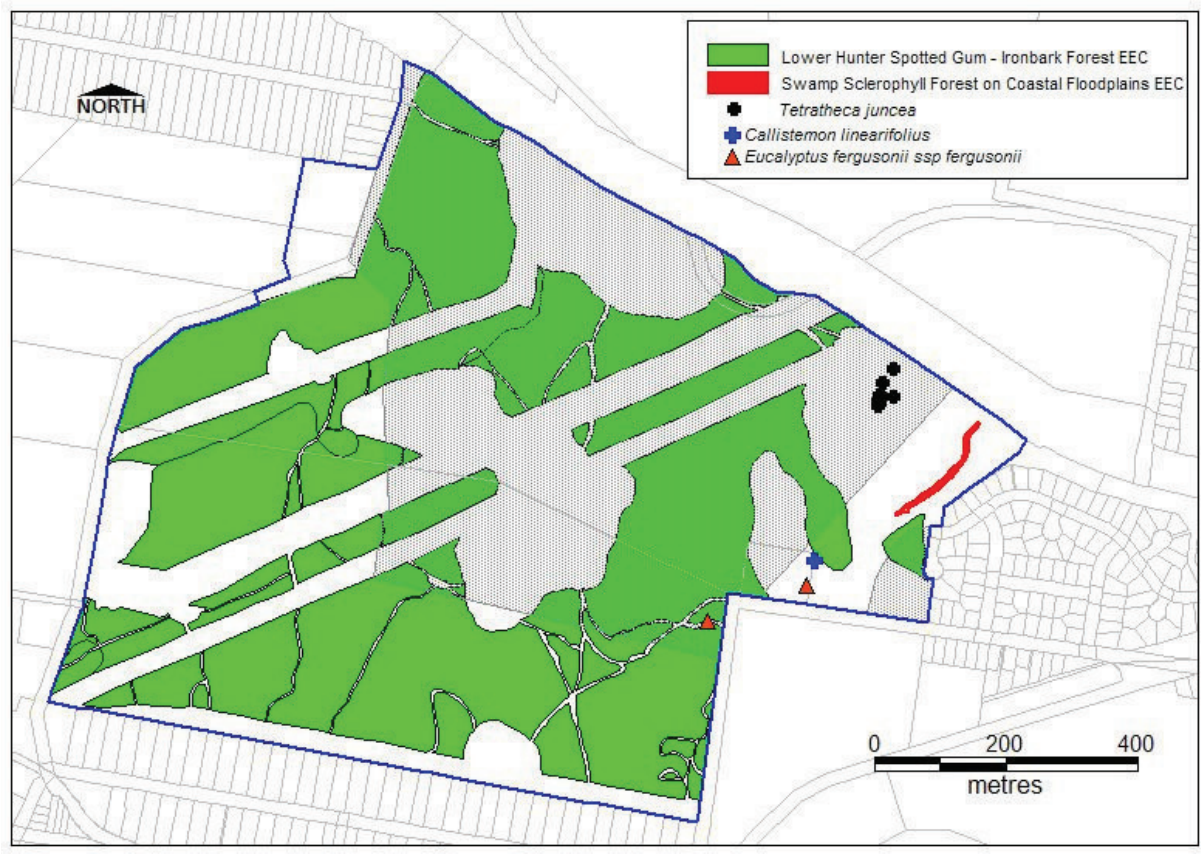

Figure 10 Proposed development area (shaded), Edgeworth LES.

7. CONCLUSIONS & RECOMMENDATIONS

The Edgeworth LES study area supports five definable vegetation communities, most of which are currently in good condition. Previous mapping of the area by NPWS (2000) evidently did not adequately describe the diversity of vegetation present. Other survey and mapping programs to the north of the site in the Pambulong Forest area provide broadly complimentary descriptions of the vegetation.

The study area supports 173 native plant taxa across five vegetation communities. Three of these taxa are considered of significance within the region, two of which are currently listed on the Commonwealth *EBPC Act 1999* or the NSW *TSC Act 1995* (*Callistemon linearifolius* and *Tetratheca juncea*), and one as nationally rare (*Eucalyptus fergusonii* subsp*. fergusonii*). In the most part, community definition allowed reasonable comparisons with regional vegetation classifications recently undertaken in the Lower Hunter and Central Coast, and consequently statements of conservation significance for each community could be made. Two Endangered Ecological Communities (Lower Hunter Spotted Gum – Ironbark Forest & Swamp Sclerophyll Forest on Coastal Floodplains) are present on the site, which together occupy 54% of the total 96ha.

A potential development area has been proposed, which would allow development of 47.7 ha (~50%) of the total 96 ha area. This would entail the loss of 11 plants of *Tetratheca juncea* (Vulnerable), 22 ha of Lower Hunter Spotted Gum-Ironbark Forest EEC, and one stand of *Eucalyptus fergusonii* subsp. *fergusonii* (rare). Retained lands would conserve 29 ha of Lower Hunter Spotted Gum-Ironbark Forest EEC, 0.18 ha of Swamp Sclerophyll Forest on Coastal Floodplains, one population of *Callistemon linearifolius* (Vulnerable, 2 plants), and one stand of *Eucalyptus fergusonii* subsp. *fergusonii* (rare). Impact assessments under the EPBC Act 1999 and the TSC Act 1995 concluded with little or no significant impact for these losses.

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9. APPENDICIES

Appendix 9.1 Plant species list

Class	Family	Genus & Species
Filicopsida (Ferns)	Adiantaceae	*Adiantum aethiopicum*
		Cheilanthes sieberi subsp. sieberi
	Davalliaceae	*Nephrolepis cordifolia* *
	Dennstaedtiaceae	*Pteridium esculentum*
	Lindsaeaceae	*Lindsaea linearis*
Magnoliopsida (Flowering plants) Dicotyledons	Acanthaceae	*Brunoniella australis*
	Apiaceae	*Centella asiatica*
		Hydrocotyle bonariensis *
		Hydrocotyle laxiflora
		Hydrocotyle peduncularis
	Apocynaceae	*Parsonsia straminea*
	Asteraceae	*Ageratina adenophora* *
		Cassinia aculeata
		Cassinia uncata
		Chrysocephalum apiculatum
		Euchiton involucratus
		Lagenophora stipitata
		Senecio madagascariensis *
		Senecio tenuiflorus
		Taraxacum officinale *
		Vernonia cinerea var. cinerea
	Bignoniaceae	*Pandorea pandorana*
	Casuarinaceae	*Allocasuarina littoralis*
	Clusiaceae	*Hypericum gramineum*
	Convolvulaceae	*Dichondra repens*
		Polymeria calycina
	Dilleniaceae	*Hibbertia empetrifolia subsp. empetrifolia*
		Hibbertia pedunculata
	Elaeocarpaceae	*Tetratheca juncea* (TSC Vulnerable)

Ericaceae	*Epacris pulchella*
	Leucopogon juniperinus
	Leucopogon microphyllus var. microphyllus
	Monotoca scoparia
Euphorbiaceae	*Glochidion ferdinandi var. ferdinandi*
	Phyllanthus hirtellus
Fabaceae (Faboideae)	*Bossiaea prostrata*
	Daviesia mimosoides subsp. mimosoides
	Daviesia squarrosa
	Daviesia ulicifolia subsp. ulicifolia
	Desmodium rhytidophyllum
	Dillwynia retorta species complex
	Glycine clandestina
	Gompholobium latifolium
	Gompholobium pinnatum
	Hardenbergia violacea
	Hovea linearis
	Mirbelia rubiifolia
	Podolobium ilicifolium
	Pultenaea euchila
	Pultenaea paleacea
	Pultenaea retusa
	Pultenaea villosa
	Swainsona galegifolia
Fabaceae (Mimosoideae)	*Acacia falcata*
	Acacia implexa
	Acacia irrorata subsp. irrorata
	Acacia leiocalyx subsp. leiocalyx
	Acacia longifolia subsp. longifolia
	Acacia myrtifolia
	Acacia stricta
	Acacia terminalis subsp. angustifolia
	Acacia ulicifolia
Goodeniaceae	*Goodenia bellidifolia subsp. bellidifolia*
	Goodenia heterophylla subsp. heterophylla
Haloragaceae	*Gonocarpus tetragynus*
Lauraceae	*Cassytha glabella f. glabella*
	*Cinnamomum camphora **
Lobeliaceae	*Pratia purpurascens*
Loganiaceae	*Logania pusilla*
Loranthaceae	*Dendrophthoe vitellina*

Myrtaceae	*Angophora costata* *Callistemon linearis* *Callistemon linearifolius [to be confirmed]* *Callistemon rigidus* *Callistemon salignus* *Corymbia gummifera* *Corymbia maculata* *Eucalyptus amplifolia subsp. amplifolia* *Eucalyptus beyeriana* *Eucalyptus capitellata* *Eucalyptus fergusonii subsp. fergusonii* (ROTAP 3KC-) *Eucalyptus fibrosa* *Eucalyptus globoidea* *Eucalyptus punctata* *Eucalyptus resinifera subsp. resinifera* *Eucalyptus umbra* *Euryomyrtus ramosissima subsp. ramosissima* *Leptospermum polygalifolium subsp. cismontanum* *Leptospermum polygalifolium subsp. polygalifolium* *Leptospermum trinervium* *Melaleuca decora* *Melaleuca ericifolia* *Melaleuca nodosa* *Melaleuca thymifolia*
Oleaceae	*Jasminum spp. ** *Ligustrum sinense ** *Notelaea longifolia f. longifolia*
Oxalidaceae	*Oxalis perennans*
Pittosporaceae	*Billardiera scandens* *Bursaria longisepala* *Bursaria spinosa*
Plantaginaceae	*Plantago debilis* *Plantago lanceolata **
Polygalaceae	*Comesperma ericinum* *Comesperma sphaerocarpum*
Proteaceae	*Banksia spinulosa var. collina* *Hakea salicifolia subsp. salicifolia* *Hakea sericea* *Persoonia levis* *Persoonia linearis*
Ranunculaceae	*Clematis glycinoides var. glycinoides*
Rhamnaceae	*Pomaderris intermedia*

	Rubiaceae	*Opercularia diphylla* *Opercularia varia* *Pomax umbellata*
	Rutaceae	*Boronia polygalifolia*
	Santalaceae	*Exocarpos cupressiformis*
	Sapindaceae	*Dodonaea triquetra*
	Scrophulariaceae	*Veronica plebeia*
	Stylidiaceae	*Stylidium graminifolium*
	Thymelaeaceae	*Pimelea linifolia subsp. linifolia*
	Verbenaceae	*Lantana camara **
	Violaceae	*Hybanthus monopetalus*
Magnoliopsida (Flowering plants) Monocotyledons	Agavaceae	*Agave spp. **
	Anthericaceae	*Arthropodium minus* *Thysanotus tuberosus subsp. tuberosus* *Tricoryne elatior*
	Asparagaceae	*Asparagus aethiopicus **
	Cyperaceae	*Carex inversa* *Fimbristylis dichotoma* *Gahnia clarkei* *Gahnia radula* *Lepidosperma laterale* *Ptilothrix deusta* *Schoenus apogon* *Schoenus melanostachys*
	Doryanthaceae	*Doryanthes excelsa*
	Iridaceae	*Patersonia sericea*
	Juncaceae	*Juncus continuus* *Juncus homalocaulis*
	Lomandraceae	*Lomandra confertifolia subsp. pallida* *Lomandra cylindrica* *Lomandra filiformis subsp. coriacea* *Lomandra filiformis subsp. filiformis* *Lomandra longifolia* *Lomandra multiflora subsp. multiflora*

	Lomandra obliqua
Luzuriagaceae	*Eustrephus latifolius*
Orchidaceae	*Acianthus fornicatus* *Caladenia carnea var. carnea* *Caladenia catenata* *Caladenia fuscata* *Calochilus paludosus* *Calochilus spp.* *Cymbidium suave* *Dipodium punctatum* *Diuris aurea* *Microtis parviflora* *Microtis unifolia*
Philydraceae	*Philydrum lanuginosum*
Phormiaceae	*Dianella caerulea var. assera* *Dianella longifolia var. longifolia* *Dianella revoluta var. revoluta*
Poaceae	*Andropogon virginicus ** *Anisopogon avenaceus* *Aristida vagans* *Austrostipa verticillata* *Axonopus fissifolius ** *Cortaderia selloana ** *Dichelachne micrantha* *Digitaria ramularis* *Echinopogon caespitosus var. caespitosus* *Echinopogon ovatus* *Entolasia marginata* *Entolasia stricta* *Eragrostis brownii* *Eragrostis leptostachya* *Imperata cylindrica var. major* *Joycea pallida* *Microlaena stipoides var. stipoides* *Notodanthonia longifolia* *Oplismenus imbecillis* *Panicum simile* *Pennisetum clandestinum ** *Setaria distans* *Setaria gracilis ** *Themeda australis*
Xanthorrhoeaceae	*Xanthorrhoea latifolia subsp. latifolia* *Xanthorrhoea resinosa*

Appendix 9.2 Vegetation community profiles

Community profiles of each vegetation community present within the Edgeworth LES study area have been developed following the general format used by *Eastcoast Flora Survey* in several recent vegetation mapping programs, particularly those examining large vegetated areas and those in conservation reserves. The rationale behind the profiles is to assist end-users in the interpretation of delineated map units, and to allow the general reader with at least some basic knowledge of common plant species to identify the different vegetation types.

A summary map showing the distribution of each community within the study area is provided with each profile. As far as possible, vegetation communities described have been placed within the regional classification of NPWS (2000), to allow consistency within the Central Coast and lower Hunter region. In cases where communities recognised in the field do not readily conform to those described in NPWS (2000), new community names and profiles have been constructed.

For each vegetation community, a summary of the basic structural makeup of that unit is provided. The accuracy of structural information presented with each profile is governed by the sample size of each community (shown as "n" in the structural tables).

The derivation of diagnostic species for each community has been defined using the SIMPER routine in *Primer*. SIMPER analysis provides the relative contributions of each species to the Bray-Curtis similarity within each of the defined vegetation communities. Only those species contributing to a total cumulative contribution of 90% of the average similarity (the value shown at the top of each table) for each community are listed. These species can be described of as *typical* of that community, and have a consistently large presence within the data as reflected in the ratio of their contribution to the standard deviation (the Sim/SD field in each table) across the within-group similarities (the average similarity). Community groups with less than two samples (ie: Depression Paperbark Forest & Red Mahogany-Apple Paperbark Forest) cannot be analysed in this way. Instead, the full species list from the single plot in each community is shown, in decreasing cover abundance value.

In the *Key Diagnostic Species* tables in each profile:

- Average similarity — is the within-group similarity for all pairs of sample plots comprising the community. Higher average similarity indicates a better defined community.
- Av.Abund — is the average cover abundance of that species within sample plots comprising the community
- Av.Sim — is the average similarity (contribution) made by each species to the within-group similarity (the overall average similarity).
- Sim/SD — is the ratio of average similarity to standard deviation for each species across all pairs of samples. A high ratio represents a good discriminating species. At least three samples are required for this ratio to be calculated.
- Contrib % — is the percentage contribution of each species to the overall average similarity for the community.

Hinterland Spotted Gum – Red Ironbark Forest Unit 17o

Lower Hunter Spotted Gum - Ironbark Forest LHCCREMS Unit 17

Keith Class: Hunter-Macleay Dry Sclerophyll Forests

General Description:

Hinterland Spotted Gum – Red Ironbark Forest is typified by the presence of *Corymbia maculata* and *Eucalyptus fibrosa* in the canopy, often with the stringybarks *Eucalyptus umbra,* and *Eucalyptus globoidea*. The understorey is variable, with a dense shrub layer of species such as *Acacia ulicifolia, Dillwynia retorta, Pultenaea euchila* and *Bursaria spinosa*, or more open and dominated by the grasses *Joycea pallida, Themeda australis, Entolasia stricta* and *Panicum simile*. This vegetation type is widespread across the Edgeworth LES study area, and merges with the Coastal Plains Stringybark – Apple Forest.

Characteristic Features:

- canopy dominated by Spotted Gum and Red Ironbark
- mid-storey dominated by wattles, peas and Blackthorn
- ground layer of grasses and grass-like plants, such as Kangaroo Grass, Wallaby Grasses, Wiry Panic and Lomandras

Known Floristic/ Structural Variations:

(a) Grassy variant – much of the study area supports this variant where shrubs are sparse and a variety of grasses, graminoids and herbs dominate the ground layer.

(b) Shrubby variant – in some locations, a dense understorey of shrubs occurs, possibly in areas with a sandstone-bedrock and less clay in the soils.

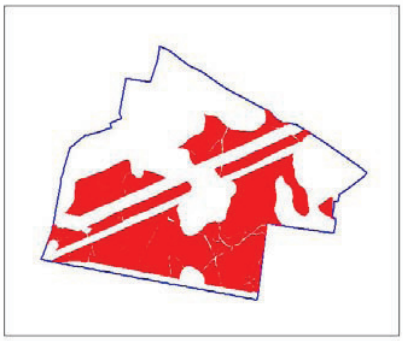
Relationship to Other Communities:

The clear dominance of Spotted Gum and Red Ironbark in this community separates it from all others in the study area. However, where it merges with the Coastal Plains Stringybark – Apple Forest some overlap in dominant species occurs (such as *Corymbia gummifera* and *Angophora costata*). Red Ironbark – Paperbark Forest is also similar, but Spotted Gum tends to be absent or in very low abundance, and a dense midstorey of *Melaleuca nodosa* and *Melaleuca decora* is typical in that community.

Equivalent Vegetation Types:

- Andrews.Neil 2004 (Pambulong SIS): Spotted Gum/Stringybark/Ironbark Forest
- Wildthing 2003 (part Pambulong SOE): not defined
- Conacher-Travers 2000 (Pambulong SIS): Stringybark-Ironbark-Spotted Gum Formation
- NPWS 2000 (LHCCREMS): Lower Hunter Spotted Gum-Ironbark Forest (MU17)

Distribution:



Edgeworth LES widespread across much of the study area, particularly in the south.

LHCC Region LHCCREMS (2003) have mapped 26518ha of their Lower Hunter Spotted Gum - Ironbark Forest (MU17) remaining in the region.

Extent 38.34 ha

Significant Species:

- Undescribed species – *none recorded*
- Threatened (EPBC Act) – *none recorded*
- Threatened (TSC Act) – *none recorded*
- Rare (ROTAP) – *Eucalyptus fergusonii subsp. fergusonii*

Community Conservation Status:

Reserve Representation - within the LHCC region, this form of Lower Hunter spotted Gum-Ironbark Forest is known only from Sugarloaf SCA. More broadly, LHSGIF occurs in Werakata and Columbey NP's.

EPBC Act (1999) Status - not currently listed.

TSC Act (1995) Status - included within the *Lower Hunter Spotted Gum – Ironbark Forest* EEC.

Species Richness:

Number of plots: 7
Total species: 83
Mean species / plot (+/- SD): 37.57 (+/- 4.12)

Vegetation Structure:

Stratum	Mean height (m)	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-	-
Tallest	15.00	8.00	22.00	31	6.27	7
Middle 1	8.00	1.00	15.00	20	13.46	7
Middle 2	-	-	-	-	-	-
Middle 3	-	-	-	-	-	-
Lowest	0.55	0.10	1.00	87	12.19	7

Key Diagnostic Species [based on 7 plots]:

Hinterland Spotted Gum - Red Ironbark Forest Average similarity: 62.12					
Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib%
Tree	*Eucalyptus fibrosa*	3.29	4.41	10.26	7.09
	Corymbia maculata	3.29	4.4	10.53	7.09
	Eucalyptus umbra	2	2.11	3.03	3.4
	Eucalyptus globoidea	1.86	1.52	0.91	2.45
Shrub	*Dillwynia retorta*	2.71	3.14	2.58	5.05
	Acacia ulicifolia	2.14	2.02	2.15	3.26
	Pultenaea paleacea	1.86	1.51	1.2	2.42
	Bursaria spinosa	1.14	0.87	0.83	1.4
Grass	*Joycea pallida*	4.14	5.48	4.95	8.83
	Themeda australis	3.43	4.54	7.43	7.32
	Panicum simile	1.86	2.47	3.67	3.98
	Entolasia stricta	2.14	2.22	1.49	3.58
	Setaria distans	1.71	2.14	1.53	3.44
	Microlaena stipoides var. stipoides	1.43	1.41	1.32	2.26
	Aristida vagans	1.29	0.87	0.83	1.4
Graminoid	*Lomandra multiflora subsp. multiflora*	1.86	2.46	3.76	3.97
	Lomandra obliqua	1.86	2.46	3.76	3.97
	Lomandra filiformis subsp. filiformis	1.71	2.05	1.52	3.29
	Ptilothrix deusta	1.71	1.69	1.37	2.72
	Lomandra filiformis subsp. coriacea	1.43	1.44	1.26	2.32
	Lepidosperma laterale	1	0.78	0.86	1.25
Herb	*Gonocarpus tetragynus*	1.71	2.11	3.03	3.4
	Opercularia diphylla	1.57	1.69	1.37	2.71
	Pratia purpurascens	1.14	0.78	0.61	1.25
Orchid	*Caladenia catenata*	1.14	1.08	1.42	1.74
Vine	*Hardenbergia violacea*	1.14	0.85	0.86	1.38

Coastal Plains Stringybark-Apple Forest Unit 30e

Coastal Plains Smooth-barked Apple Woodland LHCCREMS Unit 30

Keith Class: Sydney Coastal Dry Sclerophyll Forests

General Description:

Coastal Plains Stringybark - Apple Forest occurs within the Edgeworth LES area to disjunct locations within the wider mattrix of Hinterland Spotted Gum-Red Ironbark Forest. *Angophora costata, Eucalyptus capitellata, Corymbia gummifera* and *Eucalyptus umbra* are diagnostic species in the canopy, over an understorey of shrubs and sub-shrubs including *Dillwynia retorta, Pultenaea paleacea, Acacia ulicifolia* and occassionally *Banksia spinulosa* var. *collina*. The vegetation present differs floristically to other more widespread forms of Coastal Plains Smooth-barked Apple Forest, and further research in areas elsewhere in Lake Macquarie is ongoing to fully ascertain relationships.

Characteristic Features:

- canopy of Smooth-barked Apple, Red Bloodwood and Stringybarks
- general absence of Spotted Gum or Red Ironbark in the canopy, although both may be present in some locations resulting from floristic drift from neighbouring areas

Known Floristic/ Structural Variations:

No floristic or structural variations have been recognised for this community, however near the boundary with Hinterland Spotted Gum – Red Ironbark Forest some Spotted Gum and Red Ironbark do occur.

Relationship to Other Communities:

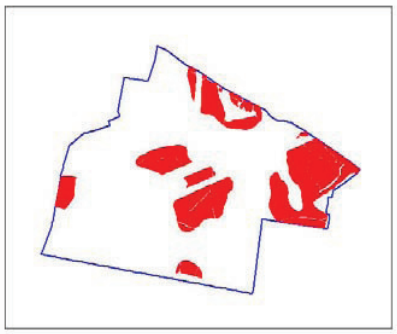
Coastal Plains Stringybark - Apple Forest can generally be recognised from all other communities in the study area by the combination of *Angophora costata, Corymbia gummifera, Eucalyptus umbra* and *Eucalyptus capitellata* in the canopy. Although *Corymbia maculata* and *Eucalyptus fibrosa* do occassionally occur in low abundance, they never approach the dominance evident in the Hinterland Spotted Gum – Red Ironbark Forest. The single drainage line supporting Red Mahogany – Apple Paperbark Forest may be confused with this community, however a higher ratio of moisture-loving species (eg: sedges and herbs) are evident in that community.

Equivalent Vegetation Types:

- Andrews.Neil 2004 (Pambulong SIS): Smooth-barked Apple/ White Mahogany/ Red bloodwood Forest
- Wildthing 2003 (part Pambulong SOE): not defined

- Conacher-Travers 2000 (Pambulong SIS): Smooth-barked Apple-White Mahogany-Red Bloodwood Formation
- NPWS 2000 (LHCCREMS): Coastal Plains Bloodwood-Apple Forest (MU30)

Distribution:



Edgeworth LES occurs in several discrete locations within the wider MU17o landscape.

LHCC Region LHCCREMS (2003) have mapped 35065ha of their Coastal Plains Smooth-barked Apple Woodland (MU30) remaining within the region.

Extent 19.36 ha

Significant Species:

- Undescribed species – *none recorded*
- Threatened (EPBC Act) – *Tetratheca juncea*
- Threatened (TSC Act) – *Callistemon linearifolius, Tetratheca juncea*
- Rare (ROTAP) – *none recorded*

Community Conservation Status:

Reserve Representation - within the LHCC region, similar vegetation is conserved in Lake Macquarie SCA, Sugarloaf SCA and potentially several other small reserves on the Central Coast. However, the it is unknown how extensive the form described here is in reserve.

EPBC Act (1999) Status - not currently listed.

TSC Act (1995) Status - not currently listed.

Species Richness:

Number of plots: 6
Total species: 97
Mean species / plot (+/- SD): 44.67 (+/- 5.35)

Vegetation Structure:

Stratum	Mean height (m)	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-	-
Tallest	15.00	12.00	18.00	35	5.48	6
Middle 1	7.00	1.00	8.00	11	6.72	6
Middle 2	2.00	0.50	3.00	48	36.14	6
Middle 3	-	-	-	-	-	-
Lowest	0.80	0.10	2.00	78	18.09	6

Key Diagnostic Species [based on 6 plots]:

Coastal Plains Stringybark - Apple Forest Average similarity: 55.37					
Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib%
Tree	*Angophora costata*	3.17	3.35	5.38	6.05
	Corymbia gummifera	2.83	2.96	4.58	5.35
	Eucalyptus capitellata	2	1.11	0.63	2.01
	Eucalyptus umbra	1.67	1.07	0.77	1.93
	Eucalyptus globoidea	1	0.48	0.48	0.86
Shrub	*Dillwynia retorta*	3.17	2.81	3.45	5.07
	Acacia ulicifolia	2.5	2.22	2.36	4.01
	Allocasuarina littoralis	1.5	1.07	1.19	1.94
	Bursaria spinosa	1	0.83	1.36	1.51
	Leptospermum polyglaifolium subsp. cistmontanum	0.83	0.51	0.79	0.92
	Pultenaea euchila	0.83	0.5	0.79	0.9
	Pultenaea paleacea	1.17	0.47	0.48	0.85
Grass	*Entolasia stricta*	3.17	3.38	4.16	6.11
	Joycea pallida	3.17	3.38	4.16	6.11
	Themeda australis	3.17	3	1.91	5.43
	Microlaena stipoides var. stipoides	2.17	2.47	22.47	4.46
	Panicum simile	1.67	1.6	1.37	2.89
	Aristida vagans	1.5	1.33	1.2	2.4
	Setaria distans	1.33	0.96	0.79	1.73
	Imperata cylindrica var. major	1.33	0.72	0.73	1.29
Graminoid	*Lomandra filiformis subsp. filiformis*	2	2.47	22.47	4.46
	Lomandra obliqua	2.17	2.47	22.47	4.46
	Ptilothrix deusta	2.17	1.93	1.28	3.48
	Xanthorrhoea latifolia subsp. latifolia	1.67	1.71	3.03	3.09
	Lomandra multiflora subsp. multiflora	1.5	1.47	3.17	2.66
Herb	*Gonocarpus tetragynus*	1.83	2.05	3.4	3.71
	Boronia polygalifolia	1.17	0.75	0.72	1.36
	Goodenia heterophylla subsp. heterophylla	1.17	0.74	0.74	1.34
	Pratia purpurascens	1.17	0.71	0.72	1.29
	Phyllanthus hirtellus	1	0.51	0.48	0.92
Vine	*Billardiera scandens*	1.17	0.9	1.25	1.63

Red Mahogany – Apple Paperbark Forest Unit 42

Riparian Melaleuca Swamp Woodland LHCCREMS Unit 42

Keith Class: Coastal Swamp Forests

General Description:

Red Mahogany – Apple Paperbark Forest occurs in a single drainage line in the east of the study area. It supports *Angophora costata, Eucalyptus resinifera* and *Eucalyptus globoidea* in the canopy, with shrubs including *Callistemon salignus, Glochidion ferdinandi, Callistemon linearis, Leptospermum polygalifolium* subsp. *cistmontanum* and *Banksia spinulosa* var. *collina*. Sedges and moisture-loving herbs are characteristic, including *Gahnia clarkei, Schoenus melanostachys* and *Polymeria calycina*.

Characteristic Features:

- canopy of Smooth-barked Apple and Red Mahogany
- ground layer of sedges and shrubs, such as Hairpin Banksia and Ti-tree
- occupies dryer drainage lines within low relief landscapes

Known Floristic/ Structural Variations:

No floristic or structural variations have been recognised for this community.

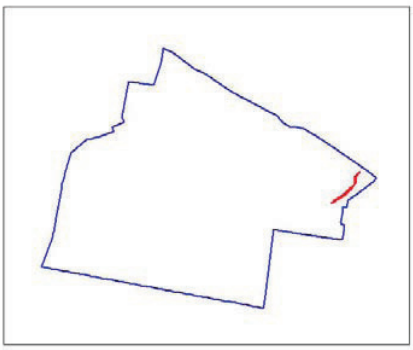
Relationship to Other Communities:

Red Mahogany - Apple Paperbark Forest can be distinguished from all other communities in the study area by the presence of sedges in the understorey, together with the combination of *Angophora costata* and *Eucalyptus resinifera* in the canopy.

Equivalent Vegetation Types:

- Andrews.Neil 2004 (Pambulong SIS): not defined
- Wildthing 2003 (part Pambulong SOE): not defined
- Conacher-Travers 2000 (Pambulong SIS): not defined
- NPWS 2000 (LHCCREMS): Riparian Melaleuca Swamp Woodland (MU42)

Distribution:



Edgeworth LES present in a single drainage line on the extreme east of the study area.

LHCC Region LHCCREMS (2003) have mapped 3774ha of their Riparian Melaleuca Swamp Woodland (MU42) as remaining in the region.

Extent 0.19 ha

Significant Species:

- Undescribed species – *none recorded*
- Threatened (EPBC Act) – *none recorded*
- Threatened (TSC Act) – *none recorded*
- Rare (ROTAP) – *none recorded*

Community Conservation Status:

Reserve Representation - within the LHCC region, this vegetation type is present in Karuah and Wallaroo NRs, Lake Macquarie SCA, Sugarloaf SCA, and is likely in small amounts in several other reserves on the Central Coast north of Gosford.

EPBC Act (1999) Status - not currently listed.

TSC Act (1995) Status - included within the *Swamp Sclerophyll Forest on Coastal Floodplains* EEC.

Species Richness:

Number of plots: 1
Total species: 41
Mean species / plot (+/- SD): 41 (+/- n/a)

Vegetation Structure:

Stratum	Mean height (m)	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-	-
Tallest	-	16.00	22.00	30	-	1
Middle 1	-	6.00	12.00	10	-	1
Middle 2	-	0.60	1.50	25	-	1
Middle 3	-	0.60	1.00	35	-	1
Lowest	-	0.10	0.60	50	-	1

Key Diagnostic Species [based on 1 plot]:

Red Mahogany - Apple Paperbark Forest
Less than 2 samples in group (full list from single plot, in decreasing cover value)

Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib%
Tree	*Eucalyptus resinifera subsp. resinifera*	-	-	-	-
	Angophora costata	-	-	-	-

	Eucalyptus globoidea	-	-	-	-
	Corymbia gummifera	-	-	-	-
Shrub	*Glochidion ferdinandi var. ferdinandi*	-	-	-	-
	Banksia spinulosa var. collina	-	-	-	-
	Leptospermum polygalifolium subsp. cismontanum	-	-	-	-
	Epacris pulchella	-	-	-	-
	Dillwynia retorta species complex	-	-	-	-
	Pultenaea villosa	-	-	-	-
	Melaleuca decora	-	-	-	-
	Allocasuarina littoralis	-	-	-	-
	Callistemon salignus	-	-	-	-
	Callistemon linearis	-	-	-	-
	Acacia ulicifolia	-	-	-	-
	Acacia falcata	-	-	-	-
	Bursaria spinosa	-	-	-	-
Sedge	*Carex inversa*	-	-	-	-
	Gahnia clarkei	-	-	-	-
	Schoenus apogon	-	-	-	-
	Schoenus melanostachys	-	-	-	-
Grass	*Austrostipa verticillata*	-	-	-	-
	Themeda australis	-	-	-	-
	Echinopogon caespitosus var. caespitosus	-	-	-	-
	Microlaena stipoides var. stipoides	-	-	-	-
	Imperata cylindrica var. major	-	-	-	-
	Entolasia stricta	-	-	-	-
	Panicum simile	-	-	-	-
	Oplismenus imbecillis	-	-	-	-
	Entolasia marginata	-	-	-	-
Graminoid	*Dianella revoluta var. revoluta*	-	-	-	-
	Lomandra longifolia	-	-	-	-
	Dianella caerulea var. assera	-	-	-	-
	Xanthorrhoea latifolia subsp. latifolia	-	-	-	-
Herb	*Brunoniella australis*	-	-	-	-
	Pratia purpurascens	-	-	-	-
	Polymeria calycina	-	-	-	-
	Gonocarpus tetragynus	-	-	-	-
Vine	*Cassytha glabella f. glabella*	-	-	-	-
	Parsonsia straminea	-	-	-	-
	Hardenbergia violacea	-	-	-	-

Red Ironbark - Paperbark Forest — Unit 110a

Not defined — **LHCCREMS Unit n/a**

Keith Class: Hunter-Macleay Dry Sclerophyll Forests

General Description:

Red Ironbark – Paperbark Forest occurs in the north-western section of the study area, and is typified by a canopy of *Eucalyptus fibrosa* over a dense mid- and shrub-layer of paperbarks (*Melaleuca decora, Melaleuca nodosa*). This community tends to occur downslope of areas supporting Hinterland Spotted Gum – Red Ironbark Forest, on clay soils where drainage is more impeded. Other prominent shrub species present include *Bursaria spinosa, Acacia ulicifolia* and *Leptospermum trinervium*, and *Angophora costata* or *Eucalyptus globoidea* may also occur in the canopy. *Corymbia maculata* may be present in some areas, but always in very low abundance.

Characteristic Features:

- canopy of Red Ironbark and tall paperbark trees
- moderately dense to dense understorey of paperbarks
- grasses and herbs on the ground

Known Floristic/ Structural Variations:

No floristic or structural variations have been recognised for this community. Understorey density may be influenced by past land use

Relationship to Other Communities:

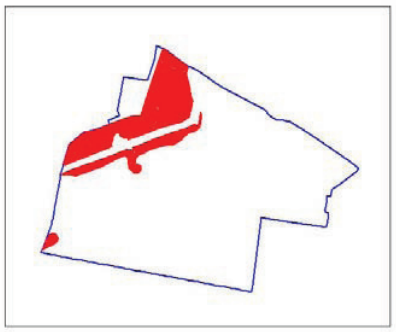
The co-occurrence of *Eucalyptus fibrosa* and *Melaleuca decora* is not replicated in any other community, particularly so with dense stands of *Melaleuca nodosa*. Depression Paperbark Forest is perhaps the most similar community, but the presence of moisture-loving herbs and sedges such as *Carex inversa, Juncus continuus, Arthropodium minus, Centella asiatica, Hydrocotyle peduncularis* and *Entolasia marginata* in that community separates the two.

Equivalent Vegetation Types:

- Andrews.Neil 2004 (Pambulong SIS): Melaleuca Woodland (?)
- Wildthing 2003 (part Pambulong SOE): Woodland Assemblage
- Conacher-Travers 2000 (Pambulong SIS): Stringybark-Paperbark Woodland (?)

- NPWS 2000 (LHCCREMS): not defined

Distribution:



Edgeworth LES occurs only in the north-west of the site, and a small outlier in the south-west with which it was possibly linked outside of the study area.

LHCC Region LHCCREMS (2003) have not defined this vegetation type, but it can be broadly included in their Lower Hunter Spotted Gum - Ironbark Forest (MU17), of which they map 26518ha remaining in the region.

Extent 12.82 ha

Significant Species:

- Undescribed species – *none recorded*
- Threatened (EPBC Act) – *none recorded*
- Threatened (TSC Act) – *none recorded*
- Rare (ROTAP) – *none recorded*

Community Conservation Status:

Reserve Representation - within the LHCC region, this vegetation type is known only within Werakata NP, but may possibly occur in some other coastal reserves. Nowhere is it extensive in distribution.

EPBC Act (1999) Status - not currently listed.

TSC Act (1995) Status - broadly included within the *Lower Hunter Spotted Gum – Ironbark Forest* EEC.

Species Richness:

Number of plots: 3
Total species: 68
Mean species / plot (+/- SD): 43.33 (+/- 2.08)

Vegetation Structure:

Stratum	Mean height (m)	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-	-
Tallest	18.00	16.00	20.00	28	7.63	3
Middle 1	11.00	6.00	15.00	40	18.02	3
Middle 2	4.00	2.00	6.00	45	49.49	2
Middle 3	2.00	1.00	3.00	10	5.00	3
Lowest	0.40	0.10	1.00	92	5.77	3

Key Diagnostic Species [based on 3 plots]:

Red Ironbark - Paperbark Forest Average similarity: 62.43					
Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib%
Tree	*Melaleuca decora*	4.33	5.2	38.49	8.32
	Eucalyptus fibrosa	3.67	4.34	5.05	6.95
	Eucalyptus globoidea	2	2.6	38.49	4.16
	Angophora costata	1.33	1.3	38.49	2.08
Shrub	*Bursaria spinosa*	2.33	2.6	38.49	4.16
	Acacia ulicifolia	1	1.3	38.49	2.08
	Leptospermum trinervium	1.33	0.89	0.58	1.42
	Melaleuca nodosa	2.67	0.84	0.58	1.35
Grass	*Entolasia stricta*	4	4.32	6.69	6.92
	Aristida vagans	2.33	2.6	38.49	4.16
	Microlaena stipoides var. stipoides	2.33	2.6	38.49	4.16
	Setaria distans	2	2.6	38.49	4.16
	Panicum simile	1.67	1.74	2.18	2.79
	Themeda australis	1.67	1.74	2.18	2.79
	Joycea pallida	2.33	0.89	0.58	1.42
	Notodanthonia longifolia	1.33	0.89	0.58	1.42
Graminoid	*Ptilothrix deusta*	2.67	3.04	3.67	4.87
	Lomandra multiflora subsp. multiflora	2	2.6	38.49	4.16
	Lomandra filiformis subsp. filiformis	1.67	1.74	2.18	2.79
	Dianella revoluta var. revoluta	1.33	1.3	38.49	2.08
	Lomandra obliqua	1.33	0.89	0.58	1.42
Herb	*Gonocarpus tetragynus*	2	2.6	38.49	4.16
	Brunoniella australis	1	1.3	38.49	2.08
	Hibbertia pedunculata	1	1.3	38.49	2.08
	Pratia purpurascens	1.33	0.87	0.58	1.39
Orchid	*Caladenia catenata*	2	2.6	38.49	4.16
Vine	*Glycine clandestina*	1.67	1.72	2.45	2.76

Depression Paperbark Forest — Unit 110b

Not defined — **LHCCREMS Unit n/a**

Keith Class: Hunter-Macleay Dry Sclerophyll Forests

General Description:

Depression Paperbark Forest occurs in a single location in a shallow drainage line within the Red Ironbark – Paperbark Forest. It is characterised by a high ratio of moisture-loving herbs, sedges and grasses in the ground layer, under dense stands of the paperbarks *Melaleuca decora* and *Melaleuca nodosa*. Emergent trees of *Eucalyptus fibrosa* may also be present, although this is more likely a factor of the surrounding community composition.

Characteristic Features:

- dense canopy and mid-storey of paperbarks
- ground layer of herbs, sedges and grasses, prone to localised flooding

Known Floristic/ Structural Variations:

No floristic or structural variations have been recognised for this community.

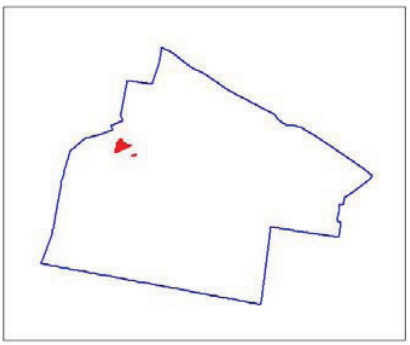
Relationship to Other Communities:

Dense stands of paperbarks also occur within the Red Ironbark – Paperbark Forest, however that community is a drier one and supports less of the moisture-loving herbs and more of species such as *Ptilothrix deusta, Joycea pallida, Aristida vagans, Lomandra multiflora subsp. multiflora, Setaria distans* and *Lomandra obliqua*. The Red Mahogany – Apple Paperbark Forest also occurs in shallow drainage lines, but is not dominated by paperbarks.

Equivalent Vegetation Types:

- Andrews.Neil 2004 (Pambulong SIS): Melaleuca Woodland (?)
- Wildthing 2003 (part Pambulong SOE): not defined
- Conacher-Travers 2000 (Pambulong SIS): Stringybark-Paperbark Woodland (?)
- NPWS 2000 (LHCCREMS): not defined

Distribution:



Edgeworth LES known from a single stand only towards the north-west of the site, bissected by powerlines.

LHCC Region LHCCREMS (2003) have not defined this vegetation type, but it can be broadly included in their Lower Hunter Spotted Gum - Ironbark Forest (MU17), of which they map 26518ha remaining in the region.

Extent 0.26 ha

Significant Species:

- Undescribed species – *none recorded*
- Threatened (EPBC Act) – *none recorded*
- Threatened (TSC Act) – *none recorded*
- Rare (ROTAP) – *none recorded*

Community Conservation Status:

Reserve Representation - within the LHCC region, this vegetation type is not known in reserve, but probably occurs in some sub-coastal reserves. Nowhere is it extensive in distribution.

EPBC Act (1999) Status - not currently listed.

TSC Act (1995) Status - possibly broadly included within the *Lower Hunter Spotted Gum – Ironbark Forest* EEC.

Species Richness:

Number of plots: 1
Total species: 46
Mean species / plot (+/- SD): 46 (+/- n/a).

Vegetation Structure:

Stratum	Mean height (m)	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-	-
Tallest	-	18.00	20.00	20	-	1
Middle 1	-	8.00	16.00	50	-	1
Middle 2	-	4.00	6.00	80	-	1
Middle 3	-	-	-	-	-	-
Lowest	-	0.10	0.40	70	-	1

Key Diagnostic Species [based on 1 plot]:

Depression Paperbark Thicket
Less than 2 samples in group (full list from single plot, in decreasing cover value)

Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib%
Tree	*Melaleuca decora*	-	-	-	-
	Eucalyptus fibrosa	-	-	-	-

Shrub	*Melaleuca nodosa*	-	-	-	-
	Leucopogon juniperinus	-	-	-	-
	Bursaria spinosa	-	-	-	-
	Acacia irrorata subsp. irrorata	-	-	-	-
	Pultenaea villosa	-	-	-	-
Sedge	*Fimbristylis dichotoma*	-	-	-	-
	Juncus continuus	-	-	-	-
	Carex inversa	-	-	-	-
	Juncus homalocaulis	-	-	-	-
Grass	*Microlaena stipoides var. stipoides*	-	-	-	-
	Entolasia stricta	-	-	-	-
	Eragrostis leptostachya	-	-	-	-
	Imperata cylindrica var. major	-	-	-	-
	Entolasia marginata	-	-	-	-
	Oplismenus imbecillis	-	-	-	-
	Panicum simile	-	-	-	-
	Themeda australis	-	-	-	-
	Echinopogon ovatus	-	-	-	-
	Dichelachne micrantha	-	-	-	-
Graminoid	*Lomandra longifolia*	-	-	-	-
	Dianella caerulea var. assera	-	-	-	-
	Dianella revoluta var. revoluta	-	-	-	-
	Lomandra filiformis subsp. filiformis	-	-	-	-
	Dianella longifolia var. longifolia	-	-	-	-
Herb	*Opercularia diphylla*	-	-	-	-
	Veronica plebeia	-	-	-	-
	Hydrocotyle laxiflora	-	-	-	-
	Euchiton involucratus	-	-	-	-
	Pratia purpurascens	-	-	-	-
	Dichondra repens	-	-	-	-
	Gonocarpus tetragynus	-	-	-	-
	Centella asiatica	-	-	-	-
	Arthropodium minus	-	-	-	-
	Senecio tenuiflorus	-	-	-	-
	Hydrocotyle peduncularis	-	-	-	-
	Lagenophora stipitata	-	-	-	-
	Oxalis perennans	-	-	-	-
	Plantago debilis	-	-	-	-
Orchid	*Caladenia catenata*	-	-	-	-
	Acianthus fornicatus	-	-	-	-
	Cymbidium suave	-	-	-	-
Vine	*Glycine clandestina*	-	-	-	-
	Cassytha glabella f. glabella	-	-	-	-
Fern	*Cheilanthes sieberi subsp. sieberi*	-	-	-	-