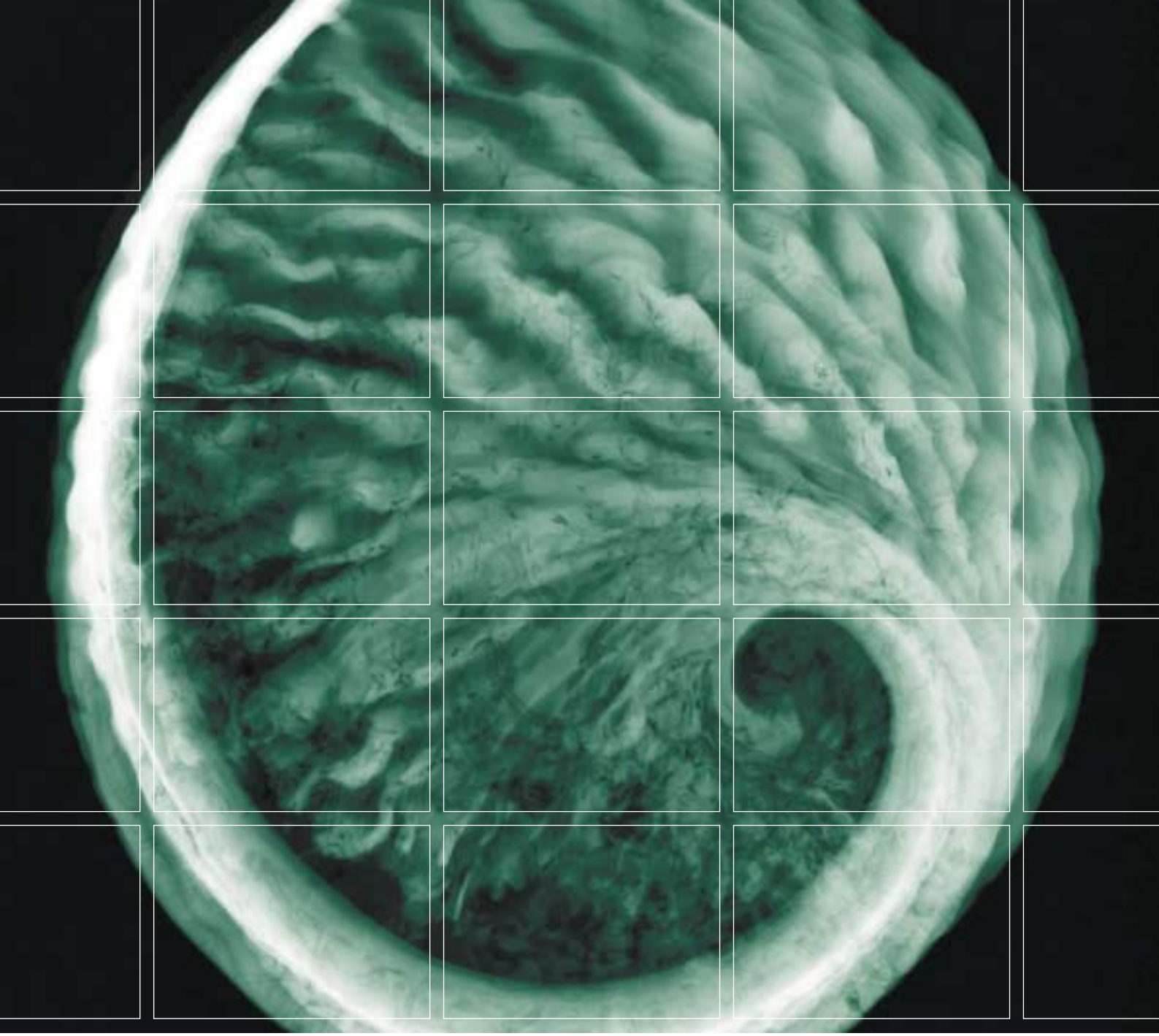

Vincentia Concept Plan - Volume 1

Species Impact Statement

Stockland Developments Pty Ltd

February 2006

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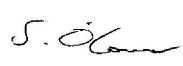
Signed:	
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FINAL REPORT

Stockland Developments Pty Ltd

Vincentia Concept Plan - Volume 1

Species Impact Statement

February 2006

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EXECUTIVE SUMMARY

This Species Impact Statement (SIS) has been prepared for the proposed Stockland development site at Vincentia, Jervis Bay on the south coast of New South Wales (NSW). Proposed activities on the subject site include a 604 lot residential development and a commercial development including facilities such as a discount department store, supermarkets, a bulky goods outlet, speciality retail, medical centre and car parking. This development would be staged over a number of years.

The subject site is 127 hectares (ha) and is bordered by The Wool Road to the south-east, Jervis Bay Road to the west and Jervis Bay National Park to the north and east. Eighteen vegetation communities including open-forest, woodland, open-woodland, low-open woodland, heathland, sedgeland and grassland were recorded across the subject site. These communities are primarily weed-free except for areas that border roads or other minor disturbances and overall biodiversity across the site is considered to be high. Some limited logging of selective trees has historically taken place although there is no evidence to suggest that the subject site has been cleared or utilised for agricultural purposes.

This SIS examines the impacts of the proposal on threatened species and endangered ecological communities as listed under the Department of Environment and Conservation (DEC) Director General's requirements and in accordance with Sections 109 and 110 of the *Threatened Species Conservation Act 1995* (TSC Act). This report will be submitted to the NSW Department of Planning (DoP) pursuant to Part 3A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

Those species listed as threatened or migratory under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) have also been considered and this proposal will be referred to the Department of the Environment and Heritage for assessment under the EPBC Act.

Information about the ecology of the subject site was initially gathered through review of a comprehensive body of literature detailing past studies undertaken on the subject site, and within the locality and the region. Extensive field surveys were carried out to provide data about the distribution of threatened species and ecological communities across the subject site and study area. In response to discussions with DEC and other stakeholders, additional targeted studies and surveys were carried out, increasing the available information on which impact assessments were made.

Multiple iterations of the footprint and development design have been undertaken, including removal of roads and reconfiguration of the development footprint. These iterations allow for the retention of habitat for threatened species and the conservation of habitat corridors along riparian zones.

Thirty-three threatened species and one endangered ecological community were listed for consideration under the DG's requirements. In addition, a further 15 species were considered based on database search results and results of field investigations for species listed under the TSC Act and EPBC Act. Of the total of 48 species considered, 14 were not considered further due to lack of suitable habitat in the study area.

The proposal will result in the removal or modification of 71 ha (or 59 %) of native vegetation from the subject site. The total area of vegetation retained under the proposal is approximately 49 ha (or 41 %), including the conservation of 47 ha of native vegetation within an Environment Zone (EZ). The EZ will provide habitat for a number of threatened species and one endangered ecological community including *Prasophyllum affine, Cryptostylis hunteriana,* Eastern Bristlebird, Ground Parrot, Eastern Pygmy-possum, Yellow-bellied Glider, Glossy Black-cockatoo, Giant Burrowing Frog, Giant Dragonfly, microchiropteran bats and Sydney Coastal Estuary Swamp Forest Complex (Swamp Sclerophyll Forest). Many of these species have been the subject of additional ecological investigations to further understanding of their use of the subject site. These have included studies on the Glossy Black-cockatoo, Giant Burrowing Frog, Giant Dragonfly, microchiropteran bats and *Prasophyllum affine* pollinators.

The current footprint design and the implementation of mitigation measures have reduced many of the potential impacts of the proposal to a level at which they are no longer considered to be significant for a number of threatened species and the endangered ecological community.

In addition, the following measures have been recommended to further minimise potential impacts on threatened species at the subject site and in the adjacent Jervis Bay National Park:

- implementation of a Weed Management Plan and Vegetation Management Plan;
- implementation of a Feral Animal Management Plan; and
- banning of cats from the development.

Species for which the potential for impacts could not be entirely removed included those with large home ranges (e.g. Yellow-bellied Glider) and those with very restricted distribution and specialised habitat requirements (e.g. Eastern Bristlebird). A summary of the conservation outcomes and potential impacts of the proposal on these threatened species are detailed below.

Eastern Pygmy-possum (*Cercartetus nanus*)

Eastern Pygmy-possums were recorded in the heathland east of Moona Creek Road and within the woodland of Lot 802. Potential impacts on this species from the proposal include direct mortality, loss of habitat connectivity and indirect impacts associated with residential and commercial development adjacent to existing habitats.

Recent amendments to the development footprint of Village Central / West have resulted in the reduction of a number of potential impacts to this species and approximately 20 ha of known habitat (including 10 ha of heathland and 10 ha of woodland) will be conserved at the subject site.

Yellow-bellied Glider (*Petaurus australis*)

Potential impacts of the proposal on the Yellow-bellied Glider may include direct mortality and indirect impacts associated with residential and commercial development adjacent to existing habitats. It is considered likely that the proposal will result in the loss of a family group from the subject site.

The proposal will conserve approximately 20 ha of known Yellow-bellied Glider habitat in the north, north-east and west of the subject site. The recent amendment to the development footprint within Lot 802 has resulted in the reduction of potential impacts to this species by conserving riparian habitats and known and potential foraging and breeding habitat.

Eastern Bristlebird (*Dasyornis brachypterus*)

The Eastern Bristlebird was recorded within Lot 801 and Lot 802. The proposal will result in the loss of habitat, reduction in connectivity of habitat and indirect impacts associated with residential and commercial development and it is likely that approximately three individuals will be directly impacted by the development.

The development footprint of the District Centre was amended to reduce impacts to the Eastern Bristlebird. Consequently, the proposal will conserve habitat and retain the corridor function of the subject site for this species through the retention of secondary habitat and primary habitat in key areas.

Ground Parrot (*Pezoporus wallicus wallicus*)

Ground Parrots were recorded within Lot 801. Potential impacts from the proposal on the Ground Parrot include indirect impacts from residential and commercial development, the potential loss of approximately two individuals through direct mortality and loss of known habitat of a species with a restricted distribution.

The EZ proposed for the site will retain habitat for this species and the corridor functionality of the subject site will be retained through retention of habitat in key areas.

Glossy Black-cockatoo (*Calyptorhynchus lathami*)

Potential impacts from the proposal on the Glossy-black Cockatoo include the indirect impacts associated with residential development, such as an increase in non-native predators, and the direct loss of existing feeding resources.

Recent amendments to the development footprint of Lot 802 will conserve two known nest trees and an area of foraging habitat for the Glossy-black Cockatoo adjoining JBNP and replanting of areas of the subject site with *A. littoralis* will provide future feeding resources.

Giant Dragonfly (*Petalura gigantea*)

Potential impacts of the proposal on the survival of the Giant Dragonfly at the subject site will be dependent on the retention of both breeding habitat and adjacent foraging habitat, and the retention of current water table and surface water regimes (GHD 2005d).

The current project plan will conserve breeding habitat along the Western creek and the majority of the Central creek riparian areas, as well as conserve the majority of potential foraging habitat in the open-woodland in the north of the subject site.

1 INTRODUCTION

1.1 BACKGROUND

Environmental Resources Management Australia Pty Ltd (ERM) was commissioned by Stockland to prepare a Species Impact Statement (SIS) for the Vincentia Development Site (Lots 72, 73, 74, 75 – DP 874010, Lots 801 and 802 - DP 1022286, and all public roads within those lots (hereafter referred to as 'the subject site') (*Figure 1.1)* to be submitted to the New South Wales (NSW) Department of Planning (DoP) as part of an Environmental Assessment Report (EAR) pursuant to Part 3A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act*).*

Initially an application for masterplan approval, subdivision and a rezoning for the subject site was submitted with DoP in February 2005 under *State Environmental Planning Policy 71* (SEPP 71). Pursuant to Section 5A of the EP&A Act, Eight Part Tests were undertaken to determine whether there was likely to be a significant impact from proposed development of the site on threatened species, populations or communities listed in the Schedules to the NSW *Threatened Species Conservation Act 1995* (TSC Act). This analysis indicated that there may be a significant impact on several threatened species and their habitats and that a SIS was required. Director General's requirements (DGRs) for the SIS were consequently sought and obtained from the NSW Department of Environment and Conservation (DEC).

Following a review of the proposal and the identified ecological constraints, the proposal has been amended to provide buffers to the Jervis Bay National Park (JBNP), conserve habitat for threatened species and to enhance the corridor function of the site. The amended proposal is now being submitted to the State Government under *State Environmental Planning Policy - Major Projects* and DGRs have been sought from the Director General of the DoP. However, as this SIS has involved extensive studies and consultation with relevant stakeholders, the DGRs are not expected to request any additional studies be undertaken at the subject site.

The proposal will also be referred to the Department of the Environment and Heritage (DEH) for assessment under the Commonwealth *Environment Protection and Biodiversity Conservation Act (*EPBC Act). Therefore, the DGRs for the SIS have incorporated the requirements for assessment of Commonwealth threatened and migratory species.

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Figure 1.1 **Location of Subject Site and Study Area**

Vincentia
Species Impact Statement

1.2 THE SUBJECT SITE

The subject site is an irregularly shaped parcel of land approximately 127 hectares (ha) in total. The subject site supports a wide variety of native vegetation types, threatened species and their habitats. Vegetation types include heathland, scrubland, woodland, forest and sedgeland. The drier woodlands and forests in the north of the site merge with the wetter heath and sedgeland communities in the south. Three watercourses drain the site to two wetlands to the northeast. These wetlands were previously known as *State Environmental Planning Policy No. 14 – Wetlands* (SEPP 14) 324 and 325, before incorporation into the Jervis Bay National Park (JBNP). Current disturbances on the subject site are limited to tracks, trails, minor rubbish dumping, powerline easements and associated edge effects. The majority of the subject site was burnt in a high intensity wildfire in 2000.

1.3 PURPOSE AND OBJECTIVES

The purpose of this SIS in the proposal consent process is:

- to identify issues pertaining to threatened species and endangered ecological communities and provide appropriate amelioration for adverse impacts resulting from the proposal;
- to assist the consent authorities in the assessment of the proposal under Part 3A of the EP&A Act; and
- to inform the NSW Minister for Planning, Minister for the Environment and Commonwealth Minister for the Environment.

The DGRs from DEC that relate to flora and fauna are provided within *Annex I* of this SIS. At the time of printing of this SIS, DGRs from DoP had not yet been received.

The assessments within the SIS have covered the potential impacts of the proposal on flora and fauna at local, regional, state, national and international levels.

The key objectives of the assessments were to:

- describe and map vegetation communities and habitats that may be directly or indirectly affected by the proposal;
- identify and describe the threatened species and communities known or likely to be present in the study area and assess which species or communities may be affected by the proposal;

- assess the potential direct and indirect impacts on this flora and fauna;
- describe the local, regional and state-wide conservation status, the key threatening processes, habitat requirements and any recovery plans or threat abatement plans applying to species or communities likely to be affected by the proposal;
- describe the type, location, size and condition of habitat of affected species and communities and provide details of the distribution and condition of similar habitats in the region;
- assess the potential effect of the proposal on subject species and subject communities, focusing on affected species and affected communities and including the qualitative effect on local populations and the cumulative effect in the region, if possible; and
- describe a suite of measures to mitigate adverse effects of the proposal on affected species and populations, and to enhance the survival of affected and subject species and communities in the study area wherever possible.

1.4 DEFINITION OF KEY WORDS

Definitions have been provided by the Director General of DEC (see *Annex I*). They have been clarified in relation to the proposal and used in the SIS as follows:

- ***Development*** has the same meaning as in the Environmental Planning and Assessment Act 1979;
- ***Activity*** has the same meaning as in the Environmental Planning and Assessment Act 1979;
- ***Proposal*** is the development, activity or action proposed;
- ***Subject Site*** means the area directly affected by the proposal;
- ***Study Area*** is the subject site and any additional areas which are likely to be affected by the proposal, either directly or indirectly;
- ***Locality*** is the area within a 10 km radius of the subject site;
- ***Region*** is the Sydney Basin Biogeographic Region (NPWS 2003b); and
- ***Subject Species*** means those threatened species known or considered likely to occur in the study area.

The following definitions also apply to this SIS:

- ***Affected Species*** are those species that are actually or likely to be affected by the proposal; and
- ***Affected Communities*** are those communities that are actually or likely to be affected by the proposal.

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

1.5 LEGISLATIVE REQUIREMENTS AND COMPLIANCE

1.5.1 NSW Environmental Planning and Assessment Act 1979

An application for masterplan approval, subdivision and a rezoning was submitted with the DoP under SEPP 71 in February 2005 after 18 months of agency and public consultation. The proposal is now being resubmitted to DoP as a Major Project under Part 3A of the EP&A Act.

1.5.2 Requirement to Prepare a SIS

In 2003, literature reviews, database searches and preliminary subject site investigations were undertaken and an Eight Part Test report was prepared to ascertain whether the development proposal was likely to have a significant impact on threatened species and determine whether a SIS would be required. The Eight Part Test report prepared in November 2003 (ERM 2003) concluded that the proposal could significantly impact upon threatened species, and therefore determined that a SIS was required.

1.5.3 NSW **Threatened Species Conservation Act 1995**

This SIS has been prepared in accordance with Sections 109 and 110 of the TSC Act, which describe the form and content of a SIS. In 2003 the requirements of the Director General of DEC were sought and obtained for this SIS, pursuant to Section 111 of the TSC Act. As part of these requirements the following 29 threatened species and one endangered ecological community were identified (see *Table 1.1*) by DEC for inclusion in this SIS:

Table 1.1 DEC Identified Species and Ecological Communities for Inclusion in the SIS

Common Name	Scientific Name
Flora	
Jervis Bay Leek Orchid	*Prasophyllum affine**
Thick Lip Spider Orchid	*Caladenia tessellata*
Leafless Tongue Orchid	*Cryptostylis hunteriana**
Tangled Bedstraw	*Galium australe*
Biconvex Melaleuca	*Melaleuca biconvexa*
Underground Orchid	*Rhizanthella slateri*
Ecological Community	
Sydney Coastal Estuary Swamp Forest Complex	
Fauna	
Southern Brown Bandicoot	*Isoodon obesulus**
Long-nosed Potoroo	*Potorous tridactylus**
White-footed Dunnart	*Sminthopsis leucopus*
Eastern Chestnut Mouse	*Pseudomys gracilicaudatus*
Large-footed Myotis	*Myotis adversus*
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*
Eastern Freetail-bat	*Mormopterus norfolkensis*
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*
Greater Broad-nosed Bat	*Scoteanax rueppellii*
Eastern Pygmy-possum	*Cercartetus nanus*
Squirrel Glider	*Petaurus norfolcensis*
Yellow-bellied Glider	*Petaurus australis*
Giant Burrowing Frog	*Heleioporus australiacus**
Glossy Black-Cockatoo	*Calyptorhynchus lathami*
Eastern Bristlebird	*Dasyornis brachypterus**
Ground Parrot	*Pezoporus wallicus*
Swift Parrot	*Lathamus discolour**
Regent Honeyeater	*Xanthomyza phrygia**
Turquoise Parrot	*Neophema pulchella*
Square-tailed Kite	*Lophoictinia isura*
Powerful Owl	*Ninox strenua*
Sooty Owl	*Tyto tenebricosa*
Masked Owl	*Tyto novaehollandiae*

Note: * denotes that the species is listed as threatened under the Commonwealth EPBC Act.

Compliance tables are provided in *Annex A* and these list the SIS requirements of the TSC Act and the requirements of the Director General of DEC that relate to flora and fauna, and indicate where they have been addressed within the SIS.

One additional threatened species, the endangered Giant Dragonfly (*Petalura gigantea*) was recorded on the subject site during field surveys in 2004 and consequently this species was the subject of additional surveys and an impact assessment (GHD 2005d).

1.5.4 *Commonwealth* Environment Protection and Biodiversity Conservation Act 1999

Under the Commonwealth EPBC Act, any action that has, or is likely to have, a significant impact on a matter of National Environmental Significance (NES), is subject to a referral and assessment process and may progress only with the approval of the Commonwealth Minister for Environment.

An action is defined as a project, development, undertaking, activity (or series of activities), or alterations to any of these. The EPBC Act currently identifies seven matters of national environmental significance:

- World Heritage properties;
- National Heritage places;
- Ramsar wetlands of international importance;
- listed threatened species and ecological communities;
- listed migratory species;
- Commonwealth marine areas; and
- nuclear actions.

As a consequence of this proposal there are likely to be impacts on listed threatened species and ecological communities and listed migratory species. Consequently, a referral to DEH under the EPBC Act has been prepared.

1.6 *STATE LISTED THREATENED SPECIES CONSIDERED*

Threatened species and communities known or considered likely to occur in the study area are termed *subject species* and *subject communities* (see Section *1.4.4*). The DGRs listed species and communities to be considered for inclusion as subject species or subject communities (*Annex I*).

Affected species or communities (subject species or communities that are likely to be affected by the proposal) must be identified within the SIS. The methodology for identifying affected species is provided in *Chapter 3*. The full list of subject and affected species or communities is provided in *Chapter 4*.

1.7 MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE CONSIDERED (NES)

Matters of NES that could have been recorded on the subject site, or that have the potential to occur in the study area include threatened species, endangered ecological communities and migratory species. These are listed in *Table 4.4.*

The assessment of likely impacts on matters of NES has been discussed within the SIS.

1.8 STRUCTURE OF THE REPORT

The SIS contains two volumes. The remainder of Volume 1 contains the following:

- Chapter 2 provides information about the proposal;
- Chapter 3 describes the methods for flora and fauna assessment including flora and fauna surveys and targeted surveys for threatened species that were conducted in the study area for this SIS;
- Chapter 4 presents the results of the flora and fauna assessment including information about the significance of flora and fauna of the locality, study area and the subject site and results of the targeted flora and fauna surveys;
- Chapter 5 assesses the likely impacts of the proposal on flora and fauna;
- Chapter 6 assesses and recommends the potential impact amelioration measures;
- Chapter 7 provides a conclusion to the SIS and summarises recommendations made for the proposal to ameliorate impacts upon threatened species; and
- the reference section provides a list of materials used in the preparation of the SIS and a list of details of personal communications.

Additional information is contained within Annexures to this document. These include:

- **Annex A** provides Compliance Tables for the SIS. This includes compliance with Sections 109 and 110 of the TSC Act and with the DEC DGRs for this SIS;
- **Annex B** provides the *Curricula vitae* of the persons who prepared this SIS and other people who have conducted research or investigations relied on in preparing this SIS;

- **Annex C** provides the flora and fauna species lists for the study area;
- **Annex D** provides descriptions of the vegetation communities that have been mapped on the subject site;
- **Annex E** provides profiles of the affected species;
- **Annex F** provides survey AMG coordinates;
- **Annex G** Bower CC (2004) Pollinators of the Jervis Bay Leek Orchid, *Prasophyllum affine*, at Vincentia, NSW – Distribution and Movements; and
- **Annex H** RoTAP Species.
- **Annex J** List of Subconsultants

Volume 2 of the SIS contains the Survey Data Sheets.

2 DESCRIPTION OF THE PROPOSAL

2.1 CONTEXT OF THE SUBJECT SITE

The subject site is located immediately west of the Vincentia township on the south coast of New South Wales (NSW) in the Sydney Basin Biogeographic Region (Environment Australia 2003a). The location of the subject site is shown in *Figure 1.1*.

The site occupies a total area of approximately 127 ha (*Figure 2.1*). The site is bound by The Wool Road to the southeast, Jervis Bay Road (otherwise known as Naval College Road) to the southwest, JBNP to the north and JBNP and the Bay & Basin Leisure Centre to the east.

2.2 PROJECT DESCRIPTION

Stockland is seeking project approval for a residential subdivision and concept approval for a district town centre in the south east corner of the subject site and an adaptable housing area adjacent to the Bay and Basin Leisure centre. The proposal is summarised below.

The residential subdivision includes:

- a total of 604 lots;
- approximately 60 hectares (47 percent of the site) of open space area, which would be comprised of environmental conservation areas, asset protection zones and urban parks;
- an internal road network with three access points to Naval College Road; and
- construction works related to providing physical infrastructure and services including some vegetation clearing.

The concept plan for the district town centre includes:

- building footprints;
- an indicative total floor area of 32,000 square metres with approximately 21,000 square metres proposed in Stage 1 and 11,000 square metres proposed in Stage 2;
- a range of uses including a discount department store, supermarket, medical centre, child care centre, restaurants, bulky goods, potential housing and specialty retail;

- a site (Stage 3) for future bulky goods development;
- a road network that includes a main street, access to The Wool Road and access to a proposed road in the subdivision;
- an indicative total of 1,399 car parking spaces to be provided in two car parking areas and at the upper level of future buildings; and
- a water feature and open space areas.

The concept plan for the adaptable housing area adjacent to the Bay and Basin Leisure centre includes an internal road network, indicative residential lot layout and access to The Wool Road.

Previous ecological reports separated the subject site into two areas: 'the Residential Site' and 'the Commercial Site'. These areas will now be referred to as 'Lot 801' (previously Commercial Site) and 'Lot 802' (previously Residential Site) (*Figure 1.1).*

Lot 801 is bound by the Wool Road and Naval College Road to the south-east and south-west respectively, and by an un-named watercourse (hereafter referred to as Eastern creek) and an un-named road that forms the boundary to the Bay & Basin Leisure Centre to the north-west and north-east respectively. Lot 801 includes the Village East residential development and that part of the District Centre to the east of the Eastern Creek.

Lot 802 is bound by the Eastern creek and Naval College Road to the south-east and south-west respectively and by JBNP to the north-east and north-west. Lot 802 includes the Village Central / West residential development and that part of the District Centre to the west of the Eastern Creek.

There are three watercourses on the subject site. The most easterly of these occurs on Lot 801 and is known as Eastern creek. The Central creek is the most easterly creek on Lot 802 and the Western creek flows through the north-west of the subject site.

Environment Zone

An Environment Zone (EZ) of around 47 ha is proposed for the subject site. The EZ will encompass a 22 ha area to the east of Moona Creek Road, the riparian corridor of the Western creek and the majority of the riparian corridor and buffer vegetation along the Central creek, as well as vegetion adjacent to JBNP in the north and northeast of Lot 802. These areas of the subject site were identified as providing habitat for a number of threatened species, an endangered ecological community, and habitat corridors for species listed under the schedules of the TSC Act and EPBC Act. Ownership of the majority of the EZ at the subject site is proposed to be transferred to DEC to be managed for the protection of threatened species and communities within the subject site and to protect species within the adjoining JBNP.

In addition to the EZ, species-sensitive design of roads, crossings and lighting will be incorporated into the development of the subject site. All these features are targeted at protecting and managing threatened species for long-term conservation.

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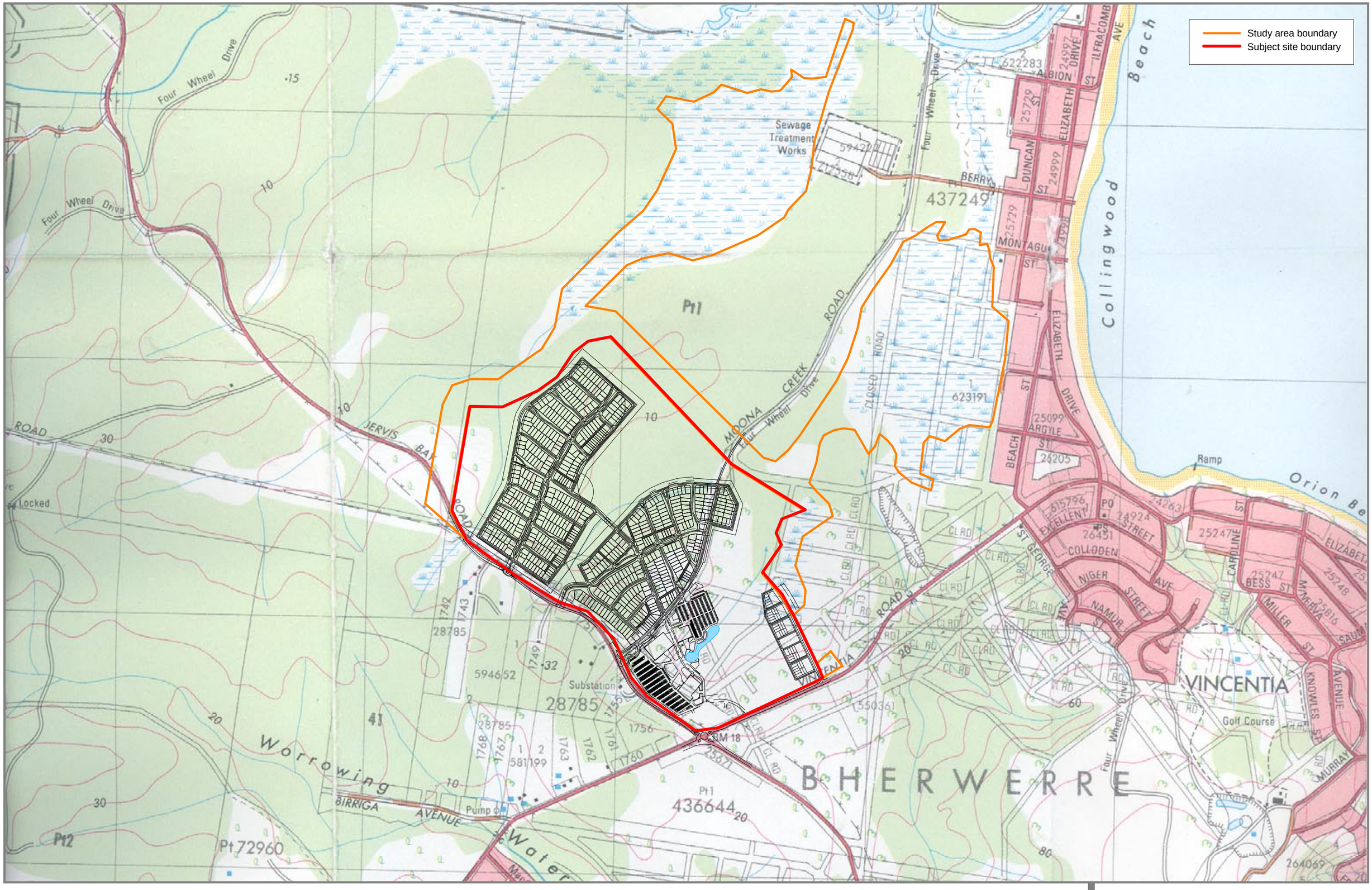

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Figure 2.1 **Proposed Concept Plan**

Vincentia
Species Impact Statement

2.3 *SUBJECT SITE HISTORY*

The subject site was purchased as part of a larger parcel of land by Henry Halloran (Realty Realizations) in 1920.

A number of local initiatives were implemented during 1970 – 1990 and included:

- commissioning of John Toon by Shoalhaven Council (SCC) to develop an initial development strategy for the Bay and Basin area in the early 1970s. Toon identified the Stockland site as the potential district centre;
- Council commencing work in 1984 on the Local Environment Study (LES) for the comprehensive Draft Shoalhaven Local Environmental Plan (gazetted in 1985). In the LES, Council identifies the need for a district centre at Vincentia. Council refers to a separate draft Local Environmental Plan for the Stockland site involving urban expansion;
- rezoning of the Stockland site for rural purposes under the Shoalhaven LEP 1985; and
- completion of an LES by Council during the late 1980s to support the draft rezoning of the Stockland site to the current residential and commercial zones.

In 1992, SCC and the DoP released a discussion paper entitled *Jervis Bay Our Heritage Our Future.* The key implications for the subject site included:

- expansion of the Jervis Bay Conservation Area to include the subject site;
- proposed use of national parks to control further urbanisation;
- expansion of Vincentia and Erowal Bay which were likely to experience a shortfall in urban land over the longer term (1992-2008);
- regional planning and environmental considerations were necessary to accommodate the urban expansion interests of individual land holders;
- habitat corridors are identified within the Jervis Bay Region and directly affect the subject site;
- a 'choke' point in the habitat corridor is noted on Wool Road adjacent to the current Bay & Basin Leisure Centre;
- the subject site was one of three areas nominated for urban expansion;

- an area for likely urban expansion is identified on the subject site;
- Crown land and state reserves are nominated as the basis for creation of the JBNP; and
- a visual corridor is identified along Jervis Bay Road including frontage to the subject site.

The *Jervis Bay Regional Environmental Plan (REP) No. 1* released by DoP nominated a portion of the land as Proposed National Park and in 1998, 282 ha of the land was acquired by NPWS from Realty Realizations. Another 12 ha of land was also acquired by SCC for community purposes and is now the site of the Bay & Basin Leisure Centre.

SCC's 1990 *Policy No. 1 – Main Centre Strategy* identified the subject site as the location of the future district centre. An LES prepared in support of the Draft *Vincentia Local Environmental Plan* was updated in 1999 for final gazettal. The site was gazetted to be zoned residential and commercial in 1999.

2.4 FIRE HISTORY

2.4.1 Regional Perspective

The subject site is bushfire prone and has been mapped as bushfire prone land by Shoalhaven City Council. According to BES (2004) the Shoalhaven area has one of the highest incidences of bush fires in NSW, accounting for approximately half of the unplanned fires in the southern region. Major bushfire events occur frequently in the locality of the subject site, and four significant bushfires have occurred in the area over the past decade. Many of the recent fires have had periods of high intensity fire behaviour with the potential to cause loss of property. Many residential buildings and sheds were damaged or destroyed by the bushfires in 2001 "Hylands Fire" in the nearby villages of Huskisson, Falls Creek and Woollamia.

2.4.2 Subject Site

The most recent bushfire in the local area occurred in Summer 2003-2004. The site at Vincentia was not burned during this event, but has been subject to both unplanned fires and hazard reduction burns in the past. A large proportion of the site was burned in the bushfires of 2001. Therefore, the majority of the site would now be of a post-fire age of approximately four years.

In addition to unplanned fires, Gunninah (2002) attributes regular hazard reduction burns to alteration of the structure and diversity of vegetation communities within the subject site.

Extensive areas of bushland are reserved in adjoining National Parks and Nature Reserves. The risk of bushfire impact will therefore be an ongoing threat to the proposed development and this has been assessed by BES (2004).

2.5 *EVOLUTION OF DEVELOPMENT FOOTPRINT*

In considering the areas available for development on the subject site, several development scenarios have been considered:

2.5.1 *Project Scenario 1*

The original Masterplan included approximately 850 lots in line with the *Jervis Bay Settlement Strategy*. In comparison to the current proposal this scenario involved:

- greater overall disturbance and earthworks primarily due to the orientation of the roads;
- greater tree removal;
- narrower riparian corridors; and
- smaller Environmental Zone habitat retention south of Moona Creek Road.

2.5.2 *Project Scenario 2*

The District Centre was originally located on the north and north-eastern section of Lot 801, adjacent to the Bay & Basin Leisure Centre and The Wool Road. This development plan was considered to have adverse impacts on the flora and fauna of the subject site, especially *Prasophyllum affine* including:

- large scale development up slope of the main population of *P. affine* with potential changes to surface and ground water regimes;
- removal of pollinator habitat;
- potential over-shadowing of the *P. affine* population;
- increase in vehicular traffic, in particular large trucks; and
- significant increase in people movement through the area.

To minimise or avoid these impacts the proposed location of the District Centre was shifted to the south-east of Lot 801.

Alternative development concepts were developed for the area adjacent to the Bay & Basin Leisure Centre, which were aimed at having nil impacts on the *P.affine* population.

2.5.3 Project Scenario 3

During a meeting held on 28 September 2004 at the DEC office in Queanbeyan, DEC tabled a document that identified key threatened species which it considered to have the potential to be significantly impacted by the proposed development.

As a consequence of this, Stockland collected more data, considered further information and liaised with DEC. Changes to the footprint were implemented and these were aimed at providing additional habitat within the subject site and strengthening connectivity across the subject site. Changes included:

- removal of proposed development to the north of the Western creek to provide habitat for a range of woodland and creek-dependent fauna;
- removal of a road connecting the Bay & Basin Leisure Centre with the District Centre increasing the habitat corridor value of this area;
- replacement of the road connecting the Bay & Basin Leisure Centre and Village Central with a raised walkway thus reducing the impacts on an endangered ecological community and increasing connectivity to off-site areas;
- reconfiguration of the District Centre to conserve habitat for movement of the Eastern Bristlebird; and
- reconfiguration of the District Centre pond to allow water to be stored outside the Eastern Bristlebird movement corridor and to be delivered back into Eastern creek from the northern side.

2.5.4 Project Scenario 4

During a meeting held by the former Department of Infrastructure Planning and Natural Resources (DIPNR) on 18 July 2005, both DEC and Stockland discussed their concerns over that part of the subject site known as DEC 'Area 5.' Area 5 encompasses the north-eastern section of the Central creek riparian corridor to a width of approximately 250 – 300m, and vegetation in the north of the subject site adjoining JBNP and the Central creek corridor.

As a consequence of negotiations with DIPNR, DEC concerns and the results of additional field investigations undertaken throughout 2005, further amendments were made to the project plan for the Village Central / West footprint to include:

- conservation of habitat within the DEC 'Area 5' (within Lot 802);
- conservation of hollow-bearing trees and ecotonal vegetation;
- conservation of nesting, breeding and foraging habitats for the Glossy Black-cockatoo, Giant Dragonfly, Giant Burrowing Frog, Eastern Pygmy-possum, microchiropteran bats and Yellow-bellied Glider;
- an adequate buffer to the sensitive wetlands of JBNP; and
- mitigation of intensive fire management within JBNP.

This SIS provides an assessment of the current proposal which reflects Project Scenario 4.

3 ASSESSMENT METHODOLOGY

3.1 INTRODUCTION

To assess the likely impacts of the proposal on flora and fauna, including threatened species, information was obtained on the distribution and abundance of biota in the study area and their significance in the local, regional, state, national and international context. This information came from both published and unpublished information in reports and databases, and from flora and fauna surveys conducted for this SIS including surveys targeted at specific species.

Field surveys for inclusion in this SIS have been ongoing since October 2003. Surveys additional to those required to meet the DGRs of DEC have been undertaken to address further issues raised by DEC and other stakeholders. This extensive set of studies were designed to map and describe the vegetation communities and habitats and target threatened flora and fauna that may be directly or indirectly affected by the proposal to enable potential impacts on flora and fauna to be assessed.

To comply with the requirements of a SIS, targeted surveys must:

- use appropriate methods to detect the target species;
- be conducted during appropriate weather conditions to ensure detection of target species if they are present; and
- be conducted by suitably qualified personnel, as detection of many threatened species is specialised and difficult.

This section provides a summary of the survey methods used and the total survey effort for each fauna or flora group. Suitably qualified personnel with extensive knowledge of flora and fauna assessment protocols conducted the surveys. *Curricula vitae* for each of these ecologists are provided in *Annex B*. Appropriate methods were used and surveys were generally conducted during suitable weather conditions. Where weather conditions were not suitable, a precautionary approach was adopted which assumed that the targeted species could occur on the subject site if suitable habitat was recorded. The DGRs of DEC were incorporated into the methods for all surveys.

3.2 *IDENTIFICATION OF SUBJECT SPECIES AND AFFECTED SPECIES*

DGRs for the SIS were received from DEC on 17 December 2003, with an additional amendment on 19 December 2003 (*Annex I*). However, surveys were commenced prior to the DGRs being received so that they could take advantage of the appropriate conditions during spring and summer, thereby increasing the likelihood of detecting species that have potential to occur on the subject site.

Pursuant to Part 3A of the EP&A Act, DGRs from DoP were requested on 16 December 2005. At the time of printing of this SIS the DGRs had not yet been received. However, given the extensive set of studies undertaken at the subject site, it is not expected that any additional surveys or consideration of other species will be necessary to assess the impacts of this proposal on the flora and fauna of the subject site or of the locality.

A large number of species and plant communities occur in the locality but only a subset of these are likely to be impacted by the proposal. The DGRs of DEC (including advice from government agencies to DEC) listed the species and communities to be considered for inclusion in this assessment.

This information was used in conjunction with database searches, literature reviews, vegetation maps, habitat assessment, flora and fauna surveys and known habitat requirements to identify which species, populations or communities were likely to be affected by the proposal.

A number of these species included threatened species that have the potential to occur within vegetation communities and habitats identified on the subject site but which were not recorded during targeted surveys for a number of reasons. This may be due to time constraints, the season in which surveys were conducted or because such species are cryptic and unlikely to be detected unless intensive surveys are undertaken over a number of years and in ideal weather conditions. Alternatively, these species may simply not occur on the subject site. Limitations of this study are discussed in Section 3.6.

A list of species and communities that may be affected by the proposal is provided in *Table 4.5*.

3.3 *BACKGROUND INFORMATION*

Various sources of published information and data are available on threatened flora and fauna and their conservation significance. These references are cited in the text where appropriate and provided in the reference list at the end of the report. The subject site and surrounding area has been subject to a number of flora and fauna studies and assessments over the years providing a large amount of available background information.

A review of scientific literature was undertaken to investigate the ecology of threatened species recorded on the subject site and within the study area. This included reviewing scientific papers, as well as management plans, recovery plans, vegetation maps and previous impact assessments undertaken pertaining to the study area and surrounding locality. Other information was sourced directly from species experts or specialists in a particular field.

3.4 DATABASE SEARCHES

Various database searches were used to obtain records of significant species and matters of national environmental significance (NES) within the locality. The flora and fauna records obtained from the database searches were plotted using a Geographic Information System (GIS) and were reviewed to document known threatened flora and fauna locations within the locality *(Figure 4.3* and *Figure 4.4*). The dates and sources of these records were reviewed to assess the accuracy and current relevance of the sightings of threatened flora and fauna. These databases searches included:

- National Parks and Wildlife Service (NPWS) Wildlife Atlas database for threatened species listed under the TSC Act for the locality (2003);
- DEH Protected Matters Search Tool on-line map search for matters of NES listed under the EPBC Act that may occur in the locality (2004);
- Birds Australia New Atlas of Australian Birds database for the locality (2003);
- Australian Museum database for threatened species listed under the TSC Act and EPBC Act (2003); and
- Sydney Royal Botanic Gardens Database for threatened species listed under the TSC Act and EPBC Act (2003).

During the course of this study new records became available which added to the knowledge of spatial distribution of threatened species within the locality. These records were taken into consideration when assessing the impacts of the proposal within the locality and region.

3.5 MAPPING AND INTERPRETATION OF DATA

Various sources of information were used and this material included:

- aerial photographs dated 1961, 1975, 1980, 2001, 2003;
- topographic map (Huskisson 1:25,000 9027-4-N);

- masterplan drawings provided by Stockland;
- previous survey data;
- multispectral Image (100 km^2) captured 1 May 2004; and
- topographic and cadastre ground survey undertaken by Allen Price.

Mapinfo

The Geographic Information System (GIS), *MapInfo* (Version 7.5), was an important tool used to map and interpret data in this SIS. Vegetation communities and available subject species records were plotted on georeferenced aerial photographs and other maps at scales of 1:25,000. Scale plans of the proposal were overlaid to provide an indication of the vegetation communities and habitats to be directly and indirectly impacted by the proposal. *MapInfo* was then used to calculate areas and percentages of plant communities and other habitats to be cleared within the study area.

Multispectral Satellite Image

A multispectral satellite image of the locality was captured on 1 May 2004 via Landsat satellites through the ETM+ and Thematic Mapper (TM) sensors. The radiometric characteristics of the ETM+ and TM sensors provide information in the visible, near, middle and thermal infrared regions of the electromagnetic spectrum. These spectra are useful for detailed mapping of vegetation types and habitat distribution and are regularly used by NPWS for both small and large scale mapping exercises (e.g. Kingsford *et al*. 2003, NPWS 2002). Band Number 3 of the spectral range of 0.63 – 0.69 and EM Region of Visible Red was used to distinguish broad scale vegetation types on the subject site and locality.

Satellite imagery was then classified to highlight areas of known vegetation types on the subject site. These were then cross-referenced to known vegetation characteristics either on the subject site or within the locality. For example, areas of *Prasophyllum affine* habitat along the access road to the Bay & Basin Leisure Centre were classified, and cross-referenced to additional areas of occurrence surrounding Eastern creek. This configuration was then applied to the locality to highlight areas of similar vegetation. Although the outcomes of this methodology can only be considered indicative without extensive ground-truthing, it does indicate areas of similar potential habitat throughout the area.

Mapping Data Limitations

When conducting the field survey, spatial coordinates for features recorded in the field were captured using Global Positioning Systems (GPS) and transferred to the *MapInfo* GIS. The accuracy of the GPS readings was dependent on the quality and number of the signals received by the GPS unit from orbiting satellites. Consequently, the methods used to map ecological data have some important limitations that should be understood when interpreting results.

The database records for subject species that were used for plotting within the GIS program varied in quality, reliability and the accuracy of the geographic coordinates. Therefore, some species records have high spatial accuracy, while other records are more tentative and only contain estimates of the geographic coordinates of the locality.

Records of the distribution and abundance of subject species in the locality, as indicated by the atlas databases and other sources of information are not exhaustive and are likely to be influenced by survey quality and effort.

3.6 FLORA

3.6.1 General Vegetation Survey

Vegetation communities within the subject site were identified and mapped using aerial photographs and quadrat-based field surveys.

Locations of quadrats (vegetation sample areas) were identified by considering the draft vegetation maps produced and data collected by Gunninah (1999, 2000a, 2000b, 2000c), examining aerial photographs and by driving and walking through the subject site. Twelve 20 m x 20 m quadrats were randomly chosen within representative locations in broad vegetation communities (Walker and Hopkins 1990) and these are shown in *Figure 3.1*.

All vascular plant species within the quadrats were identified and recorded together with the height and percentage cover of the dominant species within each structural layer. Random meander searches (Cropper 1993) were also conducted in each of the communities to record any additional species that did not fall within the quadrats.

Vegetation communities were described and named according to height, percentage cover and dominant species at the subject site in accordance with Specht (1981). The identification of forest and woodland communities based on the dominant canopy species is unlikely to be complicated by the effect of fire, since canopy species (i.e. trees) would still be present after a fire. In other communities where fire may remove or alter the canopy, such as heathland, dead canopy shrubs and the presence of their seedlings were noted during vegetation mapping. Current and past aerial photographs and vegetation maps also informed the vegetation community mapping process.

Plant species names follow Harden (1992, 1993, 2000, 2002) or more recent naming conventions as provided by the Sydney Royal Botanic Gardens. Species that could not to be identified in the field were retained for later identification by the National Herbarium at the Sydney Royal Botanic Gardens.

3.6.2 Threatened or Significant Flora Surveys

The likelihood of threatened or significant flora occurring in the study area was determined by consideration of the type and condition of vegetation and habitats on the subject site, analyses of database records, consultation with the DEC and Shoalhaven City Council (SCC) and reviews of previous work undertaken on the subject site and in the area (Gunninah 1999, 2000a, 2000b, 2000c, 2001, 2002a, 2002b; NPWS 1999a, 2003c; Mills 1989, 1993).

Threatened flora species that are known to occur on the subject site included *Prasophyllum affine* (Jervis Bay Leek Orchid) and *Cryptostylis hunteriana* (Leafless Tongue Orchid).

Other threatened species that were considered to have potential to occur on the subject site included *Arachnorchi tessellata (*prev. *Caladenia tessellata*) (Thick Lip Spider Orchid), *Rhizanthella slateri* (Underground Orchid), *Galium australe* (Tangled Bedstraw) and *Melaleuca biconvexa* (Biconvex Melaleuca).

Consideration was given to the potential for the following RoTAP species to occur on the subject site: *Corybas undulatum*, *Leptospermum epacridoideum*, *Pultenaea villifera* and *Platysace stepensonii*, since information on their presence or absence would be necessary in the SIS should any of these species be listed on the Schedules to the TSC Act prior to submission of the SIS (refer DGRs in *Annex I*).

Attention was paid to the timing of flora surveys, as many threatened plants are only present above the ground for a few months each year and can only be identified with confidence when flowering. Previous surveys and assessments were also used to assist in ensuring that surveys for these species had been undertaken in the most appropriate seasons. The specific survey methods for each threatened species that was considered to have potential to occur on the subject site are discussed below.

Targeted surveys for both threatened and RoTAP species were also incorporated into quadrat surveys and included random meander searches in each vegetation community so that species that did not fall within the quadrats could be recorded. Species were also searched for when walking and driving between sites.

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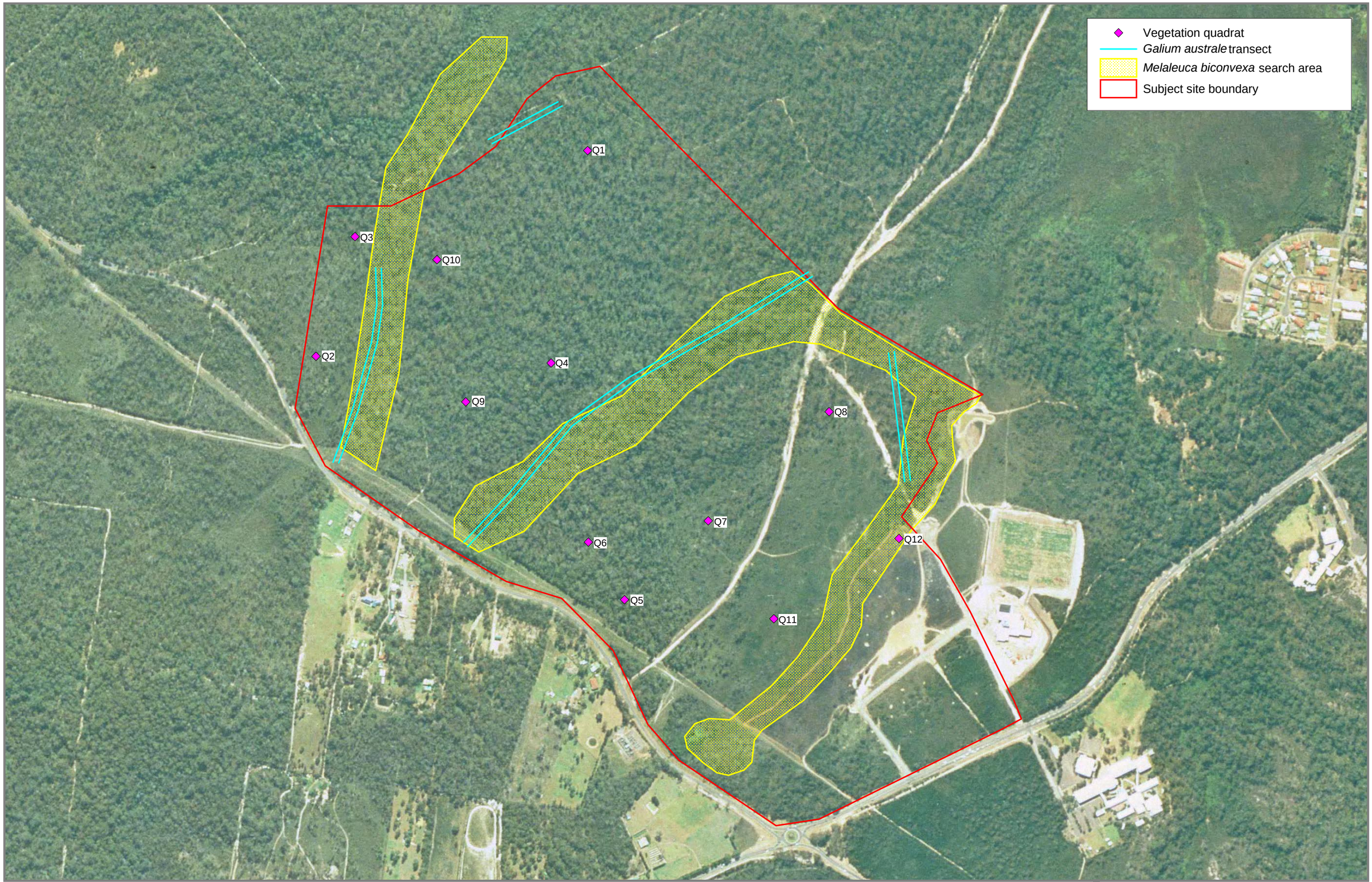

Figure 3.1 **Vegetation Quadrats and *Galium australe* *Melaleuca biconvexa* Survey Locations**

Vincentia
Species Impact Statement

Considerations

Threatened orchids with the potential to occur on the subject site include *Prasophyllum affine*, *Cryptostylis hunteriana*, *Arachnorchi tessellata* (prev. *Caladenia tessellata*) and *Rhizanthella slateri*. The survey methodology for these species was developed in consultation with DEC, the Jervis Bay Leek Orchid Recovery Team, Dr Mark Clements (*pers. comm.*) and Alan Stephenson (*pers. comm.).* Surveys for these species were undertaken during their flowering periods and were aimed at adequately describing the extent of the population on the subject site.

P. affine does not necessarily flower every year and often skips years when rainfall has not occurred prior to the flowering period (NPWS 2003c). *P. affine* was not recorded at previously known locations in 2002, and this is probably due to the state-wide drought conditions experienced the preceding year. *P. affine* produces a leaf in late winter/early spring, which can be up to 50 cm long and remain until after the flower spike emerges from near the leaf apex in late October/early November (NPWS 2003c). In 2001, the main flowering period was from the 30 October to the 18 November and fruits were ripe by mid December 2001.

The exact flowering time of *C. hunteriana* is unpredictable and it can flower anytime between early December and mid March.

A. tessellata has been recorded flowering from early September until early November.

The appropriate timing and survey techniques for *R. slateri* are currently being developed by SCC and a recognised underground orchid expert. This information could not be provided by SCC. However, a survey technique was employed based on the knowledge of the habitat and habit of the species.

Threatened Orchid Survey Methods

Surveys for these species included systematic transect surveys within Lot 801, random meandering and opportunistic surveys within both Lot 801 and Lot 802 and transects in woodland areas.

Permanently Marked Transects

Surveys along 57 permanently marked transects were undertaken within Lot 801. These transects are spaced 10 metres (m) apart and identified in the field by wooden stakes with coloured flagging (*Figure 3.2)*. These transects covered the majority of Lot 801, and included all areas of heath/shrubland and low woodland with heath/shrubby understorey. Other areas were not considered to provide potential habitat for any threatened orchid species. These transects were surveyed by two or three ecologists at roughly two week intervals from October 2003 to January 2004 (*Table 3.1*). Surveys were undertaken both before and after a number of known individuals on the subject site had commenced flowering. The primary purpose of these surveys was to identify and count individuals of *P. affine* within Lot 801. However, all threatened orchids were targeted during these surveys when surveys were undertaken within their flowering periods. During the first transect survey, the numbers of *P. affine* plants that were identified was recorded and each individual or group was flagged and their locations were recorded using a GPS. On subsequent surveys, the location and number of individuals were checked and additional individuals were flagged and their locations recorded with a GPS.

Systematic Transect

Systematic transects were surveyed in the heathland between Eastern creek and Moona Creek Road and in the grassy area directly west of Moona Creek Road. These transects involved two to three ecologists walking along transects no greater than 5 m apart through known habitat. Any threatened orchid species recorded was flagged and the location marked using a GPS.

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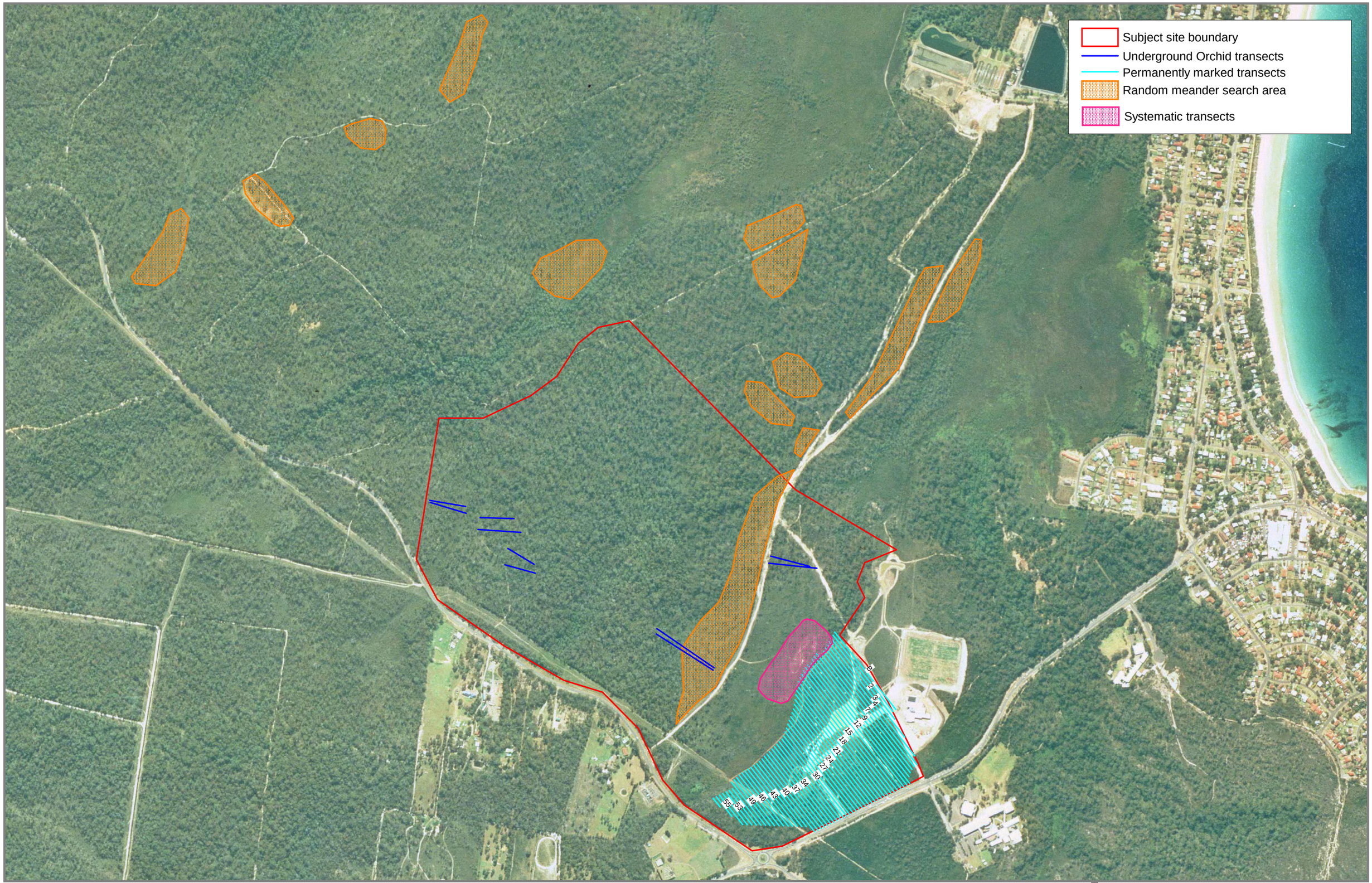

Figure 3.2 **Threatened Orchid Survey Locations**

Vincentia
Species Impact Statement

Table 3.1 Threatened Orchid Surveys

Date	Survey Method	Site/Location	Species Targeted
October 2003			
22.10.03	RM	Lot 802 (Woodland west of Moona Creak Road)	*P. affine* *A. tesselatta*
23.10.03	PMT	Lot 801	*P. affine* *A. tesselatta*
November 2003			
4.11.03	RM	Lot 802 (woodland west of Moona Ck Rd)	*P. affine* *A. tesselatta*
5.11.03	RM	Lot 802 (woodland west of Moona Ck Rd)	*P. affine* *A. tesselatta*
6.11.03	RM	Lot 802 (woodland west of Moona Ck Rd)	*P. affine* *A. tesselatta*
17.11.03	PMT	Lot 801	*P. affine* *A. tesselatta*
18.11.03	PMT	Lot 801	*P. affine* *A. tesselatta*
18.11.03	RM	Lot 802 - woodland west of Moona Ck Rd	*P. affine* *A. tesselatta*
18.11.03	ST	Lot 802 - heathland east of Moona Ck Rd	*P. affine* *A. tesselatta*
19.11.03	RM	Lot 802 (woodland/sedgeland in SW corner east of creek and woodland west of Moona Creek Rd)	*P. affine* *A. tesselatta*
26-27.11.03	RM	JBNP along Moona Creek Rd towards the sewerage treatment plant	*P. affine*
December 2003			
2.12.03	PMT	Lot 801	*P. affine* *C. hunteriana*
3.12.03	ST	Lot 802 – west of Moona Ck Rd	*P. affine* *C. hunteriana*
3.12.03	ST	Lot 802 – heathland east of Moona Ck Rd	*P. affine* *C. hunteriana*
3-4.12.03	RM	JBNP – western, central and southern areas	*P. affine*
29.12.03	PMT	Lot 801	*C. hunteriana*
30.12.03	RM	Lot 802 Corner Naval College & Moona Ck Rds NE corner at bottom of last trap line	*C. hunteriana*
30.12.03	Transect	Lot 802 – Scribbly Gum (11) Moona Ck Rd and Leisure Centre road.	*Rhizanthella slateri*
31.12.03	RM	Lot 801 (in locations where it had been previously recorded)	*C. hunteriana*
January 2004			
15.1.04	PMT	Lot 801	*C. hunteriana*
16.1.04	ST	Lot 802 – heathland/Scribbly Gum Woodland	*C. hunteriana*
		Surveys undertaken by GHD (GHD 2005a)	
December 2004-Jan 2005			

1. RM = Random Meander Technique (Cropper 1993)
2. PMT = Permanently Marked Transects
3. ST = Systematic Transects
4. JBNP = JBNP

Random Meander Technique Surveys

The Random Meander Technique involves walking in a haphazard manner throughout the subject site, habitat or survey area and noting every plant species seen (Cropper 1993). During the initial site inspection random meander transects were walked across the majority of the subject site to identify potential habitat for threatened orchid species. Random meander surveys for targeted orchids were then undertaken within Lot 802 within potential orchid habitats.

In addition, random meander surveys were undertaken within Lot 801 in areas where *C. hunteriana* had previously been recorded to supplement the transect surveys within Lot 801. The dates of random meander surveys, locations and species targeted are shown in *Table 3.1*.

Random meander surveys were also carried out in the adjacent JBNP in areas which have similar habitat to that in which they are known to occur within Lot 802 and East Sites (*Figure 3.2*). These areas were chosen through studying aerial photographs and topographic maps of the area.

Additional surveys for *P. affine* and *C. hunteriana* and monitoring of known populations was undertaken by GHD during summer 2004 / 2005 (GHD 2005a). Methodologies used were those described above. Surveys by GHD for orchids at the subject site are ongoing.

Underground Orchid Surveys

Two 100 m transects separated by approximately 10 m were surveyed for the Underground Orchid by two ecologists in five locations within the Scribbly Gum Woodland across Lot 802. This vegetation type was considered the most likely to provide habitat for this species as a nearby population occurs in similar habitat (Alan Stephenson (*pers. comm.)*. A hoe was used to gently scrape away leaf litter from around the base of Scribbly Gums. The Underground Orchid species flowers between October and November (Bishop 2000). However, it is likely that the flower head would have still been visible by late December when these surveys took place (Mark Clements *pers. comm*.).

Other Threatened Plants

Other threatened plants that were considered to have potential to occur on the subject site included *Galium australe* (Tangled Bedstraw) and *Melaleuca biconvexa (*Biconvex Melaleuca*)*.

G. australe was listed as Endangered (Presumed Extinct) under the TSC Act until a population was discovered in 2002 near Lake Windemere, around 7 km to the south-east in the Booderee National Park growing with *Eucalyptus pilularis/Eucalyptus botryoides* and *Syncarpa glomulifera* (on slopes with friable loamy soil and abundant ferns in the understorey). Past descriptions of this species noted a patchy distribution and consequently it can be easily overlooked during flora surveys. Targeted surveys were used to survey for this species in potential habitat on Lot 801 and Lot 802. This species is impossible to identify without flowers or fruit and the best time for survey appears to be summer (DEC – DGRs) (see *Annex I*).

Access to, or information about, whether the one known population of this species was flowering at the time of surveys was unavailable from DEC. However, the targeted surveys were undertaken within summer, which is the flowering period noted for this species in Harden (1992). Knowledge of the vegetation communities along with slope and soil types identified those areas adjacent to creek lines as having the most suitable habitat for this species on the subject site. Sites mid-slope and near the ridgelines did not have loamy friable soils nor abundant ferns in the understorey. Transects separated by 10 m adjacent to creeks were surveyed by two ecologists on 30 December 2003 for a total of 4 person hours (*Figure 3.1*).

M. biconvexa is a small tree species with a distinctive leaf structure that is relatively easy to detect and consequently can be surveyed at any time. Potential habitat included drainage lines on the subject site and targeted surveys were used to search for this species in those areas during the two week flora and fauna survey (24 November to 5 December 2003). Surveys were extended to include adjacent areas in JBNP (*Figure 3.1*).

Rare or Threatened Australian Plants

Consideration was given to the potential for the following Rare or Threatened Australian Plants (RoTAPs) (Briggs and Leigh 1996) (refer to *Annex H*) to occur on the subject site: *Corybas undulatus* (Tailed Helmut Orchid), *Leptospermum epacridoideum*, *Pultenaea villifera* var. *villifera* and *Platysace stepensonii*. Information on their presence or absence is a necessary consideration as some or all of these species have the potential to be listed on the Schedules to the TSC Act prior to submission of this SIS (see DGRs in *Annex I*).

The *Corybas undulatus* is an orchid that has a RoTAP code of 3KC- and flowers from May to July (Bishop 2000). It is rare and sporadically distributed in coastal and near-coastal regions north from Jervis Bay (Harden 1993). It favours low wet heathland, and is often associated with scattered *Banksia ericifolia*, around Sydney but has also been reported from sclerophyll forests (Bishop 2000). Consequently, this species has the potential to occur on the subject site, although it was not previously recorded (Gunninah 2002a). As the SIS surveys were undertaken outside the flowering period this species was not targeted during surveys for the SIS. Instead vegetation communities that provide potential habitat for this species were mapped and the species was assumed to be present in these areas.

P. villifera var. *villifera* is a shrub and has a RoTAP code of 3RC- (Briggs and Leigh 1996). It is known to occur in dry sclerophyll forest on sandy soil in the lower Blue Mountains to Eden district (Harden 2002). This species was identified within Lot 802 by Gunninah (2002a) in Open Woodland/Woodland/Open Forest. However, this was an incomplete report and no vegetation maps or other details of the location of this species on the subject site were available. This species was targeted during studies for the SIS using quadrat surveys and random meandering transects through potential habitat. Any vegetation communities that provide potential habitat for this species were mapped.

Leptospermum epacridoideum is a shrub with a RoTAP code of 2RC- (Briggs and Leigh 1996). It grows in heath and sclerophyll forest, on sandstone mostly confined to the Jervis Bay area (Harden 2002). This species has not previously been recorded on the subject site (Gunninah 2002a). This species was targeted during studies for the SIS through surveys of quadrats and random meandering transects through potential habitat. Any vegetation communities that provide potential habitat for this species were mapped.

*Platysace stephensonii*is a small shrub and has a RoTAP code of 2RC- (Briggs and Leigh 1996). It grows in dry sclerophyll forest and heath, often on sandstone near the coast, chiefly from Ku-ring-gai Chase to Jervis Bay (Harden 1992). This species has not previously been recorded on the subject site (Gunninah 2002a). This species was targeted during studies for the SIS through surveys of quadrats and random meandering transects through potential habitat. Any vegetation communities that provide potential habitat for this species were mapped.

Regionally Significant Vegetation

Flora Species

There is no formal list of regionally significant plant species for the Sydney Basin Bioregion. However, Mills (1993) lists botanically significant plant species in the Jervis Bay region and Mills (1996; 1998) lists botanically significant plant species in parts of the Shoalhaven and Jervis Bay regions (Gunninah 2002a). This list was reviewed and botanically significant plant species listed in these references were targeted as a part of the quadrat and random meander surveys.

Vegetation Communities

There is no formal list of regionally significant vegetation communities for the Sydney Basin Bioregion. However, Mills (1993) lists botanically significant vegetation communities in the Jervis Bay region. These communities were surveyed for by mapping the vegetation on the subject site and relating these communities to the community descriptions provided by Mills (1993).

Vegetation mapping of the South Coast district, which included the Jervis Bay 1:100 000 map sheet, has recently been completed as part of the Native Vegetation Mapping Program (NVMP) under the *Native Vegetation Conservation Act 1997* (NVC Act). However, the accompanying scientific report is not currently available and therefore, this information could not sensibly be used in this SIS.

3.6.3 Endangered Ecological Communities

The likelihood of the endangered ecological community *Sydney Coastal Estuary Swamp Forest Complex* (SCESFC) occurring on the subject site was assessed by consideration of the description of this community contained in the NSW Scientific Committee Final Determination (1999) and by reviewing the vegetation, soils and hydrology of the subject site to determine if it matched the description in the Final Determination.

In addition, the Preliminary Determination to list Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions as an Endangered Ecological Community, and as a result to omit reference to SCESFC in the Sydney Basin bioregion from Part 3 of Schedule 1 of the TSC Act was also taken into consideration when assessing the occurrence of endangered communities occurring within the subject site. Since that time, the Scientific Committee has made a Final Determination to list Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions as an endangered ecological community.

To determine if SCESFC occurred at the subject site, the following five key features taken from the SCESFC Final Determination were assessed:

- whether the site is within the area defined by the Determination;
- whether the site occurs on waterlogged estuarine alluvial soils strongly influence by periodically poor drainage conditions;
- whether the site is any of the mosaic of vegetation types listed in Section 5 of the Determination;
- whether any of the listed characteristic species occur (including as part of the soil seed bank); and
- whether the site is similar to vegetation mapped as Coastal Swamp Forest Complex (Map Unit 27a) in Benson and Howell (1994) or part of the alluvial forest (Chafer 1997).

These characteristics were assessed during ground-truthing of vegetation, mapping and by review of relevant literature. The primary consideration was whether the subject site occurred in the Sydney Basin Bioregion and the presence and extent of waterlogged estuarine alluvial soils strongly influenced by periodically poor drainage conditions. Once these factors were considered, the nature of the vegetation on waterlogged estuarine alluvial soils was considered by comparing vegetation on the subject site to the last three points noted above that describe vegetative characteristic of SCESFC.

The presence of alluvial or estuarine soils that were waterlogged and experience periodically poor drainage was estimated by reviewing test pit data collected by Network Geotechnics (2003). The degree of waterlogging was also noted in the field by visually assessing whether the soil drained freely or was saturated after rain.

The locations of test pits with alluvial or estuarine soils were identified and mapped on an aerial photograph. The vegetation types and their boundaries that were located at, and adjacent to, these test pits were compared to the vegetation descriptions of SCESFC based on the final three features given above. This comparison included the assessment of not only the canopy layer, but of other structural layers and dominant species in those layers. The degree of regrowth of vegetation on the subject site after fire was also taken into account when comparing the vegetation on the subject site to descriptions of SCESFC vegetation.

The Preliminary Determination to list Swamp Sclerophyll Forest as an Endangered Ecological Community was also referred to in assessing whether this community occurred within the subject site. Swamp Sclerophyll Forest will replace and include the SCESFC and includes a broader assemblage of species. Therefore, as well as the above environmental variables, the occurrence of the assemblage of species characteristic of Swamp Sclerophyll Forest (listed in Part 1 of the Preliminary Determination) was also assessed for vegetation communities across the subject site. Since this time the Scientific Committee has made a Final Determination to list Swamp Sclerophyll Forest as an endangered ecological community. However, as no significant amendments were made to the Determination, the initial assessment of whether this community occurs at the subject site, based on the Preliminary Determination for Swamp Sclerophyll Forest and the Final Determination for SCESFC, still stands.

3.7 FAUNA

3.7.1 Habitat Evaluation

Habitat Assessment

A variety of vegetation maps and previous studies were used to identify and assess the distribution of habitat types within the subject site. Microhabitat diversity for native fauna was also assessed within vegetation quadrats and during traverses of the subject site and the following habitat characteristics were documented:

- the presence of nesting / shelter sites such as tree hollows, litter, fallen timber, hollow logs, decorticating bark and logs;
- cover abundance of ground, shrub and canopy layers and flowering characteristics of shrubs and trees;
- emergent vegetation within and around waterbodies and the presence of free water;
- rocks and basking sites for reptiles; and
- extent and nature of previous disturbances.

Habitat Usage

Habitat usage of the subject site by fauna was documented through analysis of tracks, scats, diggings and other traces. Traces of threatened and significant species that might occur within the subject site were the focus of the surveys. Searches were conducted during the entire survey period and included:

- searches for owl and other raptor pellets;
- other scats;
- raptor nests;
- tracks and diggings;
- Yellow-bellied Glider (*Petaurus australis*) feed trees;
- foraging signs of Glossy Black-cockatoo (*Calyptorynchus lathami*);
- identification of road kills; and
- other indicators of fauna such as scratches on trees and runways through vegetation.

Tree Hollow Counts

Hollow-bearing tree surveys were concentrated within Lot 802 since hollows are a necessary breeding resource for a wide range of native fauna including the Yellow-bellied Glider, Squirrel Glider and the Glossy Black-cockatoo, which have been previously recorded on this subject site. Survey effort was focused in areas of the subject site that were most likely to be impacted by the project and likely to be utilised by the target species. As riparian areas are to be retained on the subject site, survey effort was focussed in other areas.

Tree hollow counts were undertaken along 19 randomly placed transects in wooded areas across the subject site (*Figure 3.3*). These surveys involved one person slowly walking 100 m along the centre of a 100 x 20 m transect and recording the occurrence of any hollows. Details recorded included the height, diameter and number of hollows within the tree and the species of tree. This provided some qualitative data about the number of hollow-bearing trees per hectare in each vegetation type, and the potential for the area to provide habitat for a number of hollow-dependent fauna species.

3.7.2 General, Significant and Threatened Fauna

Prior to undertaking the fauna surveys, an assessment of the known and potential fauna assemblages of the subject site was made using database records, previous reports, habitat mapping and habitat requirements of native fauna species. Survey effort was focused in areas of the subject site that were most likely to be impacted by the project and likely to be utilised by the target species. *Figure 3.4, Figure 3.5 and Figure 3.6* show the location and types of fauna surveys.

The aim of the fauna surveys was to identify fauna assemblages and provide information about the distribution and abundance of fauna on the subject site, including threatened or significant species.

Opportunistic searches and sightings complimented survey effort for birds, frogs and reptiles during the survey periods.

Fauna survey techniques included the use of ground A-size Elliott traps and cage traps, B-size Elliott traps placed in trees, ultrasonic detection of bats, frog call playback, spotlighting for mammals and visual and auditory surveys for birds, including call playback. These are described below.

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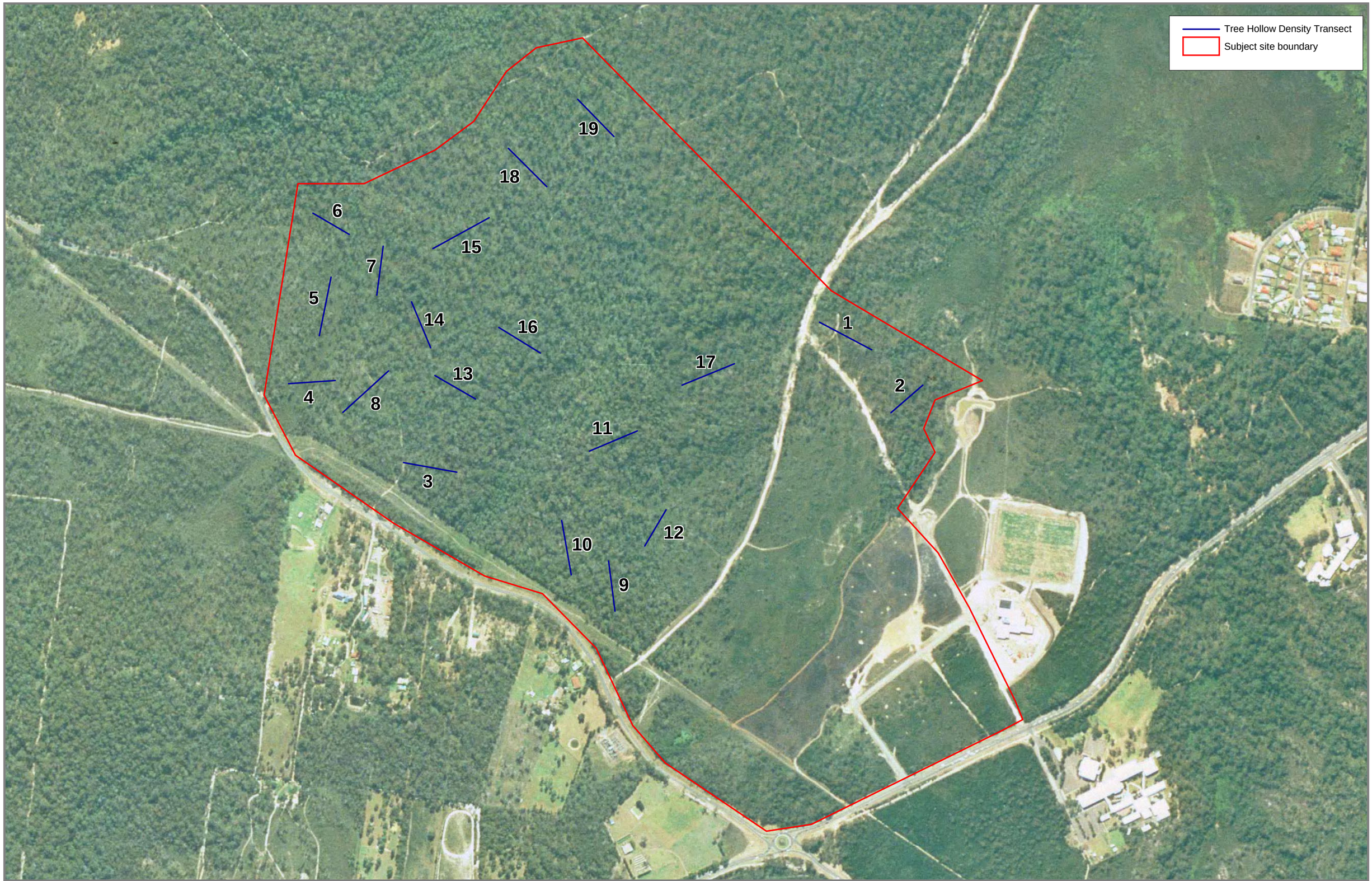

Figure 3.3 **Hollow-bearing Tree Transect Locations**

Vincentia
Species Impact Statement

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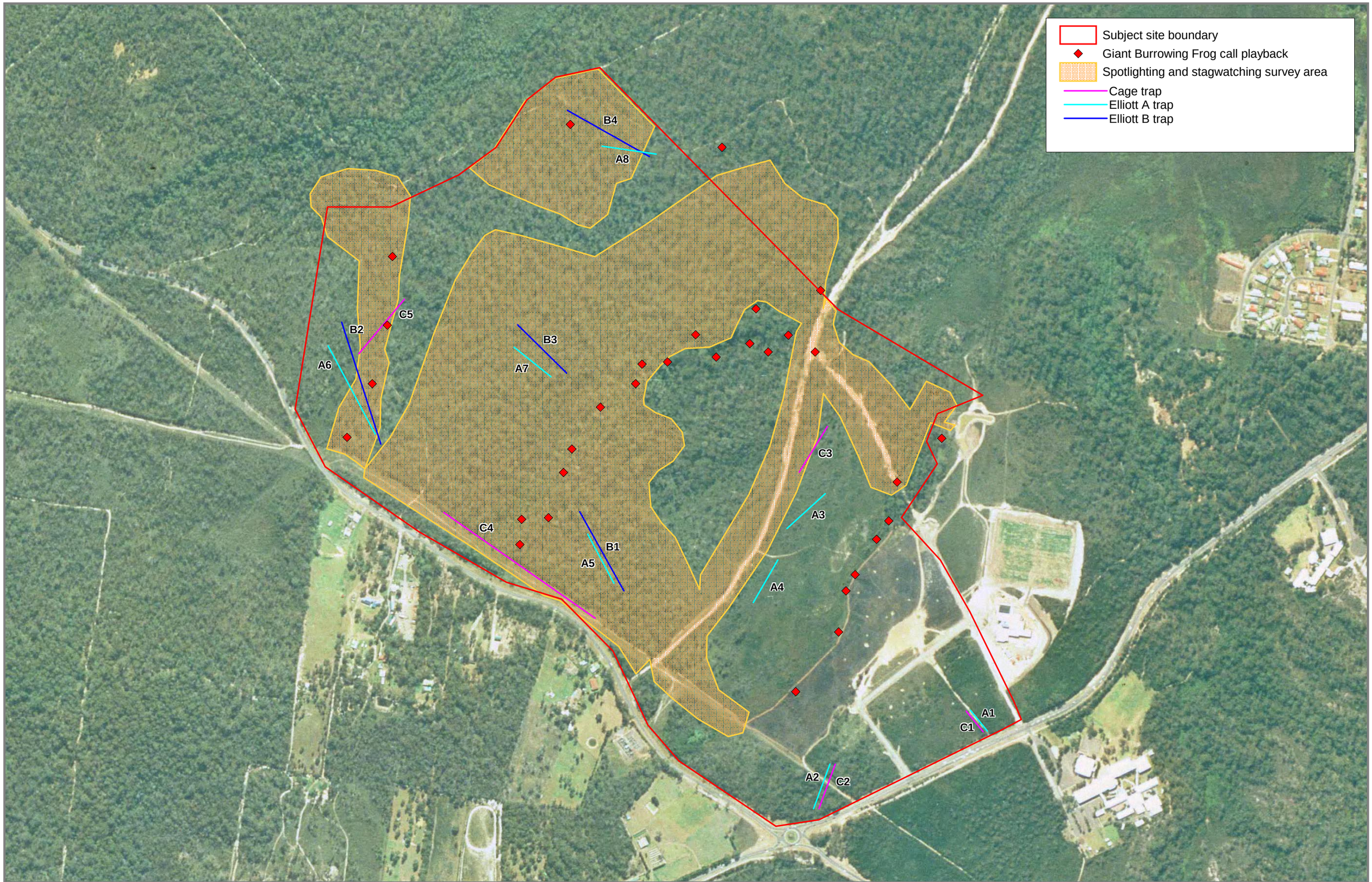

Figure 3.4 **Spotlighting, Call Playback and Trapping Survey Locations 2003**

Vincentia
Species Impact Statement

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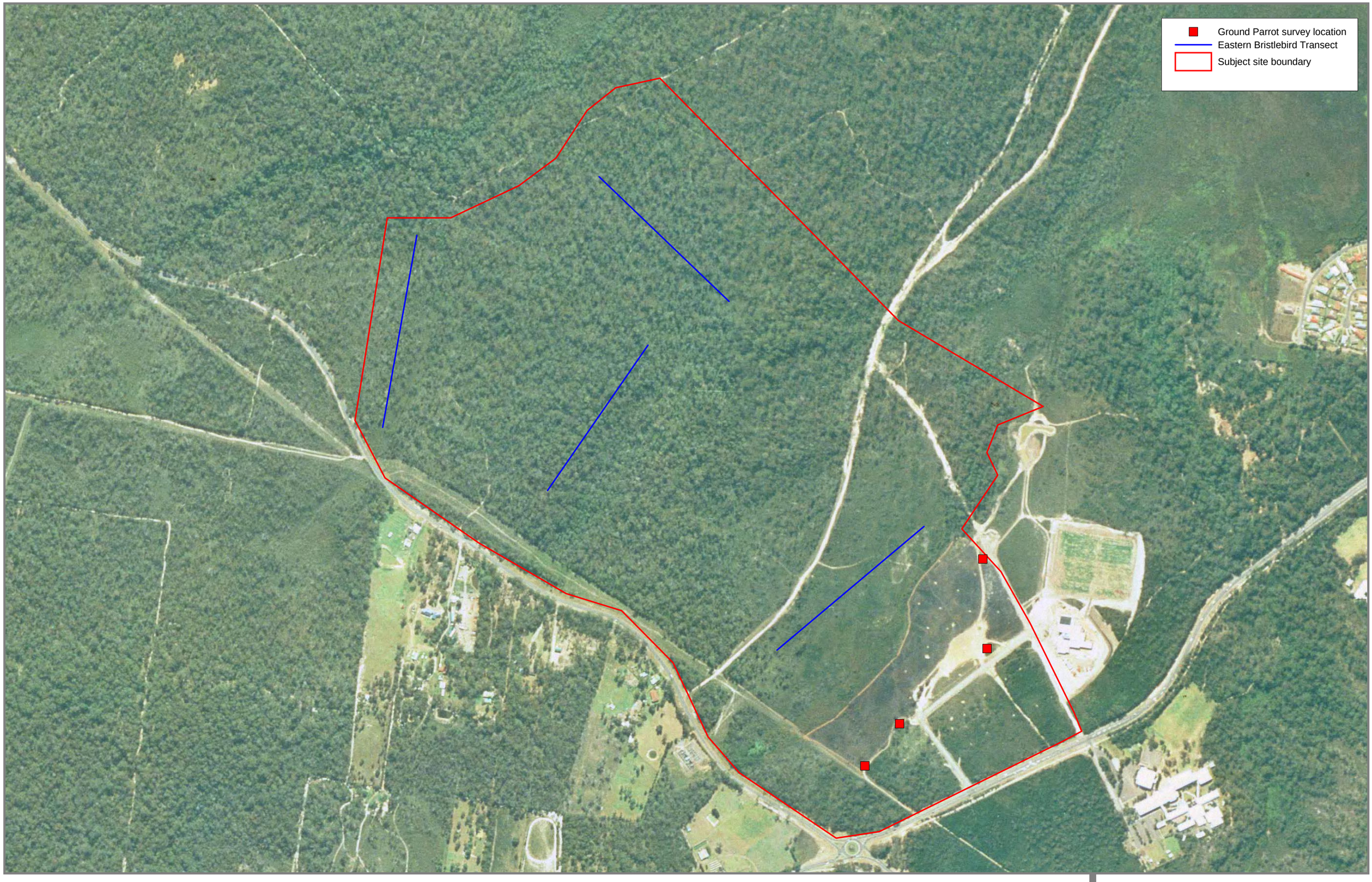

Figure 3.5 **Eastern Bristlebird and Ground Parrot Survey Locations**

Vincentia
Species Impact Statement

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Figure 3.6 **Location of September 2004 Bird Surveys**

Vincentia
Species Impact Statement

Amphibians

Amphibian searches were conducted along drainage lines / creeks on the subject site at different locations over six nights from 24 November to 5 December 2003. Auditory and visual records of frogs were noted during these surveys.

Rainfall was experienced on all survey days and the mild to warm weather experienced during the surveys made conditions suitable for detecting a wide range of reptiles and amphibians.

Nocturnal call playback and targeted searches were conducted for the Giant Burrowing Frog (*Helioporus australiacus*) within the riparian zones and adjacent terrestrial habitats away from the drainage lines each night. Searches away from streams were focussed in areas of deep pools containing water and in the area in which Gunninah (2002b) previously recorded a single tadpole of this species.

Call playback was conducted for 5 minutes followed by a 10 minute listening period, repeated twice at four locations at 100 – 150 m intervals each night. Over the course of the survey over 400 m of each creek was sampled. The dedicated survey effort per night was eight person hours (48 person hours in total), and active survey effort was four person hours per night (24 hours in total). Active searches included nocturnal spotlight searches along creeks and drainage lines during rain events on mild evenings.

Table 3.2 Giant Burrowing Frog Survey Detail

Site	Date	Detail
Adult Surveys		
Western creek and adjacent areas	4/12/03	4 call playback sessions along 400m.
Northern corner of subject site	24-25/11/03	2 call playback sessions upstream from the Western creek at a stationary water body over 2 nights.
Central creek and adjacent areas	24-27/11/03 2 & 4/12/03	20 call playback sessions along the length of Central creek over 6 nights.
Eastern creek and adjacent areas	26-27/11/03	8 call playback sessions over 2 nights.
Tadpole Surveys		
North-western corner of subject site and Western creek	5 & 30/12/03 17/9/04	Dip netting in pool habitats with stationary water.
Midslope to the east of Central creek	29/12/03	Dip netting in pool habitats with stationary water.

Although the timing of these surveys was outside those specified in the DGRs of DEC, the survey timing is still considered appropriate. The Frog and Tadpole Study Group Inc. conducted surveys for this species in all months of the year as part of a baseline study funded by the Natural Heritage Trust in 1996. In those surveys males were recorded calling in July, September and October outside the normal calling period but coinciding with ideal weather conditions. Recsei (1996) concluded that the Giant Burrowing Frog could be sampled at any time of the year, providing it is raining. Surveys in November/December 2003 were conducted under ideal weather conditions after a period of record drought conditions on the south coast of NSW. By February 2004, weather conditions had returned to drought.

Additional searches for tadpoles were undertaken on 29 – 30 December 2003 and 5 February 2004 by two ecologists for a total of eight hours. Another survey was undertaken on 17 September 2004 by one ecologist for a total of 2.5 hours as larval life span in the field can vary from 3 – 11 months (Anstis 2002). Surveys for tadpoles were undertaken along the creeklines and adjacent terrestrial habitat up to mid-slope of the ridgelines. A dip net was dragged through each pool for one to two minutes. Visual surveys of pools were also undertaken.

Additional surveys for both adults and tadpoles, as well as habitat surveys were undertaken by GHD at a reference site and in the northern and north-eastern sections of the subject site. Full details on the survey methodology and results can be found in the full report (GHD 2005b).

Reptiles

Reptiles were surveyed by actively searching potentially suitable habitat during diurnal searches for at least one hour per day over the entire survey period. Ground debris, decorticating bark and rocks were overturned and replaced during searches as these provided suitable habitat for a wide range of species. Opportunistic reptile sightings were also noted.

Birds

December 2003 Targeted Surveys

Targeted surveys were conducted to detect threatened bird species with potential to occur on the subject site. These are outlined below.

Ground Parrot

Ground Parrot (*Pezoporus wallicus*) surveys were conducted at two locations within Lot 801 (*Figure 3.5*). Surveys were undertaken by two ecologists over a period of eight days between 25 to 28 November and 1 December to 4 December 2003. Each listening period lasted one hour. During this time the number and location of calling Ground Parrots were recorded.

Two survey periods were conducted per day, one at dawn and one at dusk. Dawn surveys were conducted one hour before sunrise (04:45 to 05:45 hours), and dusk surveys commenced 15 minutes after sunset (20:00 to 21:00 hours). A total of 32 person hours were spent over the eight day period.

Eastern Bristlebird

Surveys were conducted for the Eastern Bristlebird (*Dasyornis brachypterus*) at four locations (*Figure 3.5*) across the subject site over a period of eight days. A listening period of 30 minutes beginning at sunrise was undertaken at selected points. Following the listening period a slow search was conducted through potential habitat. This involved walking at a slow steady speed of approximately two kilometres an hour along a transect representative of the study area.

On completion of the slow search, call playback was conducted for two minutes followed by a 30 minute listening period. Call playback sessions were repeated twice along a given transect through suitable habitat. The distance between survey points was at least 200 metres. A total of 32 person hours were spent surveying for this species.

Owls

Surveys were conducted along drainage lines by two people to identify key nesting and roosting resources. Searching for evidence of 'white-wash' indicating roost sites was undertaken from 2 to 3 December 2003. A total of 16 person hours were spent searching for roosting and nesting sites.

Glossy Black-cockatoo

Surveys were conducted by two people to map potential feeding habitat (*Allocasuarina littoralis*) for the Glossy Black-cockatoo (*Calyptorhynchus lathami*). Stands of *A. littoralis* were mapped using GPS and plotted into *MapInfo* GIS for final map production. A total of 30 person hours were spent undertaking this mapping.

In addition, potential nesting habitat was documented during the hollow-bearing tree surveys (Section 3.7.1). The location of the tree hollow surveys is shown in *Figure 3.3*. These surveys involved one person slowly walking 100 m along the centre of a 100 x 20 m transect and recording the occurrence of any hollows. Details recorded included the height, diameter and number of hollows within the tree and the species of tree. This provided some qualitative data about the number of hollow-bearing trees per hectare in each vegetation type, and the potential for the area to provide habitat for a number of hollow-dependent fauna species.

Square-tailed Kite

Diurnal surveys were conducted to identify if there was a resident bird or pair of birds on the subject site. Surveys were undertaken by two people to locate potential nesting trees on the subject site.

Other Bird Species

Opportunistic sightings of bird species were recorded across the study area during targeted field surveys for threatened species from the 24 November to 5 December 2003 and during targeted orchid surveys during October, November and December 2003.

All bird species heard and/or observed throughout the survey period were recorded.

September 2004 Targeted Surveys

Additional bird surveys were conducted between the 6 and 12 September 2004. These were aimed at targeting threatened bird species for which previous surveys had not been conducted in a season that was optimal for their detection, and to better address the intent of the DEC Director General requirements. These additional surveys were conducted by two experienced ornithologists and the following techniques were employed:

- diurnal bird surveys to detect Turquoise Parrot, Regent Honeyeater and Swift Parrot. Surveys were conducted at dawn and dusk at eight sites using standard 2 hectare 20 minute searches. Regent Honeyeater call playback was conducted for five minutes at the beginning of each dawn and dusk survey. Each site was surveyed at least twice and a total of 50 surveys were conducted over the seven day period. The eight survey locations are shown in *Figure 3.6*;

- nocturnal owl call playback to detect Powerful Owl, Sooty Owl and Masked Owl. Owl call playback was conducted in six locations, shown in *Figure 3.6*. Seven owl call playback sessions were conducted over six nights. Very poor weather conditions during the survey period affected the number of surveys that could be conducted. For example strong winds (trees down) and heavy rain were experienced on four of the six survey nights. Calls of the target species were played from a CD through a megaphone and each session involved the following:

    - 15 minutes listening prior to playing a call;

    - 5 minutes call play; and

    - 5 minutes listening following call play;

- This sequence was repeated for each target species, then followed by 15 minutes spotlighting. The order of species calls played was Powerful Owl, followed by Masked Owl, followed by Sooty Owl;

- Glossy Black-cockatoo surveys were conducted at dawn and dusk over a six day period and opportunistically over the seven days. Surveys were conducted in areas that supported hollow-bearing trees and focussed on detection of adult bird activity with the intention of observing movements and following birds back to nesting hollows if possible. Surveys were conducted concurrently with diurnal surveys. Additional observations were made at water points at dusk and while travelling between survey sites.; and

- Ground parrot habitat mapping. Using a satellite image, areas of potentially suitable habitat for Ground Parrots were identified within a 2 km radius of the subject site. Potentially suitable areas were initially identified from the photo, using known habitat on the subject site as a reference. These areas were then ground-verified and assessed for characteristics such as height and type of vegetation and whether a previous record existed for the subject site.

In addition to targeted threatened species surveys, all bird species observed or heard were recorded during all surveys.

2005 Surveys

Glossy Black-cockatoo nest and breeding activity surveys were undertaken by GHD in May 2005. The methodology and results of these surveys can be found in the full report (GHD 2005c).

Mammals

Vegetation maps and previous studies were used to identify and assess the distribution of habitat types within the subject site. These preliminary findings were used to focus surveys in suitable habitat for threatened mammal species known, or expected, to occur across the subject site. Targeted surveys were undertaken across the subject site between 24 – 28 November and 1 – 5 December 2003. The locations of all fauna surveys are shown in *Figure 3.3* and *Figure 3.4* and the amount of effort expended on each technique is detailed in *Table 3.3*. Standard practices were used to collect data relating to fauna and were based largely on guidelines developed by NPWS (NPWS 1999), requirements as outlined in the DGRs of DEC and through discussions with DEC officers.

Eastern Pygmy-possum, White-footed Dunnart and Eastern Chestnut Mouse

Ground and shrub-mounted Elliott Traps (Size A) were used to target the Eastern Pygmy-possum (*Cercartetus nanus*), White-footed Dunnart (*Sminthopsis leucopus*) and Eastern Chestnut Mouse (*Pseudomys gracilicaudatus*). Eight transects of ten traps were set in areas of potential habitat across the subject site (total of 640 trap nights). Alternate traps were placed off the ground in a Banksia shrub. All other traps were placed on the ground. The traps remained open for two periods consisting of four nights each separated by two nights on which traps were closed. A plastic bag was placed over the closed end of the trap on those nights in which rain was expected in order to keep any captured animal dry and warm. Each trap was baited with a mixture of honey, rolled oats and peanut butter. Any captured animals were identified to species and then released at the capture site.

Weather conditions over the survey period precluded the use of pit fall traps as these would have posed a drowning risk to captured animals at times of heavy rains.

Table 3.3 Fauna Survey Effort

Fauna Group	Technique	Sample Unit	Survey Period							
			24 -28 Nov 2003	1-5 Dec 2003	29-31 Dec 2003	5 Feb 2004	6-12 Sep 2004	10-14 Dec 2004	9-15 May 2005	Total Units
AMPHIBIANS										
General	Auditory/visual	Person hours	16	8						24.00
Giant Burrowing Frog	Call playback	Person hours	32	16					1.7	49.70
	Active searches	Person hours	16	8					1	25.00
	Tadpole searches	Person hours			6	2			2	10.00
REPTILES	Active searches	Person hours	4	4						8.00
BIRDS										
Ground Parrot	Visual/auditory	Person hours	16	16						32.00
Eastern Bristlebird	Visual/auditory/transects	Person hours	16	16						32.00
Owls	Visual/Roost searches	Person hours		16						16.00
Raptors	Visual/Roost searches	Person hours		16						16.00
Owls	Call playback	Person hours					12.25			12.25
Turquoise Parrot	Visual/auditory	Person hours					33			33.00
Swift parrot	Visual/auditory	Person hours					33			33.00
Regent Honeyeater	Visual/auditory	Person hours					33			33.00
Glossy Black-cockatoo	Visual/auditory/nest sites	Person hours					40		94.9	139.4
MAMMALS										
Ground-dwelling	Elliott traps – Size A	Trap nights	320	320						640
	Cage traps	Trap nights	208	208						416
	Scat searches	Person hours	6	6						12.00
Arboreal	Elliott traps – Size B	Trap nights	132	132						264
	Spotlighting	Person hours	23	11.5						34.50
	Stagwatching	Person hours	14	5						19.00
Bats	Anabat call detection	Person hours	2	1.5				120		123.50
	Harp Trapping							24		24

Southern Brown Bandicoot and Long-nosed Potoroo

Cage traps measuring 400 x 200 x 200 mm were used to survey for Southern Brown Bandicoot (*Isoodon obesulus*) and Long-nosed Potoroo (*Potorous tridactylus)*. Five transects consisting of 10 traps per line (total of 416 trap nights) were placed in areas where conical-shaped forage diggings were recorded, or in areas in which dense shrub vegetation bordered areas of more open foraging habitat. The traps remained open for two periods consisting of four nights each separated by two nights on which traps were closed. A plastic bag was placed over the closed end of the trap on those nights in which rain was expected in order to keep any captured animal dry and warm. Each trap was baited with a mixture of honey, rolled oats and peanut butter. Any animals captured were identified to species and released at the capture site. No animals were captured for which the accuracy of identification could not be guaranteed.

Squirrel Glider and Yellow-bellied Glider

Tree-mounted Elliott Traps (Size B: 320 x 100 x 100 mm) were used to target Squirrel Gliders (*Petaurus breviceps*) and Yellow-bellied Gliders (*Petaurus australis*). Four transects of between eight and nine traps (a total of 264 trap nights) were mounted on wooden brackets screwed to trees in woodland. approximately two metres above the ground. Traps were secured to the bracket using rubber bands and plastic bags were placed over the closed end of the trap on those nights in which rain was expected in order to keep any captured animal dry and warm. The traps remained open for two periods consisting of four nights each separated by two nights on which traps were closed. Each trap was baited with a mixture of honey, rolled oats and peanut butter and a mixture of honey and water (1:2) was sprayed liberally each day onto the tree trunk above and below the trap. The location of transects is shown in *Figure 3.4*.

Any arboreal mammals captured were placed into a cloth bag and kept in a dark quiet location before being released at the capture site at dusk. Each animal captured was identified to species and weighed. Where animals identified as Sugar Gliders were captured, both hair and faeces samples were taken and sent to Barbara Triggs of Dead Finish for identification.

Spotlighting for mammals was undertaken at night to target the Squirrel Glider and Yellow-bellied Glider. Meander transects were walked for one hour by each ecologist over six nights (total of 34.5 person hours) during the main survey period using a 100 watt 12 volt spotlight. Meander transects were concentrated along the creeklines, slopes and ridge tops in woodland areas within Lot 802. Animals were identified to species using 40 x 8 binoculars.

A requirement of the DGRs of DEC was the use of call playback to elicit responses from Yellow-bellied Gliders that would not otherwise be recorded using spotlighting techniques. The technique was not used as Yellow-bellied Gliders were recorded continually calling across the subject site, making the use of this technique redundant.

Stagwatching was also undertaken to target these species. Hollow-bearing trees, both alive and dead, were identified during the day in areas of known arboreal mammal activity. Each of these trees was visually surveyed using a 100 watt 12 volt spotlight for emergence of animals around the time of dusk for 40 to 60 minutes. Animals seen emerging from hollows were identified to species using 40 x 8 binoculars.

Threatened Microchiropteran Bats

Threatened microchiropteran bats were surveyed using Anabat detectors. The species of particular interest were Large-footed Myotis (*Myotis adversus*), Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Eastern Freetail-bat (*Mormopterus norfolkensis*), Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*), Greater Broad-nosed Bat (*Scoteanax rueppellii*), Large Bentwing Bat (*Miniopterus schreibersii*) and Large-eared Pied Bat (*Chalinolobus dwyeri*). Anabat detectors with delay units were left overnight for three nights in flyways and along creeklines. One detector was used on two nights and two detectors on an additional night.

Stagwatching at hollow-bearing trees, both alive and dead, was undertaken in areas suitable for bat roosts. Each stag was then surveyed using a hand-held Anabat detector from dusk for 40 to 60 minutes (total person hours 3.5) for a total of four nights over the main survey period.

Bat tapes were analysed by Glenn Hoye of Fly By Night Bat Surveys Pty Ltd.

Rain during the main survey period meant that weather conditions were not ideal for detecting microchiropteran bat activity. Consequently, further studies to ascertain the use of the subject site by threatened bats were undertaken by Glenn Hoye of Fly By Night Bat Surveys Pty Ltd using a methodology discussed with and approved by Doug Mills of DEC. Harp trap and echolocation call detection surveys were undertaken at the subject site over three nights between 10 and 14 December 2004. A full report detailing these additional surveys was provided as an addendum to the SIS submitted in 2005 (ERM 2005).

Invertebrates

Giant Dragonfly

Giant Dragonfly habitat mapping was undertaken in May 2005 by GHD (GHD 2005d) after the species was recorded on the subject site in December 2004.

3.8 *WEATHER CONDITIONS*

Weather conditions were recorded on survey data sheets for all surveys. Additionally weather data for the survey periods was obtained from the Bureau of Meteorology Point Perpendicular Weather Station. Survey specific weather data is shown on data sheets in Volume 2 of the SIS. Summary weather conditions for the main study period are given in Chapter 4.

3.9 *NOMENCLATURE*

Vegetation communities were classified and named according to height, percentage cover and dominant species at the subject site in accordance with Specht (1981).

Naming conventions for scientific and common names follow those of:

- Plants: Harden 1992, 1993, 2000, 2002 or Sydney Royal Botanic Gardens;
- Amphibians and reptiles: Cogger (1992);
- Birds: Pizzey and Knight (1999);
- Bats: Churchill (1998); and
- Other mammals: Strahan (1995).

3.10 *ASSESSMENT OF CONSERVATION SIGNIFICANCE*

The following areas were assessed for conservation significance to provide a comparison between habitats in the study area:

- woodland and forest communities;
- sedgeland and grassland communities;
- heathland communities;
- wetlands;
- subject site; and
- study area.

A semi-objective rating system was used to assign conservation significance on the subject site and in the study area. This involved ranking the following characteristics as well as noting special habitat features such as size of the area assessed:

- **Connectivity**: 0 = cleared / no connectivity, 1 = partial connectivity, 2 contiguous with vegetation in the vicinity;

- **Significant Species**: 0 = not present / unlikely, 1 = habitat present / significant species not recorded, 2 = habitat present / significant species recorded / likely;

- **Significant Vegetation Communities / Habitat**: 0 = not present, 1 = present;

- **Conservation Status**: 1 = represented in conservation reserves / wide distribution, 2 = not represented in conservation reserves / limited distribution; and

- **Ecological Integrity:** relates to the intactness of vegetation, proportion of weeds, representation of vegetation layers, potential fauna habitat. The higher the score the higher the ecological integrity**.** 0 = poor, 1 = moderate, 2 = good, 3 = high.

The scores for each area were summed and areas were ranked to provide a comparison of conservation significance within on the subject site and in the study area. These scores are not intended to be viewed necessarily as a definable quantity but rather are indicators of extent and condition.

3.11 EFFICACY OF ASSESSMENT METHODOLOGY

It is considered that appropriate methodology, during the most appropriate season, was used during these surveys to target threatened fauna and flora. Nonetheless, all studies are limited in their ability to detect all species on all occasions and these limitations are discussed below. As a result of the inherent limitations, a precautionary approach has in general been applied. Threatened species for which reliable records are available, and for which suitable habitat occurs on the subject site, were considered to be present in the area and impacts on these species are considered even if they were not detected during these current surveys.

3.11.1 General

Although surveys were undertaken over several months and several periods it was not possible to survey all neighbouring areas and therefore aerial photography and satellite imagery interpretation were used to aid in the determination of the likely vegetation communities and habitat types in the locality. The likelihood of species occurring in the locality was assessed through interpretation of this information with the integration of known populations of threatened species in the area. However, some surveys were extended into the neighbouring JBNP and these were targeted at detecting *Melaleuca biconvexa* and *Prasophyllum affine* (refer *Figure 3.1* and *Figure 3.2*).

3.11.2 Flora

In general the targeted surveys for threatened flora species were undertaken during the known flowering period using well developed survey methodology, thereby increasing the opportunity for these species to be detected. Undertaking surveys during the flowering period is especially important for small and / or cryptic species as detection outside of the flowering time may be difficult or impossible. For those species for which the precise flowering period and well developed survey methodology were not available, i.e. *Galium australe* and *Rhizanthella slateri*, the current best practice techniques were employed at the most likely time of flowering.

3.11.3 Fauna

Standard practices were used to collect data relating to fauna and were based largely on guidelines developed by NPWS (1999), requirements as outlined in the DGRs of DEC and through discussions with species experts. However, as with all studies there were limitations and as a consequence, a precautionary approach has generally been applied.

In relative terms these studies were undertaken over a short time span. Species that are secretive or occur at low densities, can be difficult to detect and often require surveys to be carried out over several seasons and even years. Consequently, this may have resulted in low captures or non-detection for some target species during these surveys.

Unsuitable weather conditions often contribute to low detection rates of some fauna. Whilst fine, warm weather after a period of rain probably contributed to the detection of targeted threatened orchids during October, early November and late December, a period of rain during the main survey period of November / December may have resulted in low detection of some species. For example, some rain on all but two nights precluded the use of all-night Anabat detection and probably reduced the activity level of bats during the SIS surveys. The wet weather conditions also meant that all traps were covered with plastic bags for most of the trapping nights to ensure that any captured animals remained dry and warm. This may have resulted in reduced trapping success, as some fauna may be inhibited by the presence of rustling plastic. Conversely, the wet and warm weather conditions would have increased the chances of detecting the presence of such species as the Giant Burrowing Frog, which is active during periods of rain.

Weather conditions during the September 2004 bird surveys were variable with fine weather generally experienced during the day but deteriorating in late afternoon and evening. Five of the six survey days experienced either rain, thunderstorms or very strong winds, or all three.

4 RESULTS

4.1 INTRODUCTION

This chapter places the subject site into a regional and local context and provides details of the vegetation communities, fauna habitats and species that are known from, or likely to occur in, the study area and adjacent environments. It includes a discussion of both protected and threatened flora and fauna, including those species listed under the TSC Act and EPBC Act.

4.2 THE LOCALITY

Location and Topography

The subject site is situated on the south coast of New South Wales in Vincentia in the Sydney Basin Biogeographic Region (Environment Australia 2003) and the botanical subdivision of the South Coast (Harden 2000). The Sydney Basin Biogeographic Region consists of soils of sandstones and shales from Permian to Triassic age. The locality is defined as a 10 km radius around the subject site.

Climate

Weather data were obtained from the Bureau of Meteorology (BOM) Jervis Bay (Point Perpendicular Lighthouse) weather station approximately 12 km to the north-east of the study area.

Weather during the threatened plant surveys of October to November 2003 was generally fine and warm with minimal rainfall. Weather during the November / December 2003 flora and fauna surveys was wet, with rain recorded most days. Consequently, surveys for bats were often hampered or not possible and additional bat surveys were then conducted between 10 and 14 December 2004 during ideal weather conditions. Although not evident from the rainfall data for Point Perpendicular, rainfall was also experienced during bird surveys conducted in September 2004.

Table 4.1 Weather Conditions During the Survey Periods

Survey Period		Oct 2003									Nov 2003									
Day	21	22	23	4	5	6	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Temperature 9am (°C)	21	14.2	14.3	17.2	16.4	19.2	15.8	17.2	20	21.6	19.4	16.2	14.2	13.3	13.7	14.8	14.5	16.6	19.4	20.6
Relative Humidity 9am (%)	48	85	77	68	90	68	73	80	74	87	93	100	97	97	97	84	88	79	67	79
Wind Direction 9am (°)	310	180	230	360	310	310	310	180	20	360	200	200	180	180	180	180	180	160	360	360
Wind Speed 9am (km/hr)	13	27.7	3.6	22.3	7.6	7.6	25.9	14.8	13	11.2	1.8	18.4	29.5	27.7	29.5	48.2	22.3	7.6	25.9	31.3
Cloud Cover am (8ths of sky)	1	7	4	3	1	8	5	7	1	3	8	8	8	8	7	6	8	3	1	5
Max Temperature (°C)	25.9	16.9	18.3	20.5	23.6	23.6	18.3	20	24.7	27.4	20.4	16.8	16.4	16.2	16.8	17.8	18.2	19.9	23.7	24.9
Min Temperature (°C)	12.7	13	11.2	13.4	13.4	16.1	12.9	13.7	14.7	18.1	18	15.8	13.2	12	12.3	12.9	14.3	14.5	17.2	17
Rainfall (mm)	0	3.7	0	0	0	0.1	13.4	0.9	0.1	0.1	2.3	22.2	19.8	9.5	17.3	10.6	2.3	2.4	0	0
Temperature 3pm (°C)	25.4	14.9	17	20	21.4	21.7	17.5	17.5	23.2	21.4	18.3	16.1	16.4	15.4	14.3	17.3	15.7	19.5	22.5	22.9
Relative Humidity 3pm (%)	57	67	77	70	62	53	58	81	74	85	97	94	84	75	94	69	81	72	78	82
Wind Direction 3pm (°)	7.6	14.8	18.4	37.1	22.3	18.4	27.7	18.4	18.4	29.5	7.6	25.9	37.1	29.5	37.1	25.9	37.1	22.3	38.9	44.3
Wind Speed 3pm (km/hr)	360	130	360	20	70	250	180	180	50	20	180	180	180	180	180	180	180	50	20	20
Cloud Cover pm (8ths of sky)	4	8	7	0	2	8	3	3	2	8	8	8	7	7	8	4	7	1	2	7

Survey Period				Dec 2003					Jan 2004					Sep 2004			
Day	1	2	3	4	5	29	30	31	15	16	6	7	8	9	10	11	12
Temperature 9am (°C)	24.8	16.5	20.7	21.1	16.8	20	22.7	23.3	18.7	20.7	12.3	15.4	18.5	16.2	15	16.1	11.1
Relative Humidity 9am (%)	57	99	92	85	94	79	79	85	86	85	65	68	77	60	62	53	46
Wind Direction 9am (°)	340	200	360	340	180	130	340	360	200	0	0	360	360	270	270	360	270
Wind Speed 9am (km/hr)	16.6	7.6	18.4	14.8	48.2	3.6	16.6	20.5	3.6	0	0	15	28	37	15	28	19
Cloud Cover am (8ths of sky)	8	8	8	2	8	4	0	7	8	8	4	1	6	3	3	3	4
Max Temperature (°C)	25.5	21	22.5	25.9	17.1	23.3	25.7	26.4	24.9	22.2	17.2	19.6	24.2	19.8	18.4	21.2	14.1
Min Temperature (°C)	18.8	16	16.3	16.6	16.8	18	18	20.9	17	17.7	7.6	9.3	14.5	13.6	10.9	11.1	8
Rainfall (mm)	0	11.3	0.1	14.5	1.8	0.3	0	0	0	0	0	0	0	0	0	0	0
Temperature 3pm (°C)	18.5	20.1	20.8	24.6	16.4	23	25	26.4	24.4	20.5	15.9	17.1	23.6	19.3	17.7	20.9	13.5
Relative Humidity 3pm (%)	96	88	91	78	80	74	76	79	64	95	57	71	35	34	56	32	41
Wind Direction 3pm (°)	33.5	9.4	14.8	11.2	29.5	22.3	40.7	5.4	27.7	0	315	45	360	270	0	315	270
Wind Speed 3pm (km/hr)	180	50	20	70	160	50	340	50	50	0	19	19	46	28	0	46	28
Cloud Cover pm (8ths of sky)	8	7	8	3	8	0	0	8	3		5	5	5	3	0	8	5

1. Source: Bureau of Meteorology (BOM)

This report therefore assumes the presence of species that may have been undetectable where potential habitats occur on site. This has enabled the formulation of mitigation measures for such species as a precautionary measure.

Successful flowering and reproduction of the Jerivs Bay leek Orchid is thought to be dependent on favourable weather and habitat conditions, although the factors that influence flowering behaviour are poorly understood. Those years for which rainfall has been above average have generally resulted in flowering.

Leek orchids do not always flower annually when rainfall has not occurred prior to the flowering period (NPWS 2003c). In this instance the above average rainfall prior to the 2003 flowering period maximised the opportunity that a good representation of the population of *P. affine* on the subject site was recorded.

Soils

Permian age sandstones and siltstones dominate Shoalhaven geology. In the Vincentia area there are two major geological formations. The low-lying areas are covered with deep Quaternary sands, while elevated areas consist of sandstones of the Shoalhaven Group. The Shoalhaven Group is present as two formations. Gently sloping land to the north-west is underlain by the softer Wandrawandian Siltstone Formation, while the more steeply sloping land to the south-west has the much harder sandstone of the Snapper Point Formation (SCC 1996).

Most of the soils of the Shoalhaven are moderately to strongly acidic, with poor nutrient status and low water holding capacity (SCC 2002). In the Vincentia area, soil depths range from 0.10 m to greater than 10 m, depending on their topographical location. A band of deep sandy soils, formed in colluvium at the base of sloping land, occurs on either side of the Wool Road. Wetland soils are more complex, with a sequence of sands, sediments, residual soils and underlying sandstone (SCC 1996).

Drainage

Vincentia drainage is divided into three main catchments, the largest being in the north. The northern catchment covers over half of the Vincentia area and drains into environmentally sensitive areas. Two smaller catchments occur in the east and the west. The western catchment has no well defined watercourses, while the eastern catchment drains directly into Jervis Bay (SCC 1996).

Three watercourses flow through the Vincentia area in a northerly direction, discharging into two wetlands which drain into Moona Moona Creek and then into Jervis Bay Marine Park (SCC 1996).

Vegetation and Habitat

The Shoalhaven region is dominated by eucalypt forests and woodlands, with cleared land prevalent in the alluvial valleys and close to the coast (SCC 2002). The Jervis Bay area provides habitat for a number of rare and threatened plants and a number of vegetation communities are of conservation significance due to their limited distribution (SCC 1996).

Broad vegetation structures identified within the Vincentia locality include Open Forest, Woodland/Open Forest, Woodland, Closed-Open Heathland/Mallee, Closed Heathland/Low Shrubland Closed Sedgeland and Wetland communities (SCC 1996).

Regional and Local Connectivity

The subject site is located on the coast in the southern part of the Sydney Basin Biogeographic Region. Migratory species would be able to use the relatively extensive areas of natural bushland on the south coast to travel both north to south and from the east to the higher elevations on the Great Dividing Range to the west.

Connectivity within the locality is also relatively good for highly mobile migratory species due to the extensive areas of native bushland. Patches of bushland would also be important resting and foraging areas for migratory species as well as dispersal areas for more sedentary species.

- Corridor routes in the locality that are likely to be used most frequently by migratory or nomadic species on the south coast include:

- North-south: from the Conjola State Forest, Cudmirrah and Conjola National Parks in the south, through Jervis Bay Nature Reserve and north through the subject site and JBNP and Currambene State Forest in the north; and

- East-west: from Yerriyong State Forest and Morton National Park through vegetated areas to the subject site and JBNP.

These routes provide stepping-stones and habitat corridors facilitating movement, for example between the upper and lower Shoalhaven.

Four regional habitat corridors are identified in *Jervis Bay Our Future Our Heritage* (SCC and Department of Planning 1992) which essentially link major habitat areas within the Jervis Bay region. Of particular relevance to the subject site are HC3 and HC4 habitat corridors, which lie to the east and west of the proposed development respectively (*Figure 4.1*). The subject site was not included in the HC3 and HC4 corridors as it had been previously identified as a potential development area. Therefore the current proposal, with the conservation of habitat within the EZ, will add additional areas of vegetation to the HC3 and HC4 corridors identified by SCC and Department of Planning (1992). The habitat corridors provide a critical link between JBNP and the Booderee National Park to the south-east on the Bherwerre Peninsula. The narrow vegetated corridor between the Vincentia and Erowal Bay townships has been identified as a 'choke' point where habitat corridors become bottlenecked.

At a local level the subject site currently forms part of a habitat corridor linking JBNP and the Booderee National Park. This corridor connection is especially important given the encroachment of development to the east from Vincentia and west through rural residential development and to the south-west at the Heritage Estate site. The various corridors at a regional and local scale are shown on *Figure 4.1*.

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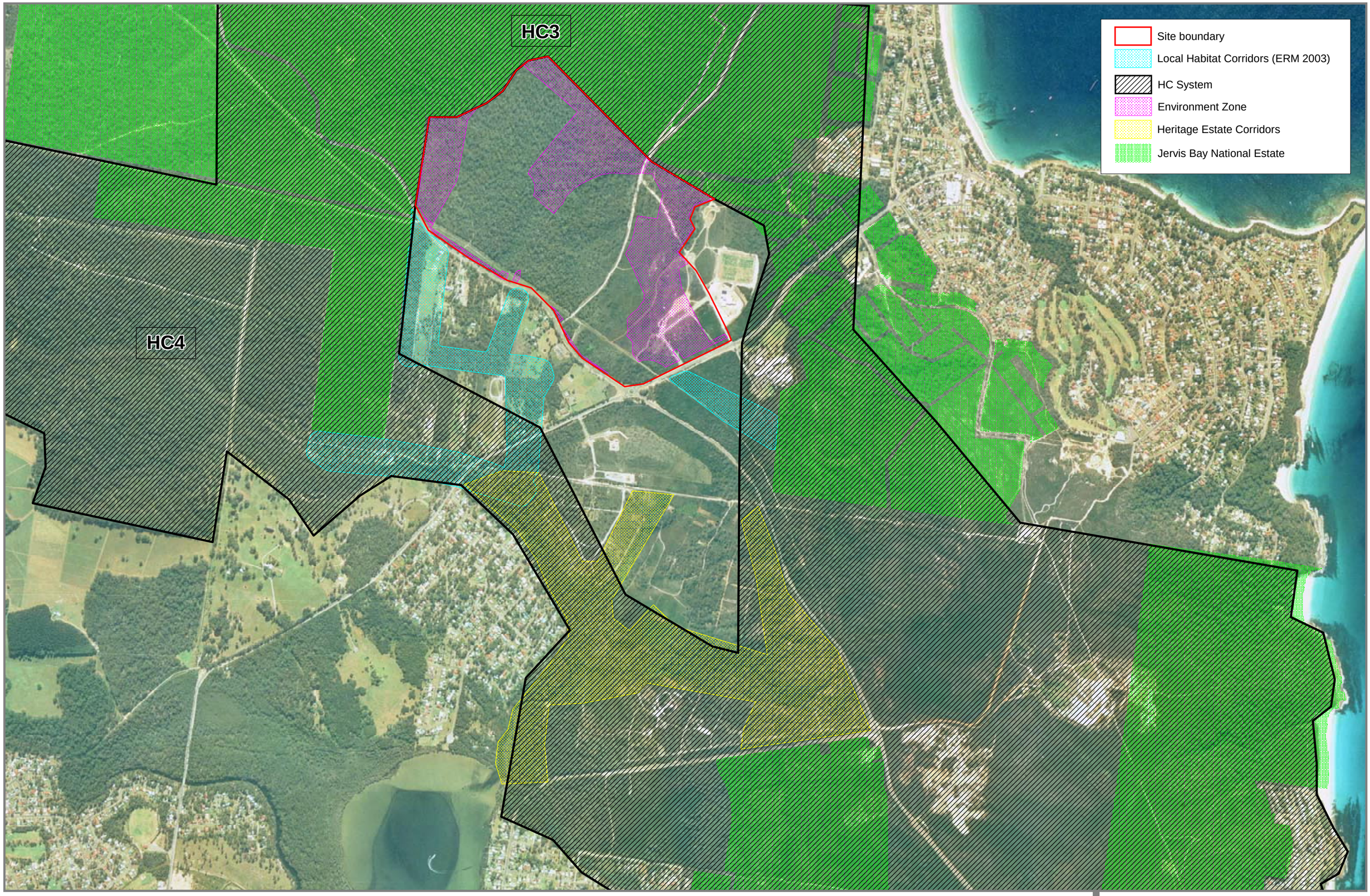

Figure 4.1

Habitat Corridors

Vincentia
Species Impact Statement

4.3 SUBJECT SITE

The subject site comprises all areas within the property boundary and is shown in *Figure 1.1*. It includes the area that would be directly impacted by the proposal, namely the development footprint areas and the Asset Protection Zones.

General Environment

The subject site is approximately 127 ha of undulating slopes and low-lying areas that support a wide variety of native vegetation types, native fauna species and their habitats. The subject site has experienced various minor disturbances in the past including altered fire regimes, minimal selective logging, clearing for unformed tracks and roads and feral animal activity. The subject site supports a range of habitat types including open-forest, heathland, sedgeland and cleared areas. The drier woodlands and forests in the north of the subject site merge with the wetter heath and sedgeland communities in the south. Introduced plant species are locally abundant in areas that have been disturbed such as along cleared road and track edges and powerline easements. A list of native and introduced plant species recorded on the subject site is provided as *Annex C*.

The subject site is part of a regional connectivity and dispersal corridor. It forms part of a habitat corridor between areas in the upper and lower Shoalhaven LGA, for highly mobile migratory and nomadic species such as birds and insectivorous bats, as well as local dispersal habitat for plants and sedentary or territorial birds, mammals, amphibians and reptiles.

The subject site is part of a larger mosaic of native vegetation and fauna habitat within the locality, including the adjacent JBNP and Booderee National Park to the south-east. The impacts of the proposal are therefore considered in this SIS in terms of threatened species and their habitats within the locality and region.

Fire History

Regional Perspective

The subject site is bushfire prone and has been mapped as bushfire prone land by Shoalhaven City Council. According to BES (2004) the Shoalhaven area has one of the highest incidences of bushfires in NSW, accounting for approximately half of the unplanned fires in the southern region of NSW. Major bushfire events occur frequently in the locality of the subject site, and four significant bushfires have occurred in the area over the past decade. Many of the recent fires have had periods of high intensity fire behaviour with the potential to cause loss of property. Many residential buildings and sheds were damaged or destroyed by the bushfires in the 2001 "Hylands Fire" in nearby villages of Huskisson, Falls Creek and Woollamia.

Subject Site

The most recent bushfire in the local area occurred in the summer of 2004-2005. The site at Vincentia was not burned during this event, but has been subject to both unplanned fires and hazard reduction burns in the past. A large proportion of the subject site was burned in the bushfires of 2001. Therefore, the majority of the site would now be of a post-fire age of approximately two years.

In addition to unplanned fires, Gunninah (2002) attributes alteration of the structure and diversity of vegetation communities within the subject site to regular hazard reduction burns.

Extensive areas of bushland are reserved in adjoining National Parks and Nature Reserves. The risk of bushfire will therefore be an ongoing threat to the proposed development and this has been assessed by BES (2004).

Major Habitat Features

The subject site is relatively undisturbed and provides a mosaic of habitat types for native flora and fauna. Disturbance was generally limited to a cleared area within Lot 801 that consisted of bare ground, as well as access roads and tracks through Lot 801 and Lot 802. Some selective logging had occurred in the past as the occasional cut stump was recorded in the woodland areas. All vegetated areas of the subject site were dominated by native flora species.

Lot 802 is dominated by woodland, which occurs predominantly to the west of Moona Creek Road and provides habitat for a diversity of species. Trees in this area are of various ages, providing fauna with a range of shelter and foraging resources. Tree hollows are abundant within the woodlands and provide nesting habitat and shelter for a range of arboreal mammals and bird species. Areas of woodland dominated by *Allocasuarina littoralis* provide foraging resources for cockatoos such as the Glossy Black-cockatoo (*Calyptorhynchus lathami*) and the Yellow-tailed Black-cockatoo (*C. funereus*).

Fallen branches and logs are relatively abundant within the woodland areas, providing resources for ground dwelling mammals such as *Antechinus* and *Rattus* species and a variety of reptiles. The occurrence of dense ground vegetation interspersed with open areas provides habitat for ground mammals such as Bandicoots.

Heathland occurs within Lot 802 to the east of Moona Creek Road and across much of Lot 801. Heathland is not a common vegetation community on the South Coast (SCC 1991), and as such provides a unique set of resources for the flora and fauna species of the subject site.

Three watercourses flow through the subject site, flowing north-east through a variety of vegetation communities and eventually draining into adjacent wetlands. The presence of fringing vegetation and pools of various depths along the length of the watercourses provides a diversity of habitats for amphibian and aquatic species.

4.4 STUDY AREA

The study area is defined as the subject site plus areas that could be indirectly affected by the proposal (*Figure 1.1*). The study area includes a zone of continuous bushland around the subject site and the two wetlands within the catchment of the subject site. This is an arbitrarily defined study area that aims to encompass direct and indirect impacts to threatened species and their habitats. The zone around the subject site aims to include consideration of bushland that could be subject to potential indirect impacts associated with edge effects. These impacts include:

- increased competition and predation by domestic or feral predators;
- altered noise and light regimes,
- micro-climate changes (solar radiation, humidity, air temperature, wind speed and soil temperature);
- changes in vegetation and wildlife brought about by weed invasion;
- disturbance of roosting areas; and
- human disturbance (e.g. access, rubbish dumping and fire wood collecting).

The two wetlands are included within the study area because they have the potential to be affected by changes in hydrology resulting from development on the subject site. Other potential indirect impacts such as changes to fire regime and habitat fragmentation are more closely associated with landscape functions.

Wetlands

The two wetlands to the north of the subject site, Wetlands No. 325 and No. 324, were former SEPP 14 Wetlands before being incorporated into JBNP. As a part of a wetland inventory, SCC funded a number of studies aimed at gathering data on the biological significance of SEPP 14 wetlands in the southern region of the Shoalhaven LGA. As a part of these studies changes to the natural boundaries of Wetlands No. 325 and No. 324 were mapped by interpretation of aerial photography. Overall wetland areas were found to have increased from 1981 to 1997 by 10.5 % and 18.5 %, respectively. Such an increase may reflect natural spatial and temporal variation or may be a consequence of changes to the hydrology in the area over this time.

4.5 VEGETATION COMMUNITIES

Vegetation types of the subject site include open-woodland, woodland, open-forest, sedgeland, closed-sedgeland, heath and grassland. Disturbance is limited to the boundaries of cleared and developed areas, a transmission line easement which lies parallel to Jervis Bay Road, and the verges of unformed tracks.

Vegetation communities of the subject site are shown in *Figure 4.2* and listed, along with their area in hectares, in *Table 4.2*. Detailed descriptions of the vegetation communities are provided as *Annex D*.

Vegetation communities described by Mills (1993) that correspond with those identified within the subject site are also shown in *Table 4.2*. Vegetation mapping undertaken by Mills (1993) was reviewed for consistency, but due to the large scale of the mapping project, it was not the final determinant in identification of vegetation communities of the subject site. Shoalhaven City Council is currently mapping the vegetation of the LGA, and will use a single classification system for the whole of the Shoalhaven, incorporating the mapping of Mills (1993). However, this is currently in draft form and no data are available.

The vegetation communities recorded across the study area include:

- Open-forest Communities

The open forest communities on the subject site corresponded to Community 5.2 *Eucalyptus maculata* Forest of Mills (1993), which is widespread in the Jervis Bay region, including on plateaus and within gullies.

1. ***Corymbia maculata / Eucalyptus globoidea*** **Open-forest** occurred on the lower and upper slopes on either side of the Central creek. Dominant trees included tall mature *Corymbia maculata* and *Eucalyptus globoidea*. This community graded into woodland communities dominated by *E. sclerophylla* woodland towards the upper slopes and into *Eucalyptus longifolia* Open-woodland along Central creek. It had a tall shrub layer of *Allocasuarina littoralis*, a low sparse to open shrub layer and an open grassy layer with abundant *Lomandra longifolia*.
2. ***Eucalyptus globoidea / Corymbia gummifera*** **Open-forest** occurred on lower slopes in the north-west of the subject site. Dominant trees included *E. globoidea* and *C. gummifera*. This community graded into *Eucalyptus sclerophylla* Open-woodland up slope and *Eucalyptus longifolia* Open-woodland down slope along the Western creek. It had a low sparse to open shrub layer and thick grassy layer of native grasses, sedges and herbs. Minimal selective logging had disturbed the woodland, but no introduced flora species were present.

- Woodland Communities

3. ***Eucalyptus sclerophylla / Corymbia gummifera*** **Woodland** occurred on the north-west facing slopes in the western part of the subject site. Dominant trees included mature *E. sclerophylla* and *C. gummifera*. This community graded into open-woodland with a sedge dominated ground layer on the lower slopes, open-woodland to the north and forest to the east on east-facing slopes. It had a low shrub layer and a thick ground cover of native grasses, sedges and herbs. Minimal selective logging had disturbed the Woodland and introduced species occurred along tracks. The total weed cover in the community was estimated to be 1 %.

4. ***Eucalyptus sclerophylla / Eucalyptus globoidea*** **Woodland** occurred on the lower slopes adjacent to the Central creek. Dominant species included *E. sclerophylla* and *E. globoidea*. This Woodland had a relatively open shrubby layer and a dense grassy layer, as well as stands of *A. littoralis*. Minimal selective logging had disturbed the Woodland and introduced species occurred along tracks. The total weed cover in the community was estimated to be 1 %.

5. ***Eucalyptus sclerophylla / Corymbia gummifera / Eucalyptus globoidea*** **Woodland** occurred on mid slopes. It had a tall, patchy shrub layer of *A. littoralis* and a lower diverse shrub layer. The ground layer consisted of native grasses, sedges and herbs. This community graded into open-woodland and heathland. Minimal selective logging and car dumping had disturbed the woodland and introduced species occurred along tracks. The total weed cover in the community was estimated to be 1 %.

6. ***Eucalyptus sclerophylla*** **Woodland** occurred on mid slopes adjacent to Jervis Bay Road. This community had been patchily burnt. However, tree ferns, wet sclerophyll species and relatively tall *Hakea teretifolia* provide evidence that some patches have remained unburned for a relatively long time. This community graded into heathland and occurred adjacent to sedgeland. The shrub layer was tall and open to very dense and the ground layer was very dense and dominated by native grasses and herbs. This Woodland had been disturbed by past clearing and introduced species occurred along tracks and transmission line easements. The total weed cover in the community was estimated to be 1 %.

The above four Woodland communities corresponded to Community 5.4 *Eucalyptus sclerophylla/Eucalyptus gummifera* Forest of Mills (1993), which has been mapped on broad ridges in the north of the Jervis Bay region.

7. ***Eucalyptus robusta* Woodland** was a narrow community that occurred along the drainage line in the north-east of Lot 802 and adjacent to Lot 801. Dominant tree species included *E. robusta* and other trees included *E. sclerophylla* and *Syncarpia glomulifera*. The understorey layer was relatively dense and dominant species included *Melaleuca linariifolia* and *Acacia longifolia*, sedges and riparian species along the creek. The total weed cover in the community was estimated to be 1 %.

This community corresponded to Community 3.2 *Eucalyptus robusta* forest – woodland of Mills (1993), which is a botanically significant vegetation community in the Jervis Bay region because it has limited occurrences and can contain wetland habitats. It is also considered to be Sydney Coastal Estuary Swamp Forest Complex (now referred to as Swamp Sclerophyll Forest) and this is discussed in Section 4.5.2.

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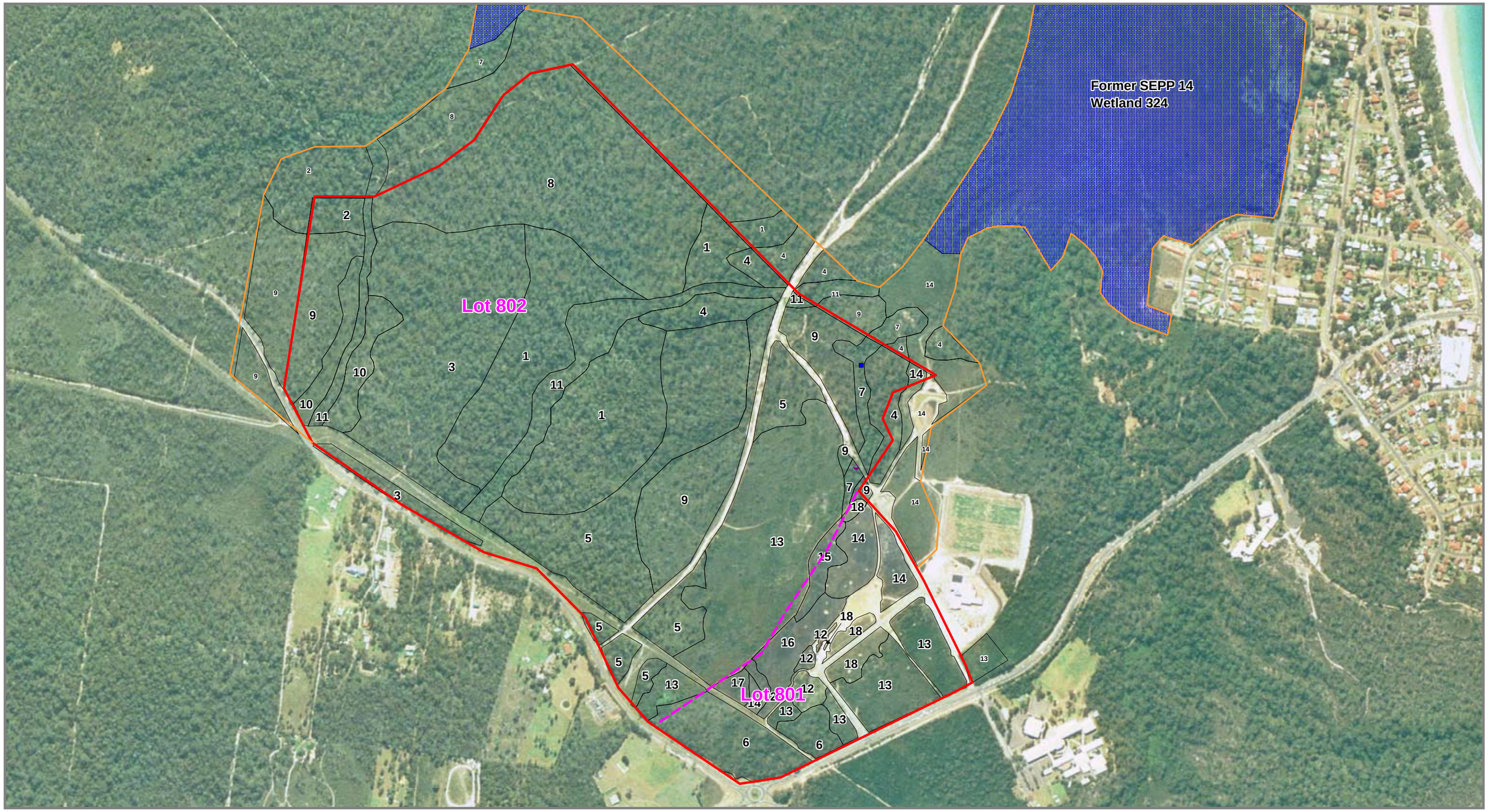

Open-forest Communities

1 Corymbia maculata/Eucalyptus globoidea	Open-forest
2 Eucalyptus globoidea/ Corymbia gummifera	Open-forest

Woodland Communities

3 Eucalyptus sclerophylla/Corymbia gummifera	Woodland
4 Eucalyptus sclerophylla/Eucalyptus globoidea	Woodland
5 Eucalyptus sclerophylla/Corymbia gummifera/Eucalyptus globoidea	Woodland
6 Eucalyptus sclerophylla	Woodland
7 Eucalyptus robusta (SCESFC)	Woodland

Open-woodland Communities

8 Eucalyptus sclerophylla/Corymbia gummifera	Open-woodland
9 Eucalyptus sclerophylla	Open-woodland
10 Eucalyptus sclerophylla	Open-woodland (sedge and tick bush understory)
11 Eucalyptus longifolia	Open-woodland

Low-open Woodland

12 Eucalyptus sclerophylla	Low Open-woodland

Heathland Communities

13 Banksia ericifolia/Hakea teretifolia	Heathland

Sedgeland and Grassland Communities

14 Xanthorrhoea resinifera	Sedgeland
15 Anisopogon avenaceus	Grassland
16 Lepidosperma laterale	Sedgeland
17 Baumea articulata	Closed Sedgeland
18 Anisopogon avenaceus/ Lomandra filiformis	Grassland

Subject site boundary
Study area boundary
Bore hole 9
Test pit 5

ERM

0 350 700
Metres

Figure 4.2 **Vegetation Communities**

Vincentia
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Table 4.2 Vegetation Communities and Approximate Areas (ha)

No.	Vegetation Community	Subject Site	Study Area	Corresponding Vegetation Community of Mills (1993)
	Open-forest Communities			
1	*Corymbia maculata/Eucalyptus globoidea* Open-forest	17.9	18.6	Community 5.2 *Eucalyptus maculata* forest
2	*Eucalyptus globoidea/Corymbia gummifera* Open-forest	0.9	3.6	Community 5.2 *Eucalyptus maculata* forest
	Woodland Communities			
3	*Eucalyptus sclerophylla/Corymbia gummifera* Woodland	15.5	15.5	Community 5.4 *Eucalyptus sclerophylla/Eucalyptus gummifera* forest
4	*Eucalyptus sclerophylla/Eucalyptus globoidea* Woodland	3.7	5.5	Community 5.4 *Eucalyptus sclerophylla/Eucalyptus gummifera* forest
5	*Eucalyptus sclerophylla/Corymbia gummifera/Eucalyptus globoidea* Woodland	14.7	14.7	Community 5.4 *Eucalyptus sclerophylla/Eucalyptus gummifera* forest
6	*Eucalyptus sclerophylla* Woodland	4.4	4.4	Community 5.4 *Eucalyptus sclerophylla/Eucalyptus gummifera* forest
7	*Eucalyptus robusta* Woodland*	1.3	2.7	Community 3.2 *Eucalyptus robusta* forest – woodland
	Open-woodland Communities			
8	*Eucalyptus sclerophylla/Corymbia gummifera* Open-woodland	17.8	28.2	Community 5.4 *Eucalyptus sclerophylla/Eucalyptus gummifera* forest
9	*Eucalyptus sclerophylla* Open-woodland	11.1	15.9	Community 5.4 *Eucalyptus sclerophylla/Eucalyptus gummifera* forest
10	*Eucalyptus sclerophylla* Open-woodland (sedge and tick bush understorey)	2.9	2.9	Community 5.4 *Eucalyptus sclerophylla/Eucalyptus gummifera* forest
11	*Eucalyptus longifolia* Open-woodland	5.1	6.1	Community 3.3 *Eucalyptus longifolia – Melaleuca* forest – woodland
	Low-open Woodland			
12	*Eucalyptus sclerophylla* Low Open-woodland	1.0	1.0	Community 5.4 *Eucalyptus sclerophylla/Eucalyptus gummifera* forest
	Heathland Communities			
13	*Banksia ericifolia/Hakea teretifolia* Heathland	17.11	17.7	Community 4.3 Mallee- heathland
	Sedgeland and Grassland Communities			
14	*Xanthorrhoea resinifera* Sedgeland	2.71	7.9	Community 4.4 Sedgeland – heathland (fresh swamp)
15	*Anisopogon avenaceus* Grassland	0.91	0.9	Community 4.4 Sedgeland – heathland (fresh swamp)
16	*Lepidosperma laterale* Sedgeland	1.7	1.7	Community 4.4 Sedgeland – heathland (fresh swamp)
17	*Baumea articulata* Closed Sedgeland	0.4	0.4	Community 4.4 Sedgeland – heathland (fresh swamp)
18	*Anisopogon avenaceus/Lomandra filiformis* Grassland	1.2	1.2	Community 4.4 Sedgeland – heathland (fresh swamp)
	Cleared Land		10.2	
	Total		**159.1**	

1. * = Considered to be Sydney Coastal Estuary Swamp Forest Complex.

- Open Woodland Communities

8. ***Eucalyptus sclerophylla / Corymbia gummifera*** **Open-woodland** occurred on mid slopes in the northern corner of the subject site. It was dominated by mature *E. sclerophylla* and *C. gummifera* and graded into open forest and woodland communities. It had a low shrub layer and an open ground layer of native grasses, sedges and herbs. A denser shrub layer of *Leptospermum polygalifolium* subsp. *polygalifolium* occurred on the south-east facing slopes where the soil appeared to be more waterlogged. The woodland had been disturbed by minimal selective logging and introduced species occurred along tracks. The total weed cover in the community was estimated to be 1 %.

9. ***Eucalyptus sclerophylla*** **Open-woodland** occurred on mid slopes, mostly in a triangular shape west of Moona Creek Rd. It was dominated by *E. sclerophylla* and graded into woodland and heathland. It had an open, tall shrub layer of *L. polygalifolium* subsp. *polygalifolium* and a diverse, low, open shrub layer. The ground layer was open and included native grasses, sedges and herbs. The woodland had been disturbed by minimal selective logging and introduced species occurred along tracks. The total weed cover in the community was estimated to be 1 %.

10. ***Eucalyptus sclerophylla*** **Open-woodland** (sedge and Tick Bush understorey) occurred on either side of the Western creek in the north-west of the subject site. It graded into *Eucalyptus longifolia* Open-woodland along Western creek and *E. sclerophylla/Corymbia gummifera* Woodland and *Eucalyptus sclerophylla* Open-woodland. Canopy species included *E. sclerophylla*. The shrub layer was low and dense, and characteristic species included *Kunzea ambigua* and *L. polygalifolium* ssp. *polygalifolium*. This community occurred on waterlogged soils and the sedges were dominant in the ground layer.

The three communities described above corresponded to Community 5.4 *Eucalyptus sclerophylla/Eucalyptus gummifera* forest of Mills (1993), which has been mapped on broad ridges in the north of the Jervis Bay region.

11. ***Eucalyptus longifolia*** **Open-woodland** occurred along the Western and Central creeks, in the middle and western sections of the subject site. It was characterised by riparian vegetation in the shrub and ground layers. *E. longifolia* was the dominant canopy species and *M. lineariifolia* was the dominant shrub species. Dominant ground layer species included *Lomandra longifolia*, *Hydrocotyle laxiflora*, *Centella asiatica*, *Juncus continuus*, *Dampiera stricta* and *Lepyrodia scariosa*. It had been disturbed by past clearing and introduced species occurred along the transmission line easement in the south. The total weed cover in the community was estimated to be 1 %.