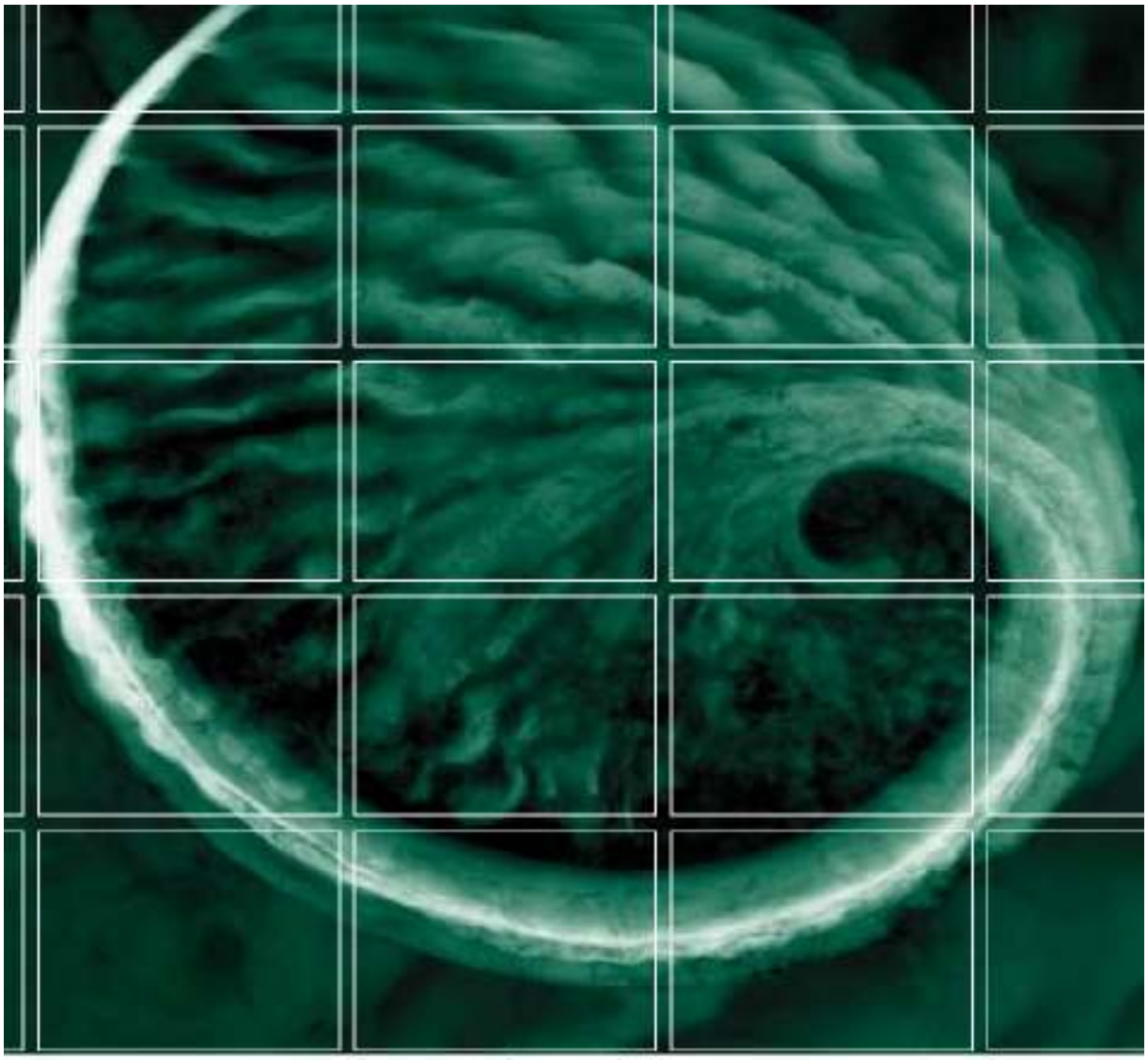
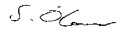
Appendix 4
Ecological Assessment
Stage 1 (ERM)



Salamander Waters Estate – Stage One

Ecological Assessment

Hill PDA

Approved by:	*Andrew Hamer*
Position:	Project Manager
Signed:	
Date:	*0 XXX, 0000*
Approved by:	*Naomi Bucchorn*
Position:	Project Director
Signed:	
Date:	*0 XXX, 0000*
Partner:	
	Steve O'Connor

Environmental Resources Management Australia Pty Ltd Quality System

Salamander Waters Estate – Stage One
Ecological Assessment

Hill PDA

First Draft

0023633

www.erm.com

CONTENTS

CONTENTS

ANNEXURES

LIST OF FIGURES

LIST OF PHOTOGRAPHS – IN ANNEX C

EXECUTIVE SUMMARY

Environmental Resources Management Australia Pty Ltd (ERM) was commissioned by Hill PDA to undertake a flora and fauna assessment for a proposed residential subdivision for Stage One of the Salamander Waters Project (Part Lot 59 DP 831253) at Salamander Bay. This report has been prepared to accompany a Development Application to be lodged for the proposed Stage One development. The aim of the ecological assessment was to assess the potential impacts of the proposed development on State and Commonwealth listed threatened and migratory species. The report addresses the performance criteria of the Port Stephens Comprehensive Koala Plan of Management.

Three vegetation communities are present on the site: coastal sand apple – blackbutt forest, swamp mahogany – paperbark forest and Lepironia *swamp. A total of 81 vascular plant species were recorded on the site. No rare or threatened flora species were found or are considered likely to occur on the site. Swamp mahogany – paperbark forest is preferred koala habitat and remaining areas of vegetation are 50 metre habitat buffer over supplementary koala habitat to the preferred and supplementary koala habitat.* Lepironia *swamp is the endangered ecological community Sydney Freshwater Wetlands in the Sydney Basin Bioregion and occurs in the southern section of the site.*

Along with swamp mahogany, which provides a food resource, hollow-bearing trees comprise an important fauna habitat resource on the site. Swamp mahogany – paperbark forest and Lepironia *swamp provides habitat for the threatened wallum froglet. A suite of threatened species have been recorded on the site including the wallum froglet, koala, squirrel glider, large-footed myotis, little bentwing-bat, greater broad-nosed bat and eastern freetail-bat. The powerful owl was recorded within two kilometres of the site. Swamp mahogany – paperbark forest along the western edge of the old Soldiers Point Road is a movement corridor for koalas and squirrel gliders. This corridor is core koala habitat that links preferred koala habitat in Wanda Wetlands Reserve to Tilligerry Nature Reserve and Stony Ridge Reserve.*

The development footprint is proposed to be restricted to the northern section of the site, in order to minimise impacts to preferred koala habitat and the Lepironia *swamp in the southern section. However, a small area of preferred koala habitat, 50 metre buffer over supplementary koala habitat and supplementary koala habitat will be removed from the northern section. The development footprint is not likely to compromise the integrity of the fauna movement corridor. Indirect impacts will be minimised by applying appropriate habitat buffers and implementing environmental management plans.*

Eight-part tests were completed for one flora species and 16 fauna species. The tests concluded no significant impacts on these species are likely, provided that mitigation measures are implemented. Likewise, no significant impacts are likely on Commonwealth Matters of National Environmental Significance, including threatened and migratory species. To offset the loss of preferred koala habitat on the site, it is recommended that a contribution be provided to the rehabilitation of habitat within the fauna movement corridor.

1 INTRODUCTION

1.1 BACKGROUND

Environmental Resources Management Australia Pty Ltd (ERM) was commissioned by Hill PDA to undertake a flora and fauna assessment for proposed residential subdivision of Stage One of the Salamander Waters Project (Part Lot 59 DP 831253) at Salamander Bay (see *Figure 1.1*). Hill PDA propose to develop 34 individual allotments with provision for access, parking, stormwater detention basins and services including sewer, power and water. Stage Two of the Project involves land south of the site. ERM prepared a report detailing the ecological constraints associated with development in the Stage Two area (see ERM 2005).

Previous flora and fauna surveys of the site and its vicinity have been undertaken by:

- ERM (2004a) Proposed rezoning Lot 2 DP 847022 Salamander Way. Ecological Assessment. Prepared for Port Stephens Council.

- General Flora and Fauna (2004) Flora and Fauna Assessment. Lot 59, DP 831253 360 Soldiers Point Road, Salamander Bay. Prepared for Port Stephens Council.

- ERM Mitchell McCotter (1999) Salamander Bay Waste Transfer Station. Environmental Impact Statement. Prepared for Port Stephens Council.

- Conacher Travers (1998) Flora and Fauna Assessment Report. Proposed residential development project Stage 16 and 17, Lot 59 DP 831253 Kanimbla Drive, Salamander Bay. Prepared for Salamander Projects Pty Ltd.

- ERM Resource Planning (1995) Fauna Impact Statement for proposed residential development at Wanda Avenue, Salamander Bay. Prepared for Port Stephens Council.

- Gunninah Consultants (1995) Salamander Residential Development Stages 24 & 25, Lot 2 DP 847022, Salamander Way. Fauna Impact Statement. Prepared for Salamander Projects Pty Ltd.

This report has been prepared to accompany a Development Application to be lodged for the proposed Stage One development. A separate report has also been prepared that details the ecological constraints and opportunities associated with development of Stage Two (herein referred to as the "constraints report"), which will accompany a Statement of Environmental Effects.

1.2 PURPOSE

The purpose of this assessment was to:

- identify the extent and distribution of vegetation communities on the site;
- assess the structural and floristic characteristics of each vegetation community;
- detect rare or threatened plant species;
- assess the extent and suitability of habitat resources for threatened fauna species on the site;
- identify the extent of koala habitat on the site according to the Port Stephens Council Comprehensive Koala Plan of Management (CKPoM) (2001), and conduct a koala spot assessment if preferred feed trees are present;
- undertake bird, mammal, reptile and amphibian censuses; and
- discuss the ecological attributes of the site with respect to potential wildlife corridors.

The locality is defined as the area within 10 kilometres of the study site.

1.3 SITE

The site comprises approximately 5.0 hectares of land and is bordered to the east and south by existing residential areas and Port Stephens Drive, to the west by the old Soldiers Point Road, and to the north by Soldiers Point Road and the waste depot. The site is zoned residential 2(a) in Port Stephens Local Environmental Plan 2000 (LEP 2000).

Drainage from the site is by overland flow into the localised wetland and ponds on the site. A constructed drain flows along the western edge of the site adjacent to the old Soldiers Point Road.

1.4 SOIL LANDSCAPE

The site is located on the Shoal Bay soil landscape as mapped and defined by Matthei (1995). The landscape comprises well-drained Pleistocene aeolian sand sheets and low dunes. Slopes are generally less than 5%, but on rolling dunes are up to 15%. The dunes are usually well drained, but minor swampy areas occur in deflation areas. The vegetation is tall open forest with tall shrub understorey. One landscape variant occurs within a small area on the site,

characterised by poorly drained Pleistocene sand sheets, with the watertable close to the surface. The vegetation is composed of *Melaleuca* swamp forest.

1.5 LEGISLATIVE REQUIREMENTS

When determining the impacts of a proposal on native flora and fauna, a number of legislative requirements must be considered. These are briefly discussed below.

1.5.1 Environmental Planning and Assessment Act 1979 and the Threatened Species Conservation Act 1995

Developments requiring approval from a Council or a statutory authority of the NSW State Government, are required to be assessed in accordance with the *Environmental Planning and Assessment Act 1979* (EP&A Act), as amended by the *Threatened Species Conservation Act 1995* (TSC Act).

Section 5A of the EP&A Act, outlines eight points which must be considered in order to determine the significance of the impact of a development on the habitat of threatened species, population and ecological communities, known or considered likely to occur in the study area and environs. This assessment is commonly referred to as an 'eight-part test'.

Where a proposed development is likely to significantly affect critical habitat of a threatened species, population or ecological community, or is in critical habitat, as defined by Part 3 of the TSC Act, a Species Impact Statement (SIS) must be prepared. If the Director-General of NSW Department of Environment and Conservation (DEC) assesses that the development will harm threatened species, populations or ecological communities, then a licence under section 92 of the TSC Act may be required. The Director-General of DEC may apply conditions to this licence.

1.5.2 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) requires approval of the Commonwealth Minister for the Environment for actions that may have a significant impact on matters of national environmental significance. The EPBC Act also requires Commonwealth approval for certain actions on Commonwealth land. Matters of national environmental significance under the Act include the following:

- World Heritage properties;
- Ramsar wetlands of international importance;
- threatened species or ecological communities listed in the EPBC Act;

- migratory species listed in the EPBC Act;
- Commonwealth marine environment; and
- nuclear actions.

There are no World Heritage properties, Ramsar wetlands, Commonwealth marine areas or nuclear actions on or near the site. The Ramsar wetland (Myall Lakes) is in the locality but the site is not within its catchment and therefore the proposed residential development cannot impact upon the wetland. There is the potential for nationally listed threatened and migratory species to inhabit or frequent the site. There are no threatened ecological communities listed under the EPBC Act within 10 kilometres of the site. There is no Commonwealth land within the locality. The nearest Commonwealth land to the site is the Williamtown RAAF base, Salt Ash Air Weapons Range and Parachute Range. The proposed rezoning will not impact upon these sites.

1.5.3 Fisheries Management Act 1994

Fisheries Management Act 1994 as amended by the *Fisheries Management Amendment Act 2001* includes provision to declare and list threatened species of fish and marine vegetation, endangered populations and ecological communities, and key threatening processes. These provisions are similar to those in the TSC Act and must be considered when referring to section 5A of the EP&A Act. An assessment of the aquatic habitat value in the proposed area of disturbance and an assessment of the impact of the proposal on aquatic habitats and threatened fish species under section 5A of the EP&A Act are required.

There are permanent, semi-permanent and ephemeral waterbodies located on the site, however they do not form permanent or intermittent streams or rivers that connect to Port Stephens or other waterways in its catchment. Therefore there is no fish passage or connecting habitat suitable for the movement of aquatic species. Fly Point and Halifax Park Aquatic Reserves occur within the locality, but they will not be affected by the proposal.

1.5.4 Native Vegetation Conservation Act 1997

The principle aim of the *Native Vegetation Conservation Act 1997* (NVC Act) is to streamline approvals and to regulate the clearing of native vegetation in NSW by making it subject to development consent. The legislation requires the assessment of proposals to clear native vegetation for the purposes of ensuring that native vegetation is protected and managed in the environmental, social and economic interests on the State.

A number of exemptions apply to the clearing of native vegetation. One of these exemptions includes clearing of native vegetation on land that is within

a zone designated "residential" (but not "rural-residential"), "village", "township", "industrial", or "business" under an environmental planning instrument. The site is zoned 2(a) Residential. Therefore, clearing of native vegetation on the site is exempt from the provisions of the NVC Act.

1.5.5 Native Vegetation Act 2003

The *Native Vegetation Act 2003* (NV Act 2003) will replace the *Native Vegetation Conservation Act 1997* when the regulations setting out how the Act will work are developed. Like the NVC Act 1997, the NV Act 2003 does not apply to land that is:

'within a zone designated "residential" (but not "rural-residential"), "village", "township", "industrial" or "business" under an environmental planning instrument or, having regard to the purpose of the zone, having the substantial character of a zone so designated'.

This means that the clearing of native vegetation within the site will be exempt from the provisions of the NV Act when it comes into force.

1.5.6 SEPP 14 - Coastal Wetlands

State Environmental Planning Policy 14 – Coastal Wetlands (SEPP 14) aim to ensure that coastal wetlands are preserved and protected in the environmental and economic interests of the State. If a proposed development is in the proximity of a wetland, the flora and fauna assessment should assess the impact of the development on the wetland, and recommend measures to minimise impacts of the proposed development.

The site is adjacent to SEPP 14 wetland no. 766, although it is separated by the old Soldiers Point Road. There are wetland areas on the site but these are not classified under SEPP 14. Therefore the provisions of the policy do not apply to the proposed subdivision. The larger of these wetlands appears to be natural, however the smaller ponds are likely to have been created from sandmining activities.

1.5.7 SEPP 44 - Koala Habitat Assessment and Port Stephens Comprehensive Koala Plan of Management 2001

State Environmental Planning Policy 44 - Koala Habitat Protection (SEPP 44) aims to:

> *'...encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas, to ensure permanent free-living populations over their present range and to reverse the current trend of population decline...'*

The practical effect of SEPP 44 is that in consideration of a development application (DA), the consent authority must ensure that approval is not issued without prior investigation of *potential* and *core* koala habitat. The policy applies to land in relation to which a DA has been made when the site has an area of more than one hectare. This policy applies to all local government areas within the known statewide distribution of the koala, including the Port Stephens Local Government Area (LGA).

Potential koala habitat is defined as vegetation that incorporates a minimum of 15% of tree species in the 'upper or lower strata of the tree component' listed in Schedule 2 of SEPP 44. A person suitably qualified in tree identification (clause 7 (2)) must assess the identification of potential koala habitat. If the subject land is not deemed to contain *potential* koala habitat, the consent authority may grant development consent. Identification of *potential* koala habitat requires further investigations to determine whether the site supports *core* habitat.

Swamp mahogany (*Eucalyptus robusta*) is listed in Schedule 2 of SEPP 44 is a key diagnostic species within the swamp mahogany – paperbark swamp forest vegetation community that is present on and adjacent to the site (CRA Unit NPWS 2000). An assessment of whether this community represents *potential* koala habitat is provided in *Section 2.8*.

Core koala habitat is defined as:

> '*...an area of land with a resident population of koalas, evidenced by attributes such as breeding females.. and recent sightings of and historical records of a koala population...*'

If the area does not support *core* koala habitat, under clause 8 of the policy the consent authority may determine the development application. If the site is determined to support *core* koala habitat, then a plan of management must be prepared and approved prior to granting development consent.

Conacher Travers (1998) undertook field investigations during September 1998 to determine whether the site supports *potential* or *core* koala habitat. Visual inspections of trees for scratch marks, searches for scats and spotlighting for individual koalas were undertaken. There was no reported occurrence or evidence of koalas using habitats within the study area. Although the site contains swamp mahogany, Conacher Travers (1998) concluded that it does not contain either *potential* or *core* koala habitat, as swamp mahogany was estimated to cover approximately 1.0% of the site.

Port Stephens Council has prepared a Comprehensive Koala Plan of Management 2001 (CKPoM) for the Port Stephens local government area (LGA) which operates under the provision of SEPP 44 (PSC 2001). The CKPoM seeks to conserve koalas over their existing range by identifying and protecting koala habitat and incorporating koala conservation into local government planning processes. The principal aim of the CKPoM is identical to that of SEPP 44.

The CKPoM identifies areas of preferred, supplementary and marginal koala habitat based on community consultation, historical records, vegetation mapping, field based surveys and identification of movement corridors between habitat areas. The site contains supplementary koala habitat (PSC 2001). Development standards and assessment criteria are outlined in the CKPoM for proposals either overlapping or adjacent to areas of preferred or supplementary koala habitat, habitat buffers or habitat linking areas.

2 METHODOLOGY

2.1 LITERATURE REVIEW AND DATABASE SEARCHES

A literature review was undertaken of relevant studies and published information for the site. Previous studies undertaken on the site and adjacent area are listed in *Section 1.1*. Vegetation mapped by the Lower Hunter and Central Coast Regional Environmental Management Strategy (LHCCREMS) vegetation mapping (House 2003) for the site and locality was reviewed. Koala habitat mapping in the Port Stephens CKPoM was reviewed and further assessed during field investigations.

A search of the DEC Wildlife Atlas database was conducted for all recent records of threatened flora and fauna within the locality (see *Figure 2.1*, *Figure 2.2* and *Figure 2.3*). This search revealed the presence of several threatened species within a 10 kilometre radius of the site. A search of the on-line database maintained by the Commonwealth Department of the Environment and Heritage (DEH) was completed to identify the presence of nationally listed threatened and migratory species in the locality. A search was also conducted of the Birds Australia New Atlas database (2004) for records of threatened and migratory birds in the locality. Records of koala deaths and injuries in the Salamander Bay/Soldiers Point area were obtained from the Native Animal Trust Fund.

All flora and fauna database records were plotted using a geographic information system and were analysed to determine the likelihood that threatened flora and fauna could occur within habitats on the site. The analysis entailed assessment of dates, source reliability and numbers of records to assess the accuracy and current relevance to the site. It should be noted that the DEH search is based on habitat requirements rather than actual records, and the assessment is based on those listed species considered likely to be on the site.

2.2 VEGETATION COMMUNITIES

Broad vegetation communities in the locality have been mapped in the Lower Hunter and Central Coast Regional Environmental Management Strategy (LHCCREMS) (House 2003). These communities are shown in *Figure 2.1*.

The site has been mapped as coastal sand apple–blackbutt forest and cleared land. The canopy within coastal sand apple–blackbutt forest is typically dominated by smooth-barked apple (*Angophora costata*) and blackbutt (*Eucalyptus pilularis*) with occasional red bloodwood (*Corymbia gummifera*), scribbly gums (*E. haemastoma* or *E. signata*), Sydney peppermint (*E. piperita*) and mahogany (*E. umbra*). Structurally it is an open forest with a moderately

open shrubby understorey of *Banksia serrata*, *Acacia ulicifolia* and *Dillwynia retorta* with a ground layer composed of grasses, herbs and bracken (*Pteridium esculentum*). Threatened species known to occur in this community are the orchids, *Diuris arenaria* and *Diuris praecox*, and black-eyed susan (*Tetratheca juncea*) (CRA Unit NPWS 2000).

2.3 *IDENTIFICATION OF THREATENED SPECIES*

A suite of threatened species have the potential to occur on the site, based on NPWS and EA database records of these species in the locality and the presence of suitable habitat on the site (see *Figure 2.1*, *Figure 2.2* and *Figure 2.3*, *Table 3.1*).

Marine mammals (eg whales and dolphins), birds (eg albatrosses and petrels), reptiles (eg sea turtles and sea snakes) and fishes (eg pipefishes, sharks) were excluded from the threatened species assessment as it is reasonable to assume they are not present or depend on habitats on the site. Migratory wader birds that depend on estuarine mudflats and saltmarsh were also excluded from the assessment, although the eastern curlew (*Numenius madagascariensis*) and whimbrel (*Numenius phaeopus*) have been recorded in the locality and are included on the DEH database.

2.4 *GENERAL FLORA*

Vegetation communities on site area were identified to verify the LHCCREMS vegetation mapping, and vegetation mapping in the koala habitat atlas (Port Stephens Council 2001). A randomly chosen 20 metre by 20 metre quadrat was sampled within the coastal sand apple–blackbutt forest on 15 October 2004. Ground-truthing of vegetation communities at this time revealed the presence of two small stands of swamp mahogany – paperbark forest: one adjacent to the old Soldiers Point Road near the entrance to the site; the other surrounding a small wetland at the southern end of the site. Subsequently, a 20 metre by 20 metre quadrat was sampled at the northern stand of this vegetation community. Random meander transects were employed to sample vegetation within the cleared areas of the site, which is regenerating sand apple – blackbutt forest, and within the wetland and small ponds.

All vascular plant species within the quadrats and within 10 metres of the transects were identified and recorded (refer to *Annex A* for results), as well as the height and percentage cover (using the modified Braun Blanquet scale) of the dominant species within each structural layer. Plant species names follow Harden (1992, 1993, 2000, 2002). The disturbance history within the study site was noted to determine the severity and timing of fire, grazing, logging/clearing, dumping and weeds.

2.5 THREATENED OR SIGNIFICANT FLORA SPECIES

A targeted search for *Diuris arenaria* was conducted by ERM on 15 October 2004 by one ecologist along tracks and cleared areas. This survey was undertaken when the species was flowering at a reference site within a cleared electricity easement at Salt Ash. A targeted search for *Eucalyptus parramattensis* subsp. *decadens* was also conducted in October 2004 within the regenerating coastal sand apple–blackbutt forest as this species occurs in similar habitats on areas previously sand mined in the Salamander Bay area (see ERM 2005).

2.6 ENDANGERED ECOLOGICAL COMMUNITIES

The likelihood of endangered ecological communities (Schedule 1, Part 3 of the TSC Act) occurring on the site was determined by considering the dominant plant species that comprise the vegetation communities, and the dominant soils present. This assessment was based on vegetation mapping by LHCCREMS, ground-truthing and the results of previous flora surveys (eg Conacher Travers 1998; General Flora and Fauna 2004).

2.7 FAUNA HABITAT ASSESSMENT

Microhabitat diversity for fauna was assessed in the vegetation quadrats and within the remainder of the site on 15 October 2004. The following habitat features were recorded:

- percentage cover of nesting/shelter/basking sites such as tree hollows, leaf litter, bare ground, rocks, logs, vegetation, caves, rock outcrops, overhangs and crevices;
- presence of freshwater aquatic habitats such as streams, swamps and pools;
- cover abundance of dominant canopy species, and the presence of fire scars and dead tops on these trees;
- connectivity to adjacent areas of habitat; and
- the extent and nature of previous disturbances.

The presence of flowering eucalypts and other plants were recorded as these may provide foraging resources for threatened species such as squirrel gliders and the regent honeyeater.

Habitat use by fauna was documented through analysis of tracks, scats, diggings, feathers and other traces. Traces of threatened species such as owls

and the spotted-tailed quoll were the focus of these surveys. Surveys were conducted opportunistically during the entire study period and included:

- searches for owl pellets and scats;
- searches for raptor nests;
- searches for tracks and diggings;
- road kills; and
- scratch marks on trees.

2.8 KOALA HABITAT ASSESSMENT

An assessment of the potential of the site to support a population of koala (*Phascolarctos cinereus*) was undertaken by ERM, with the aim to determine if *potential* and/or *core* koala habitat was present on the site. The assessment involved determining the presence of koala feed tree species on the site. If more than 15% of the upper and lower strata tree species are koala feed species, the area is designated as *potential* koala habitat, as defined by SEPP 44. This assessment was undertaken to also verify the habitat mapping in the CKPoM. Two 20 x 20 metre quadrats were sampled in the swamp forest on the site, and an additional quadrat was sampled in swamp forest within the larger Stage Two area, on 26 October 2004 (see *Figure 2.4*). The results of the habitat assessment were considered within the framework of determining whether areas qualified as *preferred* or *supplementary* koala habitat in the Port Stephens CKPoM. This was accomplished by referring to the vegetation associations of Lunney et al. (1998).

All development applications in the Port Stephens LGA must demonstrate that they are consistent with the objectives of the performance criteria outlined in Appendix 4 of the CKPoM. All subdivisions must demonstrate that their design is consistent with these objectives. Guidelines set out in Appendix 6 of the CKPoM were used to assess koala habitat on the site. The assessment involved:

1) preliminary assessment of the site which involved consulting the CKPoM and a field assessment;
2) vegetation mapping to show the distribution of vegetation associations on the site and the locations of any preferred feed trees outside the preferred koala habitat;
3) identifying the class of koala habitat on the site and in adjoining areas in accordance with the guidelines in the CKPoM;

4) assessing the proposal against development standards and assessment criteria as outlined in Appendix 4 of the CKPoM; and

5) revising the development where necessary to meet the standards outlined in the CKPoM.

The CKPoM identified the site as supplementary habitat, with areas of cleared land (see *Figure 2.5*). However, ground-truthing revealed stands of swamp mahogany – paperbark forest on and adjacent to the site, which is preferred koala habitat. Accordingly, koala spot assessments were conducted within this vegetation community to assess the level of current koala activity.

A koala spot assessment was conducted on 26 October 2004. All swamp mahogany (*Eucalyptus robusta*) trees were surveyed, each with a diameter at breast height (dbh) of greater than 10 centimetres, in the swamp mahogany – paperbark forest. Swamp mahogany is a primary koala feed tree in the Port Stephens local government area. A faecal pellet search was undertaken beneath each tree for two to three minutes by one ecologist. A thick ground cover of *Gahnia clarkei* prevented pellet searches around the wetland located at the southern end of the site. Trees were also searched for koalas and trunks inspected for the presence of the characteristic 'pock mark' scratches made by koalas. A formal assessment, with dbh of each tree inspected being recorded, was undertaken at one site where koala activity was high (see *Figure 2.4*).

The assessment of koala activity levels was based on the spot assessment technique used by the Australian Koala Foundation (Phillips and Callaghan 1995). Other trees considered to be important for koalas in the Port Stephens LGA such as smooth-barked apple (*Angophora costata*), blackbutt (*Eucalyptus pilularis*) and red bloodwood (*Corymbia gummifera*) were inspected for evidence of koala usage while undertaking flora surveys.

The koala activity level for each plot sampled in the study area was determined by dividing the number of trees containing one or more koala faecal pellets recorded beneath them, by the total number of trees assessed in the plot (Phillips and Callaghan 1995).

Plots that return activity levels of approximately 30% or greater are considered likely to be within areas containing home range trees and/or areas of major activity currently being utilised by koalas with well defined home range areas (Phillips and Callaghan 1995). Conversely, plots that return activity levels below 30% are generally indicative areas of either unsuitable habitat, little used parts of an individual koala's home range, or areas of otherwise suitable habitat that are not presently supporting a socially stable koala population (Phillips and Callaghan 1995).

2.9 GENERAL, SIGNIFICANT AND THREATENED FAUNA

An assessment of the known and potential species of fauna on the site was undertaken, based on database records, previous reports, vegetation mapping and the habitat requirements of threatened species recorded in the locality. The occurrence of potential threatened fauna habitat resources was assessed to identify ecological constraints on the site. Surveys were conducted on the site to sample amphibians, birds and mammals, with particular effort devoted to targeting threatened species. Some survey effort was undertaken in the Stage Two area to determine the presence of threatened fauna in areas adjoining Stage One.

2.9.1 *Amphibian Surveys*

Targeted surveys for the wallum froglet (*Crinia tinnula*) and green and golden bell frog (*Litoria aurea*) were conducted in the wetland at the southern end of the site and smaller ponds in the disturbed area on 25, 26 and 28 October 2004. Surveys comprised five minutes quiet listening during diurnal and nocturnal visits. Several minutes of call playback for the green and golden bell frog was conducted at the waterbodies in the old sandmining area during nocturnal visits, as they comprise habitat for this species. Surveys were conducted at an ideal time, as heavy rain had filled most waterbodies. Opportunistic recordings of frogs were made while undertaking other field activities.

2.9.2 *Diurnal Bird Survey*

A bird census was conducted on 26 October 2004 in the site while walking along tracks within the Stage One and Stage Two area. Each survey consisted of 20 minutes quiet listening for bird calls and observation, and were conducted by ornithologist Peter Ekert. Surveys were conducted in the morning, which is generally a period of high bird activity.

2.9.3 *Owl Call Playback*

Owl call playback was conducted at the top of the ridge in open forest located south of the Stage One area, on 25, 26 and 28 October 2004 (see *Figure 2.4*). Call playback techniques and spotlighting were used, with pre-recorded owl call playback tapes broadcast through a 10 watt directional megaphone designed to project the sound for at least one kilometre under calm evening conditions.

Surveys commenced within one hour after dusk. Ten minutes of quiet listening initiated the surveys, followed by several minutes of powerful owl call playback, followed by five minutes of quiet listening. Following this, several minutes of barking owl playback was broadcast, five minutes of quiet listening, and several minutes of masked owl playback, quiet listening, then several minutes of eastern grass owl playback, followed by a further ten

minutes of quiet listening. On completion of the listening time, 10 minutes of spotlighting was undertaken within 50 metres of the site.

2.9.4 Ground Mammal Sampling

Forty A-sized Elliott traps were baited with peanut butter, honey and rolled oats and placed in the field along two transects (lines of traps) at two different locations to encompass Stage One and Stage Two, to trap small-sized ground mammals (see *Figure 2.4*). Transect 1 was positioned in open forest – swamp forest – disturbed area – open forest in Stage One, while Transect 2 was positioned in open forest on a south-east slope, near the top of the ridgeline in Stage Two.

Traps were placed at approximately 10 metre intervals, depending on the nature of the ground cover. For example, traps were placed in potential runways in undergrowth, and near logs and rock outcropping. The traps were set on 25 October 2004 and recovered on 28 October 2004. The total number of A-sized Elliott trap nights was 120. The traps were checked within two hours of dawn each morning and the bait re-applied if required.

Hair funnels (*Faunatech*) were placed on the ground and left in the field for 10 nights (25 October to 4 November 2004). Ten hair funnels were placed adjacent to the Elliott A type traps along the two transects. An additional transect comprising ten hair funnels was established in the Stage Two area, at the ecotone of swamp forest/open forest (Transect 3). The total number of tube nights was 300.

Half of the terrestrial hair funnels were baited with peanut butter, honey and rolled oats, and half with sardines. The sardine mix targeted the spotted-tailed quoll, while the peanut butter mix targeted the brush-tailed phascogale and ground-dwelling mammals. Hair funnels were secured to the ground along Transect 1 and 2, whereas along Transect 3 they alternated between ground and secured to tree trunks. Hairs collected from the funnels were sent to Barbara Triggs for identification.

2.9.5 Arboreal Mammal Trapping

Five B-sized Elliott traps were placed in open forest and swamp forest, and six traps were placed in open forest in the Stage Two area (see *Figure 2.4*). These traps target small to medium-sized mammals such as the squirrel glider (*Petaurus norfolcensis*). The traps were mounted on brackets on the trees approximately two metres above the ground on the south-west side of the trunk. Traps were mounted on red bloodwood, a preferred feed species for the squirrel glider, as well as smooth-barked apple and blackbutt trees that had small to medium-sized hollows.

The traps were baited with peanut butter, honey and rolled oats, while a honey water mixture was sprayed on the main trunks above the traps to

attract arboreal fauna. The traps were checked while the A-sized Elliott traps were inspected. The traps were set on 25 October 2004 and recovered on 28 October 2004 for a total of 33 trap nights.

2.9.6 Spotlighting

Spotlighting surveys involved two ecologists walking along tracks, in cleared areas and along the Old Soldiers Point road at a rate of approximately one kilometre per hour (see *Figure 2.4*).

Spotlighting commenced once the owl call playback had been completed. The vegetation canopy and understorey was illuminated with 50 watt hand-held spotlights to search for foraging arboreal fauna and nocturnal birds. All spotlighting was undertaken within the first two hours after dusk.

2.9.7 Stagwatching

Stagwatching was conducted on 26 October 2004 at several hollow-bearing trees (blackbutts) within 30 metres of where a squirrel glider was trapped during the arboreal mammal trapping along Transect 1 (see *Figure 2.4*). The aim of this technique was to determine if there were den trees present in this area. Stagwatching was conducted for one hour at dusk and involved careful observation of selected tree hollows to identify emerging animals. A 50 watt hand-held spotlight was used during stagwatching to conduct spot checks of the hollow entrances.

2.9.8 Microchiropteran Bats

A hand-held Anabat echolocation call detector was used to record bat calls while the owl call playback, stagwatching and spotlighting was conducted. The Anabat unit remained stationery while the owl call playback was conducted, and one ecologist held the unit while spotlighting. All bat surveys commenced within one hour of dusk. Bat calls were analysed by Glenn Hoye.

2.10 SURVEY EFFORT

In order to detect the possible occurrence of threatened and protected fauna species direct and indirect fauna survey methodologies were employed during previous and current investigations on and adjacent to the site (see *Section 1.1*). Fauna sampling was undertaken during three separate periods: September and October 1998, March 2004 and October 2004.

A summary of survey effort, number of trap nights, person hours and timing of surveys is provided in *Table 2.1*. Survey sites sampled in this study are shown in *Figure 2.4*.

Table 2.1 Fauna Survey Effort of Previous and Current Investigations

Survey Methodology	Survey Effort			
	September – October 1998	**March 2004**	**October 2004**	**Total**
Diurnal bird surveys	0.5 hours	0.6 hours	0.6 hours	1.7 hours
Habitat Search	6 hours	opportunistic	opportunistic	>6 hours
Nocturnal surveys	4.25 hours including stagwatching, spotlighting & owl calls	Spotlighting, frog calls & owl calls*	12.2 hours including stagwatching, spotlighting & owl calls	>16.4 hours
Terrestrial mammal surveys	16 A trap nights, 24 B trap nights	100 A trap nights, 9 cage trap nights	120 trap nights	269 trap nights
Arboreal mammal surveys	40 trap nights	24 trap nights	33 trap nights	97 trap nights
Hair tubes	120 tube nights	N/A	300 tube nights	420 hair tubes
Echolocation call detection	3.3 hours	opportunistic	12.2 hours	15.5 hours
Harp traps (bats)	N/A	4 trap nights	N/A	4 trap nights
Herpetofauna Survey	opportunistic	opportunistic	opportunistic	N/A

1. Sep - Oct 1998 Conacher Travers (1998), March 2004 General Flora and Fauna (2004) & October 2004 ERM.
2. Opportunistic = observations made while undertaking other field activities.
3. * Time not specified in report.
4. Survey effort in hours = person hours.

Timing of the surveys was generally good, with two survey periods occurring in spring, at a time suitable to detect flowering plants and most fauna. The March survey period was suitable to detect fauna that depend on autumn/winter foraging resources such as the regent honeyeater and swift parrot. The breeding season of winter breeding frogs such as the wallum froglet includes March and October, depending on seasonal rainfall.

The precautionary principle was adopted for this study where uncertainty existed with respect to the likelihood of a species occurring on the site. Threatened fauna species likely to occur on the site was extrapolated from the fauna habitat assessment, database and literature review.

3 RESULTS

3.1 VEGETATION COMMUNITIES AND GENERAL FLORA

Ground-truthing of the vegetation on the site allowed the LHCCREMS mapping to be fine-tuned. For example, areas of swamp mahogany – paperbark forest not previously mapped are present in the Stage One area (see *Figure 3.1*). This community occurs in areas of impeded drainage near coastal swamps, lagoons and along drainage lines on alluvial flats of Quaternary sands and sediments. Structurally, this community ranges from open forest to forest with swamp mahogany and broad-leaved paperbark forming the key diagnostic species either in combination or as monospecific stands (CRA Unit NPWS 2000).

Vegetation in the wetland at the southern end of the site qualifies as *Lepironia* Swamp, due to the dominant sedge layer of *Lepironia articulata* and *Lepidosperma* sp., with a dominant canopy of *Melaleuca quinquenervia*. This community is typically found in areas where open water occurs on the landward side of Holocene transgressive dunes on poorly drained Holocene sands (Myerscough and Carolin 1986).

Areas in Stage One not mapped by LHCCREMS are regenerating coastal sand apple – blackbutt forest (see *Figure 3.1*).

A total of 81 vascular plant species from 33 families were recorded during the flora surveys, with 12 exotic species. Species recorded on the site are listed in *Annex A*. A description of the floristics and structure of each vegetation community on the site is included in *Annex B*. Photographs of each community are included in *Annex C*.

3.2 CONSERVATION SIGNIFICANCE OF VEGETATION COMMUNITIES

3.2.1 *Coastal Sand Apple – Blackbutt Forest*

This community is not regarded as having conservation significance as it is widespread across the Tomago-Stockton sandmass in the Port Stephens LGA. It extends along the narrow sand coastal strip south of Newcastle to the Central Coast wherever conditions are optimal. It is well represented in conservation reserves between Newcastle and Seal Rocks, such as Myall Lakes National Park and Tomaree National Park (Clements et al. 1992; Gunninah Consultants 1996; Bell 1997). It is the most widespread community in Tomaree National Park and it is considered adequately conserved locally, in the north coast region and nationally (Bell 1997).

Habitat elements such as hollows are moderately abundant in this community, providing potential roost sites for a variety of arboreal mammal species, owls and microchiropteran bats.

3.2.2 Swamp Mahogany–Paperbark Forest

Hager and Benson (1994) described this community as having intermediate conservation significance because, although moderate areas are located in reserves in the region, additional information on the size of an adequate sample is required. Significant areas of this community have been zoned 7(a) (Environmental Protection) on the site.

Swamp mahogany-paperbark forest occurs throughout the Tomago Sandbeds in dune swales and wetlands in the Salamander Bay area. It is not well represented in Tomaree National Park but is considered adequately conserved in the north coast region and nationally (Bell 1997). However, in the Lower Hunter Central Coast region swamp mahogany-paperbark forest has been identified as a regionally significant vegetation community that has been heavily cleared with an estimated 70% of its projected pre European distribution cleared (LHCC REMS 2003).

This community represents potential habitat for amphibians, the koala and also a seasonal foraging resource during winter and for migratory species such as the regent honeyeater.

3.2.3 **Lepironia** *Swamp*

Lepironia swamp is known from only two locations within Tomaree National Park, and although this community is generally widespread, it is present in restricted localities where it occurs (Bell 1997). This community is considered to be reasonably conserved within Myall Lakes National Park, although insufficient information is available to determine its conservation significance at a regional and national level (Bell 1997).

In the Lower Hunter Central Coast region *Lepironia* swamp has been identified as a regionally significant vegetation community on the basis of being a specialised habitat (LHCC REMS 2003). There is approximately 40 hectares of this community across the region with an estimated 15% of its projected pre European distribution cleared (LHCC REMS 2003).

3.3 THREATENED FLORA

The database search of the DEC Wildlife Atlas identified records of threatened flora in the vicinity of the site (see *Figure 2.1*). Species listed as threatened in the TSC Act and/or the EPBC Act that have been recorded within a 10 kilometre radius of the site and that have the potential to occur are detailed in *Table 3.2*.

No threatened flora was recorded during targeted searches throughout the Stage One and Stage Two areas. No threatened flora species have the potential to be affected by the proposed development, although *Callistemon linearifolius* is assessed in the eight-part test due to its presence to the north of the site in a swamp forest and dry sclerophyll forest ecotone (ERM 2004b).

3.4 THREATENED ECOLOGICAL COMMUNITIES

The ecological community 'Sydney coastal estuary swamp forest in the Sydney Basin bioregion' (SCESF) is restricted to waterlogged estuarine alluvial soils and is strongly influenced by periodically poor drainage conditions. The swamp mahogany–paperbark forest on the site does not qualify as Sydney Coastal Estuary Swamp Forest Complex, given that it occurs on aeolian-derived sandy soil on a higher watertable, rather than estuarine-derived soils.

The ecological community 'Sydney freshwater wetlands in the Sydney Basin bioregion' is restricted to freshwater swamps in swales and depressions on sand dunes and low nutrient sandplain sites in coastal areas. Freshwater wetlands on the site qualify as Sydney Freshwater Wetland Complex as they meet the geological criteria for this community and contain suitable floristic elements and structure. However, the two small ponds in the disturbed area are artificial and have formed as a result of past sand mining. They therefore support lower quality habitat than the *Lepironia* swamp, which is a natural wetland with greater vegetative structure and diversity. Moreover, no threatened species were recorded in these ponds, such as the green and golden bell frog and wallum froglet, despite targeted searches.

Table 3.1. Identification of Threatened Species in the TSC Act

Common/Scientific Name	Status TSC	Records in Port Stephens area	Preferred Habitat	Likelihood of Occurrence
Hollow dependent birds				
turquoise parrot *Neophema pulchella*	V	Grahamstown Dam[1], Tomago sandbeds	Savannah woodlands adjoining clearings and on timbered ridges and creeks in farmland,[2] nesting in dead trees.	Low to moderate.
black-necked stork *Ephippiorhynchus asiaticus*	E	No records.	Lakes, swamps, freshwater pools and mangroves.	Low to moderate. Marginal foraging and nesting habitat present.
superb fruit-dove *Ptilinopus superbus*	V	Corlette[1]	Rainforest, mangrove, eucalypt forest.	Low.
wompoo fruit-dove *Ptilinopus magnificus*	V	Corlette[1]	Rainforest.	Low.
osprey *Pandion haliaetus*	V	Tanilba Bay, Shoal Bay[1]	Forages over water; nests in large dead tree.	Low. No foraging habitat or nest sites present. Nearest known nest at Tanilba Bay.
glossy black cockatoo *Calyptorhynchus lathamii*	V	Tomago Sandbeds, Medowie.[1]	Eucalypt woodlands and forests where *Allocasuarina/ Casuarina* are abundant in the understorey and mature trees provide large nesting hollows.[3] Rarely recorded far from preferred food resource.[3]	Moderate. Suitable roosting hollows present and local records in Soldiers Point.
powerful owl *Ninox strenua*	V	Tomago sandbeds, Medowie, Tilligerry Peninsula,[1] Fern Bay,[4] Bobs Farm.[5]	Wet and dry sclerophyll forests, nesting (large tree hollows) and roosting in dense forest areas or dense gullies.	High. Likely to forage across the site. Recorded west of the site during targeted surveys.
masked owl *Tyto novaehollandiae*	V	Fern Bay,[6] Medowie, Corlette and Nelson Bay.[1]	Dry sclerophyll forest and woodland with a low sparse understorey, foraging in open or partly cleared land. Roosting and nest sites large tree hollows in sheltered aspects.	Moderate. Recorded in dunes at Salt Ash. Likely to forage across the site. Not recorded on the site during targeted surveys.

Common/Scientific Name	Status TSC	Records in Port Stephens area	Preferred Habitat	Likelihood of Occurrence
eastern grass owl *Tyto capensis*	V	No records.	Grassy or swampy plains with tussock grasses and sedges.	Low to moderate likelihood in wetlands. Not recorded on the site during targeted surveys.
barking owl *Ninox connivens*	-	No records.	Open woodlands and dry open forests, nesting in the crown of mature trees[8].	Low to moderate likelihood based on habitat available but no records. Not recorded on the site during targeted surveys.
Other birds				
swift parrot *Lathamus discolor*	E	Williamtown, Medowie, Soldiers Point, Fingal Bay[23]	Migratory species frequenting eucalypt forest and woodland,[2] following winter flowering eucalypts (eg swamp mahogany). Breeds in Tasmania	Moderate, foraging habitat only. Not recorded on the site.
regent honeyeater *Xanthomyza phrygia*	E	No records.	Nomadic species following rich sources of nectar, primarily winter flowering species (eg swamp mahogany in coastal areas).	Moderate, foraging habitat only, no records. Not recorded on the site.
bush stone-curlew *Burhinus grallarius*	E	Taylors Beach and Lemon Tree Passage.[1]	Lightly timbered open forest or woodland with a ground cover of short or sparse grass and few, or no shrubs. Occasionally in mangroves and saltmarsh where fringed by *Casuarina* thickets[9]. High fire frequency further reduces habitat suitability.	Low to moderate. Not recorded on the site.
Australasian bittern *Botaurus poiciloptilus*	E	No records.	Dense emergent vegetation in freshwater swamps, lakes and watercourses.	Moderate likelihood in wetlands. Not recorded on the site during surveys.
Cave roosting bats				
large-eared pied bat (*Chalinolobus dwyeri*)	V	Metford[1]	Roost by day in caves and mine tunnels.	Low to moderate likelihood of foraging. No roost sites present.
little bentwing-bat *Miniopterus australis*	V	Medowie, Fern Bay, Salamander Bay, Tanilba Bay, Gan Gan[1], Bobs Farm[13], roost Balickera Canal[14]	Roosts in caves, old mines, stormwater channels; forages in forested areas below the canopy.	High likelihood of foraging. No roost sites present. Recorded on the site by Conacher Travers (1998).
eastern bentwing-bat	V	Medowie[1], Salamander	Roosts in caves, old mines, stormwater channels;	High likelihood of foraging. No roost sites

Common/Scientific Name	Status TSC	Records in Port Stephens area	Preferred Habitat	Likelihood of Occurrence
Miniopterus schreibersii oceanensis		Bay, roost in Balickera Canal.[14]	forages in forested areas above the canopy.	present. Recorded on the site by Conacher Travers (1998).
large footed myotis *Myotis adversus*	V	Grahamstown Dam, roost in Balickera Canal.[14]	Roosts in caves, tunnels, under bridges & dense vegetation. Forage over nearby lakes, rivers, large streams.	High likelihood of foraging habitat, although roosting habitat is limited. Recorded adjacent to the site by General Flora and Fauna (2004).
Hollow dependent mammals & reptiles				
greater broad-nosed bat *Scoteanax rueppellii*	V	Salamander Bay, Medowie, Fern Bay and Tilligerry Peninsula[1], Bobs Farm[13]	Moist river and creek system of the ranges, roosting in tree hollows.	High likelihood of foraging and roosting. Recorded on the site by Conacher Travers (1998).
eastern freetail bat *Mormopterus norfolkensis*	V	Shoal Bay and Salamander Bay[1].	Wide range of forested habitats including rainforest to dry open forest. Roosts in tree hollows and under loose bark.	High likelihood of foraging and roosting on the site. Recorded on the site by Conacher Travers (1998).
large pied bat *Chalinolobus dwyeri*	V	Metford[1]	Roost by day in caves and mine tunnels.	Low to moderate. Foraging habitat only. No roost sites present, no local records.
yellow-bellied sheathtail-bat *Saccolaimus flaviventris*	V	Only one record for Port Stephens area, at Fern Bay[4].	Tree hollows, abandoned nests of sugar gliders (*Petaurus breviceps*), animal burrows for roosting; almost all habitats including forest and woodland for foraging.	Low to moderate. Foraging and roosting habitat present, however low number of local records.
squirrel glider *Petaurus norfolcensis*	V	Salamander Bay, Bagnalls Beach, Nelson Bay, Anna Bay, Bobs Farm and Lemon Tree Passage[1]	Dry sclerophyll forest and remnant woodland containing mature or mixed aged stands with gum-barked and winter flowering trees, and mature *Acacia* species. Nests socially in tree hollows.	High likelihood of foraging, although limited den sites. Recorded on the site during targeted surveys; records exist adjacent to the site (General Flora and Fauna 2004).
eastern pygmy possum *Cercartetus nanus*	V	North of Newcastle at higher elevations only.	Coastal areas with *Banksias, Eucalypts* and other flowering understorey plants.	Low likelihood in regenerating heath. Not recorded on the site during surveys.
brush-tailed phascogale	V	Lemon Tree Passage, Boat	Largely arboreal, prefers open dry forest with little	Low to moderate. Local populations at Anna

Common/Scientific Name	Status TSC	Records in Port Stephens area	Preferred Habitat	Likelihood of Occurrence
Phascogale tapoatafa		Harbour, Anna Bay and Salamander Bay.[1]	groundcover on ridges up to 600m altitude. Common trees box, stringybark, ironbark and blackbutt.	Bay. Low abundance of fibrous-barked tree species. Not recorded on the site during targeted surveys.
spotted-tailed quoll *Dasyurus maculatus*	V	Lemon Tree Passage, Salt Ash, Soldiers Point, Anna Bay to Boat Harbour[1]	Wide range of forested habitats including rainforest, open forest, coastal heath, riparian forest. Nests in rock caves, hollow logs or tree hollows.	Moderate likelihood of foraging, although no den sites present. Not recorded on the site during targeted surveys.
Stephen's banded snake *Hoplocephalus stephensii*	V	No records.	Arboreal, usually found under loose bark on standing trees or in hollow limbs. Rainforest and wet sclerophyll forest.	Low. No local records and lack of preferred habitat.
Other mammals				
koala *Phascolarctos cinereus*	V	Numerous records for the Port Stephens area, especially Tilligerry Peninsula and Tomago Sandbeds.[1]	Forests typically on high nutrient soils characterised by presence of preferred feed trees. In Port Stephens area preferred feed trees are *Eucalyptus tereticornis*, *E. robusta*, *E. parramattensis* subsp. *decadens*.[16]	High. Recorded on the site. Multiple records for the Salamander Bay/Soldiers Point area.
eastern chestnut mouse *Pseudomys gracilicaudatus*	V	No known local records.	Dense wet heathland on sand with thick sedges and grasses, nesting in dry grassy areas above or just below the ground[17].	Low. No records.
grey-headed flying-fox *Pteropus poliocephalus*	V	Major roosts occur at Fullerton Cove, Blackbutt Park in Newcastle and irregularly at Glenrock SRA and Dunns Creek (near Paterson). From these locations they disperse to feed in fig trees and other introduced species in adjoining areas.	Megachiropteran bat forages on fruits, blossom and nectar of eucalypts. In early summer roosts in large groups (camps) in forests or mangroves.	High likelihood of foraging. Recorded flying over the site.

Common/Scientific Name	Status TSC	Records in Port Stephens area	Preferred Habitat	Likelihood of Occurrence
Frogs				
wallum froglet *Crinia tinnula*	V	Anna Bay sandbeds[1]. Salamander Bay.[18] Oyster Cove, Tomago sandbeds.	Acid paperbark swamps, wallum sedgelands, wet heath and swamp forest.[19]	High likelihood of occurring in *Melaleuca* swamp forest. Recorded on the site.
green and golden bell frog *Litoria aurea*	E	Medowie, Salt Ash.	Swamps, lagoons, streams and ponds with emergent vegetation.	Low likelihood of occurring in *Lepironia* wetland and ponds in the disturbed area. No local records.
Flora				
Callistemon linearifolius	V	Soldiers Point	Red flowering bottlebrush growing in dry sclerophyll forest on coast and adjacent ranges from Georges River to Nelson Bay.	Low likelihood of occurring in remnant open forest. Not recorded on site.
Diuris arenaria	V	Salt Ash, Shoal Bay and Anna Bay	Coastal heath forest and woodland dominated by *Corymbia gummifera* and *Angophora* sp. with a grassy or bracken understorey. [21]	Low. Not recorded during targeted surveys in disturbed heath and open woodland. Not recorded in local area by G. Hillman (orchid expert).
Diuris praecox	V	Bobs Farm to Anna Bay [14, 28], Glenrock State Recreation Area [12]	Grassy open areas within near-coastal open forest on sand hills and slopes, including easements where there is less competition for light[22]	Low. Not recorded in local area by G. Hillman (orchid expert).
Prostanthera densa	V	Gan Gan Hill[22]	Sclerophyll forest and shrubland on coastal headlands and near-coastal ranges, chiefly on sandstone[23]. Known from Nerong peaks in Port Stephens area.	Low. No suitable habitat. Not recorded on site.
Melaleuca groveana	V	Fingal Bay/Shoal Bay[22]	Heath, often in exposed sites[24].	Low. No suitable habitat. Not recorded on site.

Common/Scientific Name	Status TSC	Records in Port Stephens area	Preferred Habitat	Likelihood of Occurrence
Rulingia prostrata	E	Williamtown area[22]	Locally recorded from Tomago sandbeds in scribbly gum open forest at ecotone with swamp mahogany.	Low. Ecotonal habitat on site grades from swamp forest to coastal sands apple blackbutt forest. Not recorded on site.
Eucalyptus camfieldii	V	Salt Ash area[22]	Coastal shrub heath on sandy soils on sandstone, often of restricted drainage[26]. Restricted to coastal sand wallum woodland – heath.	Low. No suitable habitat. Not recorded on site.
Eucalyptus parramattensis subsp. *decadens*	V	Tomago sandbeds[6]	Low woodland on sandy soil, often on Tomago sand swamp woodland. Recorded from swamp forest fringes in Salamander Bay area.	Low. Not recorded on the site during targeted surveys.
Tetratheca juncea	V	North Arm Cove[22] , Glenrock State Recreation Area [12]	pH neutral clayey soils, derived from conglomerates located in dry sclerophyll open forest on the upper part of ridges with a southerly aspect, west through to east, with the most commonly associated tree species being *Angophora costata*, *Eucalyptus globoidea* and *E. gummifera*[27].	Low. No local records and no suitable habitat. Local records generally associated with northern shores of Port Stephens. Not recorded on site.
leafless tongue orchid *Cryptostylis hunteriana*	V	Gan Gan Hill and hill at Mallabula on Tilligerry Peninsula.	Terrestrial orchid grows in coastal swamp heath on sandy soil, eucalypt woodland, swamp fringes to bare hillsides in tall forest, with *Blandfordia nobilis*, *Cryptostylis erecta* and *Cryptostylis subulata*.	Low. Records in Port Stephens area restricted to volcanic hills. Habitat in Tomaree National Park.
Endangered Ecological Communities				
Sydney coastal estuary swamp forest (SCESF)	E	Bobs Farm[29]	Waterlogged estuarine alluvial soils strongly influenced by periodically poor drainage conditions.	Low. No estuarine soils present on the site.
Sydney freshwater wetlands (SFW)	E	No known local records.	Freshwater swamps in swales and depressions on sand dunes and low nutrient sandplain sites in coastal areas.	High. Dredge ponds remaining after sand mining have potential to support this community, as does *Lepironia* swamp.

Common/Scientific Name	Status TSC	Records in Port Stephens area	Preferred Habitat	Likelihood of Occurrence
Coastal saltmarsh	E	Salamander Bay, Cromartys Bay	Intertidal zone on the shores of estuaries and lagoons including when they are intermittently closed along the NSW coast.	Low. No estuarine communities are present on the site.

Status in NSW as per Schedules 1 and 2 of TSC Act: E = Endangered; V = Vulnerable. Status in Australia as per EPBC Act: E = Endangered; V = Vulnerable.
1 = NPWS Atlas of NSW Wildlife ; 2 = Blakers et al (1984); 3 = Clout (1989); 4 = Clements & Associates (1992); 5 = ERM Mitchell McCotter (1998); 6 = ERM Mitchell McCotter (1995); 7 = Ecotone (2001a); 8 = Davey (1993); 9 = Marchant & Higgins (1993); 10 = Marchant & Higgins (1990); 11 = Clancy (1991); 12 = Smith (1991); 13 = ERM (2001); 14 = Ecotone Ecological Consultants (1995); 15 = Ecotone (2001c); 16 = Port Stephens Council (2001); 17 = Fox (1991); 18 = Law (1994); 19 = Cogger (1992); 20 = HBOC 1996; 21 = HBOC 1997; 22 = Jones (1991); 23 = HBOC 2002/2003.

3.5 FAUNA HABITAT

3.5.1 Terrestrial Habitat

Vegetation maps and field surveys assessments were used to identify and assess the distribution of habitat types on the site. The site contains two broad habitat types of open forest (analogous to dry sclerophyll forest) and swamp forest and the distribution correspond to the vegetation communities present. Approximately 22 hollow-bearing trees have been identified and mapped on the site, with most located within open forest and swamp forest at the western part of the site (Conacher Travers 1998).

Open Forest

The open forest community (ie coastal sand apple–blackbutt) provides fauna habitat in the form of tree hollows, logs and ground cover such as grasses and bracken. Logs and ground cover provide shelter and foraging habitat for reptiles and small ground-dwelling mammals. The sandy substrate enables small to medium-sized mammals to create burrows for shelter. It is likely that tree hollows of this community provide suitable roosting habitat for the squirrel glider and microchiropteran bats. No habitat in the form of bush rock or rock platform was identified on the site. The presence of Banksia in the mid-strata provides foraging resources for nectivorous birds and the squirrel glider. In regenerating areas there is little groundcover, although *Acacia* sp. in the understorey comprise a foraging resource for the squirrel glider. The grasses and sedges within the groundcover stratum would provide seed and stem resources for granivorous bird species. The overstorey tree species would also provide suitable feeding resources for folivorous fauna species such as the common brushtail possum (*Trichosurus vulpecula*).

Swamp Forest

The swamp forest community (ie swamp mahogany–paperbark forest) provides potential foraging habitat to koalas, squirrel gliders, powerful owl, grey-headed flying-fox and a suite of nectivorous birds such as the swift parrot. Swamp mahogany comprises the primary autumn/winter foraging resource in this community, although *Melaleuca* also provides a flowering resource. Some hollow-bearing trees are also present in this community, providing potential roost sites for the squirrel glider and microchiropteran bats. This vegetation community also supports wetland habitat for frog species such as the wallum froglet. Vegetation such as *Gahnia clarkei* and *Restio tetraphyllus*, and fallen logs, provide shelter habitat for frogs, small birds and small ground-dwelling mammals.

3.5.2 *Aquatic Habitat*

There is one permanent, one semi-permanent and an ephemeral waterbody present on the site, as well as an intermittent wetland at the southern end of the site (see *Photograph C.5* and *Photograph C.6*, respectively). These waterbodies and wetland are not connected to aquatic habitats of Port Stephens, such as Cromartys Bay or Salamander Bay. However, the permanent waterbody provides habitat for freshwater fish such as the introduced mosquitofish (*Gambusia holbrooki*). Areas of the bank of this waterbody that contain fallen logs comprise shelter habitat for fish, and reptiles such as tortoises, snakes and lizards. Macrophytes such as *Eleocharis sphacelata* in this waterbody and a semi-permanent waterbody in the disturbed area provide foraging and shelter habitat for waterbirds and frogs. A thick cover of *Lepironia articulata* in the wetland at the southern end of the site provides foraging and shelter habitat for such fauna as well.

3.6 *GENERAL, THREATENED OR SIGNIFICANT FAUNA SPECIES*

A number of fauna species currently listed as threatened on the TSC Act and EPBC Act are known or likely to occur in the locality, based on DEC, DEH and Birds Australia database records (see *Figure 2.2* and *Table 3.1*). Of these species, 16 species have potential to be affected by the proposal, and an eight-part test is required for each species, in accordance with Section 5A of the EP&A Act.

The vulnerable (TSC Act) squirrel glider (*Petaurus norfolcensis*) was trapped on the Stage One site in swamp forest on 26 October 2004 (see *Figure 3.1*). No other individuals or other mammal species were recorded in arboreal traps on the site. Mammals trapped in ground traps included swamp rat (*Rattus lutreolus*) in swamp forest along Transect 1, and brown antechinus (*Antechinus stuartii*) along Transect 2 (see *Table 3.2*). The hair funnel analysis detected the squirrel glider from arboreal traps along Transect 3. The black rat (*Rattus rattus*) was recorded from hair analysis along Transect 1.

Table 3.2. Elliott A Type Trapping Results

Date	Transect	Species	No. of individuals
27 October 2004	1	swamp rat	2
27 October 2004	2	brown antechinus	1
28 October 2004	1	swamp rat	3

Mammals observed while spotlighting include the common ringtail possum (*Pseudocheirus peregrinus*) and common brushtail possum (*Trichosurus vulpecula*). A response was obtained from a powerful owl (*Ninox strenua*) during call playback on 28 October 2004. The individual was heard responding some one to two kilometres due west of the playback site (see

Figure 3.1). Powerful owl is listed as 'vulnerable' in the TSC Act. Other nocturnal birds recorded on the site include southern boobook (*Ninox novaeseelandiae*) and tawny frogmouth (*Podargus strigoides*).

Several wallum froglets (*Crinia tinnula*) were heard calling from swamp mahogany–paperbark forest and the *Lepironia* wetland on the site (see *Figure 3.1*). Calls were heard throughout the day when other activities were being undertaken (eg trap checking in the early morning). Wallum froglet is listed as 'vulnerable' in the TSC Act. A suite of other frog species was recorded from waterbodies on the site (see *Annex D*). Reptiles recorded on the site include the lace monitor (*Varanus varius*) and *Lampropholis guichenoti*, and land mullet (*Egernia major*) was recorded off-site along the drain to the west.

Thirty-one diurnal bird species were recorded in the Stage One and Stage Two areas (see *Annex D*). No threatened or migratory (Japan-Australia Migratory Bird Agreement/China-Australia Migratory Bird Agreement) diurnal woodland/forest/wetland birds were recorded.

Five microchiropteran bat species were recorded during the surveys (see *Annex D*), including the threatened little bentwing-bat (*Miniopterus australis*) and large-footed myotis (*Myotis adversus*). Both species were recorded from open forest and adjacent to wetlands in the Stage Two area.

3.7 KOALA HABITAT ASSESSMENT

The koala habitat assessment was based on the Port Stephens Comprehensive Koala Plan of Management (CKPoM) and field verification. The CKPoM identifies areas of preferred, supplementary and marginal koala habitat within the Port Stephens LGA. The CKPoM also identifies the following preferred feed tree in the Port Stephens LGA – swamp mahogany (*Eucalyptus robusta*) and Parramatta red gum (*E. parramattensis* subsp *decadens*) on all substrates and forest red gum (*E. tereticornis*) on Quaternary alluvials and volcanics.

The koala habitat assessment identified the swamp mahogany–paperbark forest on the site as *potential* koala habitat as defined by SEPP 44 (see *Table 3.3*). According to the vegetation associations of Lunney et al. (1998), these areas qualify as *preferred* koala habitat, as defined by the CKPoM. The areas should therefore be mapped as *preferred* koala habitat in the CKPoM Koala Habitat Mapping (see *Figure 3.2*). Subsequent searches for koala faecal pellets within one metre of the base of swamp mahogany trees revealed koala usage around the *Lepironia* wetland. However, an estimate of koala activity could not be determined due to the thick growth of *Gahnia clarkei* and *Restio tetraphyllus* under many swamp mahogany trees. No koalas were recorded during spotlighting searches conducted around this wetland or in swamp mahogany–paperbark forest elsewhere on the site. Likewise, Conacher Travers (1998) did not find any koalas in this area.

Table 3.3 Koala Habitat Assessment

Tree Species	Upper strata		Lower strata		Total	
	No.	%	No.	%	No.	%
Swamp forest						
Angophora costata	3	6.0	1	16.0	4	**0.08**
Corymbia gummifera	1	2.0	0	0.0	1	**0.02**
Eucalyptus pilularis	1	2.0	0	0.0	1	**0.02**
*Eucalyptus robusta**	19	44.0	0	0.0	19	**38.0***
Melaleuca quinquenervia	19	44.0	5	83.0	24	**48.0**

1. * preferred koala feed tree species in Port Stephens LGA.
2. swamp forest is *potential* koala habitat (ie *Eucalyptus robusta* is greater than 15% of the total species.
3. The other tree species are considered important for koalas in the Port Stephens LGA.

A pellet search was conducted around the base of swamp mahogany between the Old Soldiers Point Road and the drain to the west of the site, for a distance of approximately 30 metres. This search was undertaken due to sightings of koalas by General Flora and Fauna in March 2004, and from reports of this area being a koala movement corridor. This search revealed high koala activity (32%), which suggests the area contains home range trees and/or areas of major activity currently being used by koalas with well defined home range areas (see *Table 3.4*). Such animals are likely to be members of a socially stable breeding aggregation, evidenced by the sighting of a female koala with a juvenile on 28 October 2004. This area therefore represents *core* koala habitat as defined by SEPP 44.

Table 3.4 Spot Assessment Results

Tree species	Total No. of Trees	Faecal Pellets Present	Height Range (m)	DBH Range (cm)
Angophora costata	4	No	6-10	13-18
*Eucalyptus robusta**	21	Yes	5-18	12-35
TOTAL TREES	25	Yes	6-18	13-35
KOALA ACTIVITY = 32.0%				

1. * preferred koala feed tree species in Port Stephens LGA.
2. The other tree recorded in the plot is considered in the CKPoM to be an *important* tree for koalas in Port Stephens LGA.
3. Centre tree was selected due to sighting of a koala and presence of pellets.
4. DBH = diameter at breast height.

3.8 MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

No flora species has the potential to occur on the site, based on presence of local records and suitable habitat (see *Table 3.5*). Eight fauna species listed as threatened have the potential to occur, as well as five bird species listed in the migratory provisions of the EPBC Act.

Table 3.5 Matters of National Environmental Significance

Species	Status	Likelihood of Occurrence
FLORA		
leafless tongue-orchid (*Cryptostylis hunteriana*)	V	Prefers volcanic hills in Port Stephens area. Unlikely to occur.
Newcastle doubletail (*Diuris praecox*)	V	Prefers sclerophyll forest on sand hills. Not recorded in local area by orchid expert (G. Hillman). Unlikely to occur.
Eucalyptus parramattensis subsp. *decadens*	V	Prefers dry woodland on sandy soils. Not recorded on the site. Unlikely to occur.
villous mintbush (*Prostanthera densa*)	V	Sclerophyll forest and shrubland on coastal headlands and near-coastal ranges, chiefly on sandstone. Unlikely to occur.
dwarf kerrawang (*Rulingia prostrata*)	E	Prefers ecotone of sedgeland and paperbark forest. Unlikely to occur.
Tetratheca juncea	V	Dry sclerophyll open forest on the upper part of ridges. Unlikely to occur.
FAUNA		
swift parrot (*Lathamus discolor*)	E, M	Foraging resources present and local records. Not recorded on the site. **Potential to occur.**
regent honeyeater (*Xanthomyza phrygia*)	E, M	Foraging resources present. Not recorded on the site. **Potential to occur.**
Australian painted snipe (*Rostratula australis*)	V	Foraging and nesting habitat present in wetlands. **Potential to occur.**
green and golden bell frog (*Litoria aurea*)	V	Breeding habitat present throughout wetlands. **Potential to occur.**
stuttering frog (*Mixophyes balbus*)	V	Species prefers rivers and creeks in rainforest, wet sclerophyll and eucalypt forests. Unlikely to occur.
large-eared pied bat (*Chalinolobus dwyeri*)	V	Inhabits dry sclerophyll forests and woodland. **Potential to occur.**
spotted-tailed quoll (*Dasyurus maculatus*)	E	Requires caves, rock crevices and hollow logs in a wide range of habitats. **Potential to occur.**
long-nosed potoroo (SE mainland) (*Potorous tridactylus tridactylus*)	V	Prefers rainforest, wet sclerophyll forest and coastal heath. **Potential to occur.**
grey-headed flying-fox (*Pteropus poliocephalus*)	V	Potential foraging habitat on the site. Roosts at Fullerton Cove. **Potential to occur**.
white-throated needletail (*Hirundapus caudacutus*)	M	May forage aerially over the site. **Potential to occur.**
black-faced monarch (*Monarcha melanopsis*)	M	Species prefers rainforest, wet sclerophyll and denser eucalypt forests, damp gullies, and mangroves. Unlikely to occur.
spectacled monarch (*Monarcha trivirgatus*)	M	Mountain/lowland rainforests, thickly wooded gullies, waterside vegetation. Unlikely to occur.
satin flycatcher (*Myiagra cyanoleuca*)	M	Species prefers forest, particularly thick gullies. Unlikely to occur.
rufous fantail (*Rhipidura rufifrons*)	M	Species prefers rainforest. Unlikely to occur.
white-bellied sea-eagle (*Haliaeetus leucogaster*)	M	Potential foraging habitat present. No nests recorded on the site. **Potential to occur**.
Latham's snipe (*Gallinago hardwickii)*	M	Foraging and nesting habitat present throughout wetlands. **Potential to occur.**

Status EPBC Act: E = endangered; V = vulnerable; M = migratory

3.9 FISHERIES MANAGEMENT ACT 1994

Three species of threatened aquatic fauna have the potential to occur in Port Stephens:

- grey nurse shark (*Carcharias taurus*) (Rafinesque 1810) which is listed as endangered under Schedule 4 of the threatened species schedules of the FM Act;
- green sawfish (*Pristis zijsron*) (Bleeker 1851) which is listed as endangered under Schedule 4 of the FM Act; and
- black cod (*Epinephelus daemelii*) (Gunther 1876) which is listed as vulnerable under Schedule 5 of the FM Act.

Fly Point – Halifax Park aquatic reserve is situated within 10 kilometres of the site in Port Stephens.

The green sawfish, black cod and grey nurse shark are restricted to marine environments and, therefore, are unlikely to occur in the freshwater wetlands of the site. Therefore, an assessment of the potential impacts on the three species (Section 5A of the EP&A Act) is not required. No endangered ecological communities are likely to occur on the site. However, an assessment of the likely impacts of the proposal on fish habitat is included in the eight-part test.

3.10 LOCAL AND REGIONAL WILDLIFE CORRIDORS

The site is part of a narrow local corridor of remnant vegetation from Wanda Wetlands Reserve across Soldiers Point Road and south through the Stage Two area to Tilligerry Nature Reserve around Cromartys Bay (see *Figure 3.3*). This corridor also connects the site to patches of native vegetation along the eastern edge of Cromartys Bay, and north to Stony Creek Reserve at Soldiers Point. Wanda Wetlands Reserve is a remnant of approximately 14 hectares of coastal sand apple–blackbutt forest and swamp mahogany–paperbark forest north of the site that supports habitat for threatened species such as koala, squirrel glider and greater broad-nosed bat (ERM Resource Planning 1995). This reserve provides a 'stepping stone' in the fauna corridor that extends from the western side of Soldiers Point and Cromartys Bay to the bushland/wetland complex of the Salamander Bay area towards the bushland of Gan Gan Hill and Tomaree National Park near Nelson Bay (ERM Resource Planning 1995).

A corridor of swamp mahogany runs adjacent to the Stage One area, which is a known koala movement corridor (General Flora and Fauna 2004; see *Photograph C.6*). Arboreal and ground-dwelling fauna are likely to use open forest on the site to move from Wanda Wetlands Reserve to habitats south of the site, including the squirrel glider. A wetland system occurs across old

Soldiers Point Road that connects swamp forest to the north and south through a drain next to an old waste depot that is being rehabilitated into a playing field (see *Figure 3.3*). The hydrology of this system has been largely modified, with more permanent waterbodies resulting from the creation of evapotranspiration pond for waste treatment purposes.

In a regional context, the site is part of a wildlife corridor that stretches from the Tomago Sandbeds and Tilligerry Peninsula through to Tomaree National Park, which includes a large area of preferred koala habitat in the Port Stephens LGA.

3.11 THREATENED SPECIES RECORDED IN THE STUDY SITE AND ENVIRONS

Schedules 1 and 2 of the TSC Act list species, populations or ecological communities of native flora and fauna considered to be threatened in New South Wales. The status of species is assessed as either:

- Endangered (Schedule 1); or
- Vulnerable (Schedule 2).

No threatened populations currently listed on the TSC Act, 1995 were recorded, or considered likely to occur, on the site (see *Table 3.1*). However, one endangered ecological community was recorded. Threatened species and endangered ecological communities recorded on or adjacent to the site during this and previous studies include:

Open Forest/Regeneration Area

- little bentwing-bat (*Miniopterus australis*);
- eastern freetail-bat (*Mormopterus norfolkensis*);
- large-footed myotis (*Myotis adversus*);
- grey-headed flying-fox (*Pteropus poliocephalus*); and
- greater broad-nosed bat (*Scoteanax rueppellii*).

Swamp Forest

- wallum froglet (*Crinia tinnula*);
- squirrel glider (*Petaurus norfolcensis*); and
- koala (*Phascolarctos cinereus*).

Lepironia *Wetland*

- Sydney freshwater wetland complex.

A powerful owl (*Ninox strenua*) responded to call playback. This individual was one to two kilometres due west of the site, across Cromartys Bay.

The likelihood of threatened or significant flora occurring on the site was determined by considering the type and condition of vegetation and habitats, and analysis of database records. No Rare or Threatened Australian Plant (ROTAP) listed species or threatened species were found on the site.

3.12 LIMITATIONS OF SURVEY

The field surveys were conducted over two seasons (late summer/autumn and spring) and years (1998 and 2004) increasing the likelihood of detecting a more representative list of fauna assemblage occupying the site and environs. Sampling for threatened fauna species generally sampled optimum times for detection of threatened species excepting migratory species such as the regent honeyeater and swift parrot. Both of these species follow winter flowering trees with the regent honeyeater generally in April to September and swift parrot records in the Hunter in May to August.

The survey period in October is generally too late in the flowering period of the flowering season for threatened orchids such as *Diurus praecox* (July to September). This species may occur in the coastal sand apple-blackbutt forest however consultation with a local orchidologist that is familiar with the site indicates that this species has not been recorded in the vicinity of the site over the last few years (George Hillman pers comm).

Given these limitations, the precautionary principle has been adopted in the threatened species assessments where uncertainty existed as to the likelihood of a species occurring on the site.

4 THREATENED SPECIES ASSESSMENT

4.1 DEVELOPMENT FOOTPRINT

The proposed development is residential housing adjoining the existing residential development along Soldiers Point Road, Kanimbla Drive and Manoora Close. The proposed development footprint has been defined to minimise disturbance of fauna habitat elements and to conserve communities with a restricted distribution (see *Figure 4.1*). The development footprint provides for protection of the *Lepironia* swamp at the southern end of the site, including swamp mahogany–paperbark swamp surrounding the *Lepironia* swamp. The development therefore provides for the protection of;

- swamp mahogany-paperbark forest as a habitat resource for migratory species, koala, squirrel glider, and grey-headed flying-fox;
- swamp mahogany-paperbark forest as preferred koala habitat with a 30 metre habitat buffer, commencing from the boundary of this community and the *Lepironia* swamp; and
- *Lepironia* swamp as a habitat resource for the wallum froglet and microchiropteran bats. A buffer of 30 metres will be maintained around this wetland to protect its integrity.

In addition to this the proposed development footprint must accommodate a bushfire hazard reduction zone. The Port Stephens bushfire prone land map maps the study site and environs as vegetation category 1 high bushfire hazard. The site supports open forest community that is vegetation group 1. ERM has completed a bushfire hazard assessment of the site.

4.1.1 Habitat Loss

The proposed development will clear approximately three hectares of coastal sands apple-blackbutt forest and 0.2 hectares of swamp mahogany–paperbark forest (see *Table 4.1*). Earlier survey by Marshall Scott has mapped hollow-bearing habitat trees. The development will clear approximately 12 habitat trees and approximately 11 habitat trees will be retained within a 30 metre habitat buffer around the *Lepironia* wetland. Two freshwater ponds and an ephemeral waterbody will be filled as a result of the proposal.

Table 4.1 Approximate Areas of Vegetation Communities on the Site

Vegetation community	Total hectares on site	Hectares in development foot print	Hectares conserved on site
coastal sand apple–blackbutt forest	0.9	0.3	0.6
coastal sand apple–blackbutt forest (regenerating)	3.4	3.0	0.4
swamp mahogany–paperbark forest	0.3	0.2	0.1
Lepironia wetland	0.2	0.0	0.2
freshwater wetland	<0.01	<0.01	0.0
TOTAL	**4.8**	**3.5**	**1.3**

The loss of remnant coastal sand apple–blackbutt forest and regenerating areas of this community on the site is not considered to be significant as this community is widespread in the locality and is adequately conserved in reserve systems. The loss of approximately 0.2 hectares of swamp mahogany–paperbark forest will be offset by the retention of approximately 0.1 hectares around the *Lepironia* swamp.

4.1.2 Habitat Fragmentation

The restriction of development to the eastern side of the old Soldiers Point Road will reduce the potential for adverse impacts on the wildlife movement corridor through the swamp forest, that maintains a link between Mambo Wetlands Reserve and Tilligerry Nature Reserve, and habitats within the Stage Two area. Therefore, development of the site would not impact significantly on the north to south corridor function of this remnant.

4.1.3 Indirect Impacts

Edge effects in the *Lepironia* swamp will be minimised by the retention of a 30 metre habitat buffer from the boundary of the swamp mahogany–paperbark forest and regenerating coastal sand apple–blackbutt forest. The application of an APZ extending from this buffer will further reduce potential impacts to this wetland.

The absence of streams and drainage lines on the site reduces the potential issue of erosion and sedimentation as a result of any development within the residential zone. However, the implementation of an erosion and sedimentation control plan, and stormwater management protocols, would restrict the movement of sediment within the site and offsite impacts to surrounding wetlands.

Weed invasion into low nutrient environments such as swamp forest/open woodland is a potential issue. However, the application of a 30 metre buffer over this vegetation community will minimise any potential for weed invasion. It is recommended that a weed management plan be produced for the construction and post-construction phases of any development on the site.

4.1.4 Cumulative Impacts

It is currently proposed to construct two access roads from the old Soldiers Point Road to the playing fields west of the site and modify the drainage system by clearing a small area of vegetation (General Flora and Fauna 2004). The former action may result in the wetland system becoming more permanent. However, the proposal aims to minimise the removal of preferred koala habitat, and to restore and rehabilitate native vegetation within the swamp forest corridor adjacent to the old Soldiers Point Road. Provided the recommendations of General Flora and Fauna (2004) are implemented, there is unlikely to be cumulative impacts arising from the proposal to develop Lot 59 DP 831253 Salamander Waters.

4.2 EIGHT PART TEST

The eight part test of significance assesses the potential impact on threatened species, populations and ecological communities which have been recorded on the site or are assessed as having a moderate or high likelihood of occurring on the site (see *Table 3.1*). These threatened species are listed below:

Hollow-dependent birds

- glossy black-cockatoo (*Calyptorhynchus lathamii*);
- masked owl (*Tyto novaehollandiae*); and
- powerful owl (*Ninox strenua*).

Nectivorous birds

- swift parrot (*Lathamus discolor*); and
- regent honeyeater (*Xanthomyza phrygia*).

Wetland birds

- Australasian bittern (*Botaurus poiciloptilus*).

Cave-roosting Microchiropteran Bats

- little bentwing-bat (*Miniopterus australis*);

- eastern bentwing-bat (*Miniopterus schreibersii oceanensis*); and
- large-footed myotis (*Myotis adversus*).

Tree-roosting Microchiropteran Bats

- greater broad-nosed bat (*Scoteanax rueppellii*); and
- eastern freetail-bat (*Mormopterus norfolkensis*).

Megachiropteran Bats

- grey-headed flying-fox (*Pteropus poliocephalus*).

Hollow-dependent mammals

- squirrel glider (*Petaurus norfolcensis*); and
- spotted tailed quoll (*Dasyurus maculatus*).

Folivorous mammals

- koala (*Phascolarctos cinereus*).

Amphibians

- wallum froglet (*Crinia signifera*).

Flora

- *Callistemon linearifolius.*

No threatened fish species listed under the *Fisheries Management Act 1994* (FM Act 1994) are likely to occur within wetlands on the site, although the green sawfish, black cod and grey nurse shark have the potential to occur in Port Stephens.

The following assessment is based on the eight part test of significance established in Section 5A of the EP&A Act as amended by the TSC Act. These factors allow a determination of whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats.

The eight part tests provide an assessment of the threatened species and ecological communities in groups rather than on an individual basis. The division into groups is based on species having similar ecological requirements, at risk from the same threats and likely to be impacted upon in similar ways by the proposed residential development.

a) In the case of threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction.

- *Hollow dependent birds*

Glossy black-cockatoo has been recorded north-west of the site by Conacher Travers (2001) and indirectly by ERM (2004c) in Stony Ridge Reserve to the north. This species inhabits eucalypt forest and woodland, feeding almost exclusively on the seeds of *Allocasuarina torulosa* and *A. littoralis* (Garnett 1992). Large tree hollows constitute critical nesting habitat. Suitable hollows are present on the site but no evidence of tree hollow usage was recorded. Suitable foraging habitat is limited on the site as there are no stands of *Allocasuarina* present. Better foraging opportunities are present in Stony Ridge Reserve and Tilligerry Nature Reserve, and elsewhere in the locality. Given this, and the absence of active nest trees on the site, a local population of the glossy black-cockatoo is not likely to be placed at risk of extinction as a result of the proposed development which necessitates the clearing of approximately 3.3 hectares of coastal sands apple-blackbutt forest.

The powerful owl is associated with wet and dry sclerophyll forests containing ecologically mature trees. Nesting sites are large tree hollows along densely vegetated gullies; the powerful owl requires hollows only for nesting, not roosting (Debus and Chafer 1994). The powerful owl is considered to be a habitat generalist, occupying a wide range of tree species communities (Kavanagh 1990, 1991). The principle diet of the powerful owl is arboreal prey such as possums and gliders (Kavanagh 1988), and the major prey species over much of its range has been identified as the common ringtail possum (*Pseudocheirus peregrinus*) (Debus 1994).

The masked owl is a sedentary species inhabiting dry eucalypt forests and woodlands, forest margins, wooded watercourses, and isolated stands of trees within cleared areas (Garnett 1992). In forests it is frequently encountered in open forest with a sparse understorey or ground cover, or at the ecotone between closed forest or woodland (Hyem 1979; Davey 1993; Debus and Rose 1994). It requires a large home range, between 500 and 1,000 hectares per pair in coastal areas, with neighbouring pairs well separated (Debus and Rose 1994).

The masked owl uses tree hollows for diurnal roost and nest sites, and the same hollow may be used for a number of years (Hollands 1991). In addition, cliffs and caves have also been known to provide roost sites, as well as dense foliage occasionally (Debus and Rose 1994). Nest hollows used by the masked owl are generally located in large trees (Schodde and Mason 1980) within relatively dense forest or woodland (Debus and Rose 1994), although observations have also been made in more open habitats and even isolated trees (Debus and Rose 1994). Hollands (1991) observed that the nest tree is often an isolated stem or emergent above the canopy. Most recorded nest sites have been in live eucalypts, however the species has also been observed

nesting in dead trees (Hollands 1991; Debus and Rose 1994). The main prey species are small to medium terrestrial mammals, arboreal mammals and birds (Garnett 1992), with terrestrial prey predominating in the diet (Hollands 1991; Davey 1993).

The powerful owl was recorded during call playback, in which a response was heard from an individual approximately one to two kilometres due west of the site. It is therefore expected that the site is part of the home range of a pair of powerful owls, which are likely to forage across the site. The masked owl has not been recorded in the vicinity of the site but has been recorded from Bagnalls Beach residential area and Nelson Bay and would be expected to forage through the Soldiers Point/Salamander Bay area. The site provides suitable foraging habitat for both owl species, and ringtail possums and squirrel gliders (prey species for powerful owl) are known from the site. Prey species for the masked owl such as swamp rat were trapped in swamp forest.

These owl species are dependent on mature trees with large hollows for roost and nests sites, and are sensitive to a reduction in prey species associated with the clearance of habitat. Both species have large foraging territories and native vegetation will be retained south of the site. Development will clear approximately 3.5 hectares of foraging habitat. This represents a marginal reduction in total foraging habitat for both species. Large areas of foraging habitat in the locality are zoned open space or environment protection affording protection. Development is unlikely to place a local population of both species at risk of extinction.

- *Nectivorous birds*

The swift parrot breeds only in Tasmania, and occurs as a visitor throughout south-eastern New South Wales and Victoria from March to November (Garnett 1992). The swift parrot inhabits eucalypt forest and woodland, almost invariably in small flocks (Blakers *et al*. 1984). The species occurs primarily where eucalypts are flowering in profusion, feeding mainly on nectar, pollen and lerp (Klippel 1992). The swift parrot is dependent on winter flowering species, such as red ironbark (*Eucalyptus sideroxylon*), yellow gum (*E. leucoxylon*), white box (*E. albens*) and swamp mahogany (*E. robusta*). Due to the irregular nature of eucalypt flowering, the abundance of swift parrots within an area is highly variable. In 2001 there were no records of swift parrot but in 2002 there were significant numbers recorded at Williamtown, Medowie, Fingal Bay and Soldiers Point (HBOC 2002; HBOC 2003).

The principal habitat of the regent honeyeater is temperate eucalypt woodland and dry open forest, forest edges, treed farmland and urban areas (Garnett 1992). The regent honeyeater is nomadic, searching for rich sources of nectar (Franklin *et al*. 1989), although the birds will regularly appear in some districts each year when certain Eucalypts and Banksias flower (Blakers *et al*. 1984). They feed predominantly on the nectar of eucalypts, in particular red ironbark (*Eucalyptus sideroxylon*), white box (*E. albens*), yellow box (*E. mellidora*) and

yellow gum (*E. leucoxylon*) (Garnett 1992). On the NSW central coast they have been recorded feeding on swamp mahogany (*E. robusta*) (Garnett 1992). There are few records for the regent honeyeater on the Tomaree Peninsula.

Potential foraging habitat for the swift parrot and regent honeyeater is proposed to be conserved, as swamp mahogany around the *Lepironia* swamp will be retained on the site. A small area of swamp forest (0.2 hectares) will be removed, although approximately 0.1 hectares will be maintained. Local populations are unlikely to exist in the locality as both species are migratory. However, individual groups in the migrating population are unlikely to be placed at risk of extinction, as foraging resources will be conserved on the site.

- *Wetland birds*

The Australasian bittern is a cryptic species occurring in shallow, freshwater or brackish wetlands. Wetlands vegetated with tall dense beds of reeds, sedges or rush species including *Phragmites*, *Eleocharis*, *Juncus*, *Typha*, *Baumea*, *Gahnia*, *Bolboschoenus* are favoured (Marchant and Higgins 1990). The species is probably sedentary in permanent habitats (Marchant and Higgins 1990), but will utilise temporary and infrequently filled wetlands as a drought refuge or during movements (Garnett 1992).

The Australasian bittern was not recorded in wetlands on the site but has potential for forage and breed within the *Lepironia* swamp. This habitat will be retained and a buffer of at least 30 metres maintained between it and the development footprint, to ensure no potential direct and indirect impacts result from the proposed development. Therefore, a local population is unlikely to be placed at risk of extinction.

- *Cave-roosting microchiropteran bats*

The eastern bentwing-bat was recorded in regenerating open forest on the site during previous investigations (Conacher Travers 1998). The little bentwing-bat has been recorded south of the site in open forest in the Stage Two area (Conacher Travers 1998; this study), and is considered likely to occur in the Stage One area based on habitat suitability. The large-footed myotis was recorded flying over the wetland system west of Old Soldiers Point Road (General Flora and Fauna 2004) and east of the road in this study.

No potential roost sites were identified on the site or are expected to occur. It is expected that the species forage in the area but do not roost. Vegetation clearing for the proposed development is expected to have a minimal impact on foraging resources of the little bentwing-bat, eastern bentwing-bat and large-footed myotis. Therefore, it is not likely to disrupt the lifecycle of these species such that a local population will be placed at risk of extinction.

- *Tree-roosting microchiropteran bats*

The greater broad-nosed bat inhabits a variety of habitats from woodland through moist and dry eucalypt forest to rainforest, and usually roosts in tree

hollows (Hoye and Richards 1995). This species is a large insectivorous bat that forages high in the canopy and or along forest edges. It has been recorded at remnant bushland nearby at Wanda Avenue (ERM Resource Planning 1995) and in the Stage Two area (Conacher Travers 1998). It has a high likelihood of occurrence on the site.

The eastern freetail bat is a small insectivorous bat that forages in or above the canopy of woodland and dry eucalypt habitats. It roosts in tree hollows or under loose bark. It was recorded flying over the regenerating open forest and further south in the Stage Two area.

The removal of open forest and swamp forest habitat will remove potential roosting and foraging habitat for both species. The occurrence of mature trees with hollows on the site suggests this resource may be used for diurnal and winter hibernation roosts, and or maternity sites for the two species. A small area of this habitat resource will be removed as a result of the proposed development. Hollow-bearing trees will be retained in the koala habitat buffer, and in the Stage Two area. Therefore, any local populations of greater broad-nosed bat or eastern freetail bat are unlikely to be placed at risk of extinction.

- *Megachiropteran bats*

The grey-headed flying-fox feeds on a wide variety of fruiting and flowering plants including the fruits of native figs and palms, and the blossoms of eucalypts, angophoras, tea-trees and banksias (Tidemann 1999). The species roosts in camps, which are commonly formed in gullies, typically not far from water and usually in vegetation with a dense canopy (Tidemann 1999).

The site does not provide roosting habitat for the grey-headed flying-fox and this species roosts in specific camps. The site provides seasonal foraging resources for this species, in the form of eucalypts, cabbage tree palms, paperbark and banksia blossoms and nectar. Several individuals were observed foraging in nearby remnant bushland (ERM Resource Planning 1995). Given the absence of roosting habitat, the extent of alternative foraging habitat in the vicinity of the site, and the mobile nature of the species, the proposal is unlikely to disrupt the lifecycle of the grey-headed flying-fox.

- *Hollow-dependent mammals*

The presence of mature eucalypts with hollows is characteristic of habitats occupied by the squirrel glider. Disjunct populations occur in remnant woodlands and open forests that contain mature or mixed-age stands of several eucalypt species. The mixed stands invariably include gum-barked and winter flowering trees, mature trees with numerous hollows and mature *Acacia* species (Menkhorst *et al*. 1988). The squirrel glider forages at all levels in the forest strata to obtain its diet of plant exudates and arthropods (Bennett *et al*. 1991).

One squirrel glider was recorded on the site in swamp forest and indirectly via hair analysis from the boundary of swamp forest and open forest in the Stage Two area. Conacher Travers (1998) found two squirrel gliders in open forest approximately 200 metres south of the *Lepironia* swamp and three gliders in adjoining land. General Flora and Fauna (2004) trapped several squirrel gliders in swamp mahogany trees adjacent to the site that occur along the wildlife corridor. ERM Resource Planning (1995) recorded the squirrel glider in Wanda Wetlands Reserve and the species is known from near Stony Ridge Reserve (ERM 2004c). Given these records, the site is likely to comprise a link in the movement corridor of squirrel gliders from Tilligerry Nature Reserve to Wanda Wetlands Reserve. However, the site is unlikely to support a local population as stagwatching of potential den trees (with hollows) did not detect nocturnal emergence of any individuals. The squirrel glider trapped in this study was released the night following capture and immediately left the site once released, moving to the south. It is therefore likely that the individual was moving through the site at the time of capture.

The squirrel glider is known to be susceptible to habitat degradation or loss (Suckling 1995). The proposed development is expected to result in the loss of approximately 0.5 hectares of foraging habitat and approximately 12 potential den sites. Approximately 0.7 hectares of potential habitat will be retained in the south of the site associated with the swamp forest, open forest and buffer zones and this will be continuous with suitable habitat in Tilligerry Nature Reserve. A wildlife corridor that is likely to be important for the movement of a local population of squirrel gliders will be retained and enhanced adjacent to the site (General Flora and Fauna 2004). The impact on this species and other hollow dependent species has been reduced through:

- minimising the development footprint;
- protection of foraging resources in particular winter nectar sources (*Banksia serrata*, *Melaleuca quinquenervia*, *Eucalyptus robusta*) in the swamp forest and coastal sands apple-blackbutt forest in the habitat buffer;
- not disrupting any wildlife corridors and ensuring continuity of habitat to the south and north west of the old Soldiers Point Road; and
- retention of potential den trees within the asset protection zone reducing the impact on available den site resource. These are most likely to be hollow bearing *Angophora costata* as they are more fire retardant than the other canopy trees.

These measures will ensure that the local population is unlikely to be placed at risk of extinction as a result of the proposed development.

The spotted-tailed quoll occurs in a wide range of habitats including rainforest, open forest, woodland, coastal heath and inland riparian forest (Edgar and Belcher 1995). The animals are opportunistic predators and will feed on a variety of prey including macropods, birds, reptiles, arboreal

mammals and small terrestrial mammals (Mansergh 1983). The home range of a male spotted-tailed quoll may be in excess of 580 hectares and up to 875 hectares (Watt 1993). Records of the spotted-tailed quoll occur in the locality and potential habitat is provided by dry sclerophyll open forest. However, no individuals have been recorded during the survey effort in the Stage One and Stage Two areas, and it is unlikely that the site comprises the home range of any individuals. The proposed development will only result in a marginal reduction in the potential foraging habitat for the species, which has a large home range (Mansergh 1983). Therefore, the proposed development is unlikely to place a local population of the spotted-tailed quoll at risk of extinction.

- *Folivorous mammals*

The koala is an inhabitant of forests containing medium to tall trees, including rainforest genera (Reed *et al*. 1990). These forests typically occur on high nutrient soils and are characterised by supporting preferred forage trees. In New South Wales, the koala is associated with several forage trees, including forest red gum (*Eucalyptus tereticornis*), tallowwood (*E. microcorys*), ribbon gum (*E. viminalis*), grey gum (*E. punctata*), river red gum (*E. camaldulensis*), swamp mahogany (*E. robusta*), Sydney blue gum (*Eucalyptus saligna*), blackbutt (*E. pilularis*), flooded gum (*E. grandis*) and small-fruited grey gum (*E. propinqua*) (Reed *et al*. 1990).

The koala is typically a solitary animal, moving infrequently and living in a small area or group of trees within the available habitat for long periods or time (Mitchell 1990). Estimates of home ranges in Victoria are 1.70 hectares for males and 1.18 hectares for females with extensive overlap (Mitchell 1990). They occur in low densities and a breeding population may consist of as few as five or six individuals (Callaghan *et al*. 1994).

The swamp mahogany–paperbark forest on and adjacent to the site has been assessed as preferred koala habitat in this study and by General Flora and Fauna (2004) (CKPoM). Koalas have been observed along the corridor of swamp forest west of the site, including a female with a juvenile. The only evidence of koala usage on the site was found within 40 metres of the *Lepironia* swamp, where pellets were found under a swamp mahogany. Approximately 0.2 hectares of preferred koala habitat will be removed from the site, although approximately 0.1 hectares will be retained in the south of the site, to maintain connectivity with the movement corridor and preferred habitat further south in swamp forest. The proposed development is unlikely to place any local populations at risk of extinction. The proposal is assessed further with regard to the CKPoM performance criteria in *Section 4.5*.

- *Amphibians*

The wallum froglet inhabits temporary sedgelands and swamps in wallum country (Ehmann 1996). The species is known to occur in paperbark swamps within the Port Stephens LGA in Tomaree National Park and Moffats Swamp

Nature Reserve. Several individuals were heard calling on the site in swamp forest and in *Lepironia* swamp. The wallum froglet has been recorded in swamp forest west of the old Soldiers Point Road and in depressions next to this road (Conacher Travers 1998; General Flora and Fauna 2004). The loss of approximately 0.2 hectares of swamp forest that is wallum froglet habitat is unlikely to place the local population on the site at risk of extinction, as approximately 0.3 hectares of *Lepironia* swamp and swamp forest will be retained.

- *Flora*

Callistemon linearifolius inhabits dry sclerophyll forest on coast and ranges in the Sydney basin bioregion mainly between Georges River and Hawkesbury River. In the Lower Hunter and Central Coast Region habitat is provided in sheltered dry Hawkesbury woodland and swamp mahogany-paperbark forest (Murray *et al* 2002). In Lower Hunter National Park near Cessnock habitat was spotted gum and ironbark forest often with dense stands of *Melaleuca nodosa* (Murray *et al* 2002). As this species occurs mainly in the greater Sydney region, it is vulnerable to clearance for urban development and the remaining populations are at risk of extinction from low population numbers.

A population of *Callistemon linearifolius* occurs on Soldiers Point on undeveloped residential land to the east of Stony Ridge Reserve. No individuals of this species were recorded on the site during plot-based searches and random meander searches for threatened flora. This species prefers dry sclerophyll forest, which occurs as a small patch of open forest on the site. It is unlikely that this remnant would support a population of *Callistemon linearifolius*. Therefore, a local population is unlikely to be placed at risk of extinction.

- Endangered Ecological Communities

Sydney Freshwater Complex is the name given to the vegetation community characterised by a particular assemblage of species that is restricted to freshwater swamps in swales and depressions on sand dunes and low nutrient sandplain sites in coastal areas (NPWS 2000). This community is a mosaic community with considerable variation due to fluctuating water levels and seasonal conditions, with characteristic vegetation including *Eleocharis sphacelata*, *Baumea rubiginosa*, *Baumea juncea* and *Gahnia sieberiana* (NPWS 2000). There may be patches of emergent trees such as *Melaleuca quinquenervia* and shrubs. Disturbed remnants are considered to form part of the community.

Sydney Freshwater Complex is present on the site, represented by *Lepironia* swamp and two ponds that have been artificially created as a result of sandmining. Although the two ponds have vegetation and soil that is characteristic of this community, the soil seedbank is unlikely to be intact. They are therefore sub-optimal forms of this community. The loss of these ponds is unlikely to place the viability of Sydney Freshwater Complex on the site at risk of extinction, as 0.2 hectares of *Lepironia* swamp will be retained.

- *Fish*

The green sawfish is a benthic species, inhabiting muddy bottom habitats and entering estuaries. The green sawfish has internal fertilisation, the young are born live and fecundity is believed to be low (Sanger 1999). This species is primarily a species found in the warm waters of the tropics, but occasionally it has been recorded around Sydney and one specimen from Jervis Bay. There has been a serious decline in the numbers of this species and the last recorded specimen from the Sydney region was taken in 1926.

The black cod is a territorial species that inhabits reef caves, gutters and beneath bommies on rocky reefs from near shore to depths of at least 50 metres (Coleman 1986; Pogonoski et al. 2002). Recently settled juveniles sometimes enter estuaries and can be common in coastal rock pools along the NSW coastline.

The grey nurse shark lives in shallow coastal waters from the surf zone down to 60 metres, although it has been recorded from water as deep as 190 metres. During the day, they are generally found in the vicinity of dropoffs, caves and ledges.

These three species are unlikely to occur on the site due to the absence of suitable aquatic habitat and fish passage. Individuals may however, be present in Port Stephens. The proposed development is unlikely to result in sedimentation impacts to this estuarine environment as the site occurs on sand, which has low potential for mobility, and it is proposed to implement an erosion and sedimentation control plan. Therefore, the lifecycle of any threatened species listed on the FM Act will not be disrupted by the proposal such that a viable local population of the species would be placed at risk of extinction.

(b) In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.

No endangered populations have been identified as occurring on the site.

There are two endangered fish populations listed on the FM Act being the purple spotted gudgeon and olive perchlet. Both species do have eastern populations however it is the western populations that are listed.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.

On a broader regional scale, the site is within the Sydney Basin bioregion. The Sydney basin region covers 36655 square kilometres south from the Hunter

River and Port Stephens to Ulladulla and west to Dunedoo. Greater than ten percent of the region is reserved (Thackway and Cresswell 2000).

The proposed residential development will result in the loss of approximately 3.3 hectares of coastal sands apple-blackbutt forest and approximately 0.2 hectares of swamp mahogany–paperbark forest habitat for threatened species and populations. This will reduce habitat for a number of threatened species, although within a regional context, a significant area of known habitat will not be removed or modified. Coastal sands apple-blackbutt forest is widespread across the Tomago Sandbeds and Stockton dune system in the Port Stephens Local Government Area (LGA) (CRA Unit NPWS 2000). It is the most widespread community in Tomaree National Park and it is considered adequately conserved locally, in the north coast region and nationally (Bell 1997). In the Lower Hunter Central Coast region approximately 44% of the projected pre-European distribution has been cleared (House 2003). Swamp mahogany–paperbark forest has been identified as a regionally significant vegetation community that has been heavily cleared with an estimated 70% of its projected pre European distribution cleared (House 2003).

Preferred koala habitat will be retained in the southern section of the site, including habitat buffers over coastal sand apple–blackbutt forest. Retention of this habitat will protect foraging and potential roosting/den sites for threatened fauna and retain connectivity to similar habitats to the north and south along a wildlife corridor.

No known habitat for fish species currently listed as threatened in the FM Act exists on the site.

(d) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.

The proposed development is located within the northern half of the site and will not disrupt the corridor afforded by swamp forest that extends along the old Soldiers Point Road. The southern section of the site that contains habitat for threatened species and an endangered ecological community will be retained to maintain connectivity to similar habitat through to Tilligerry Nature Reserve and habitat elsewhere on the Tomaree Peninsula.

(e) Whether critical habitat will be affected.

At present, there is no critical habitat listed in the locality. There are currently no areas of critical habitat listed in the FM Act.

(f) Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or similar protected areas) in the region.

Within the Sydney Basin bioregion (Thackway and Cresswell 2000), several conservation reserves (such as national parks and nature reserves) and other areas that offer a certain degree of protection (such as state forests and water conservation areas) contain known or potential habitat for those species known from, or considered likely to occur on the site. Records of threatened species from conservation reserves in the Lower Hunter Central Coast region are provided in this assessment.

- *Hollow dependent birds*

Habitat for the glossy black-cockatoo is reserved in Wambina NR, Wallaroo NR, Watagans NP, Brisbane Water NP, Dharug NP, Popran NP and Bouddi NP (Murray *et al* 2002).

The powerful owl is known from Wallaroo NR, Tilligerry NR, Brisbane Water NP, Munmorah SRA, Wambina NR, Popran NP, Yengo NP and Dharug NP (Murray *et al* 2002).

The masked owl is known from Brisbane Water NP, Dharug NP, Bouddi NP, Tomaree NP, Glenrock SRA, Yengo NP and Wallaroo NP (Murray *et al* 2002).

- *Nectivorous birds*

The swift parrot has been recorded in Wyrrabalong NR and Wollemi NP (Murray *et al* 2002).

- *Wetland birds*

The Australasian bittern has been recorded in Hexham Swamp NR and Dharug NP.

- *Cave-roosting Microchiropteran Bats*

The little bentwing-bat, eastern bentwing-bat and large-footed myotis are expected to occur in reserves in the local area and broader region based on habitat availability and regional records. It is not known whether this species is adequately represented in conservation reserves in the region. These species have been recorded in Bouddi NP, Cockle Bay NR, John Gould NR, Karuah NR, Lake Macquarie SRA, Wallaroo NR, Dharug NP, Popran NP, Wyrrabalong NP, Glenrock SRA and Yengo NP (Murray *et al* 2002).

- *Tree-roosting Microchiropteran Bats*

Regional records for the greater broad-nosed bat are sparse. Known localities in conservation reserves include Dharug NP, Karuah NR, Wallaroo NR, Wambina NR, Wyrrabalong NP and Yengo NP (Murray *et al* 2002).

Eastern freetail bat is known to occur locally in Tomaree and on the central coast from Dharug NP (Murray *et al*. 2002).

- *Megachiropteran Bats*

The grey-headed flying-fox has a roost camp at Blackbutt Reserve in Newcastle, Fullerton Cove within Kooragang NR and Glenrock SRA (Murray *et al*. 2002). The species is expected to forage widely across the region, including the majority of conservation reserves within its range. It is known from Boondelbah NR, Brisbane Water NP, Cockle Bay NR, Dharug NP, Glenrock SRA, John Gould NR, Munmorah SRA, Popran NP, Wallaroo NR, Wambina NR and Wyrrabalong NP (Murray *et al*. 2002).

- *Hollow-dependent mammals*

The squirrel glider has been recorded in Wyrrabalong NR, Brisbane Water NP, Cockle Bay NR, Lake Macquarie SRA, Munmorah SRA, Moffat's Swamp NR and Glenrock SRA (Murray *et al*. 2002). It has been recorded at Tomaree NP.

Within the Sydney Basin bioregion, conservation reserves and other areas, which offer a degree of protection and contain known or potential habitat for the spotted-tailed quoll include Bouddi NP, Brisbane Water NP, Dharug NP and Popran NP (Murray *et al*. 2002).

Folivorous Mammals

The koala is known from a number of conservation reserves in the Port Stephens area (Tomaree NP, Moffat's Swamp NR, Tilligerry NR, Karuah NR, Worimi NR) and in lower numbers at Brisbane Water NP, Yengo NP and Watagans NP (Murray *et al*. 2002).

- *Fish*

NSW Fisheries has declared eight Marine Protected Areas (85,803 hectares) and there are three Commonwealth marine reserves (203,870 hectares). A number of national parks and nature reserves, managed by NSW National Parks and Wildlife Service (NPWS), also contain some area of estuarine and tidal waters (15,894 hectares) (EPA 1997). All of these reserves cover predominantly marine and estuarine habitats and are unlikely to adequately represent threatened species or habitats. These reserves and protected areas do not occur within the vicinity of the site. It is not known whether the black cod, green sawfish and grey nurse shark are adequately conserved in these reserves.

g) Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.

At present there are 24 threatening processes listed on Schedule 3 of the TSC Act, and these are detailed in *Table 4.1*.

Table 4.1 Key Threatening Processes Listed in Schedule 3 of the TSC Act

Threatening Process	Applicable to Project
Importation of red imported fire ants into NSW.	No
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis.	No
Invasion of native plant communities by exotic perennial grasses.	**Yes**
Clearing of native vegetation.	**Yes**
High frequency fire resulting in the disruption of life cycle processes in plants and animal and loss of vegetation structure and composition.	**Yes**
Invasion of native plant communities by bitou bush (*Chrysanthemoides monilifera*).	**Yes**
Removal of bushrock resulting in the removal and/or disturbance of habitat for native species that may find shelter in or under rocks, use rocks for basking, or which grow in rocky areas.	No
Anthropogenic climate change.	**Yes**
Alteration of natural flow regimes.	**Yes**
Predation by mosquito fish (*Gambusia holbrooki*).	No
Predation by the feral cat (*Felis cattus*).	**Yes**
Predation by the fox (*Vulpes vulpes*).	**Yes**
Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*).	**Yes**
Predation from the ship rat (*Rattus rattus*) on Lord Howe Island.	No
Loss and/ or degradation of sites used for hill-topping by butterflies.	No
Competition from feral honeybees *Apis mellifera*.	No
Infection of native plants by *Phytophthora cinnamomi*.	No
Psittacine circoviral (disease affecting endangered psittacine species and populations).	No
Removal of dead wood and dead trees.	**Yes**
Death or injury to marine species following captures in shark control programs on ocean beaches.	No
Entanglement in or ingestion of anthropogenic debris in marine and estuarine environments.	No
Introduction of the large earth bumblebee (*Bombus terrestris*)	No
Predation, habitat degradation, competition and disease transmission by feral pigs	No
Competition and habitat degradation by feral goats	No

Threatening processes that are considered relevant to the proposal are discussed in the following.

- Invasion of native plant communities by exotic perennial grasses.

Exotic perennial grasses are present in disturbed areas on the site, particularly along the old Soldiers Point Road and access tracks. Implementation of a weed management plan will aim to remove exotic grasses, and reduce the risk of their spread during the construction phase and post-construction phases of the proposed development.

The need to provide adequate bushfire protection measures will result in the clearance of ground cover species from the asset protection zone. Where possible landscaping in the asset protection zone should not include introduced perennial grasses (in particular kikuyu and couch) as they may invade the adjoining bushland.

- Clearing of native vegetation.

The proposal will clear approximately 3.5 hectares of native vegetation from the site. Although the removal of this vegetation is considered to be a key threatening process, similar vegetation will be retained on the site and will not be impacted by the proposal.

- High frequency fire resulting in the disruption of life cycle processes in plants and animal and loss of vegetation structure and composition.

The residential development may increase fire sources in the immediate environs. However, hazard reduction measures included within the development will reduce the risk of fire from sources on the site.

- Invasion of native plant communities by bitou bush (*Chrysanthemoides monilifera*).

Bitou bush is present on the site particularly along the old Soldiers Point Road. Implementation of a weed management plan will aim to remove this noxious weed, and reduce the risk of its spread during the construction and post-construction phases.

- Anthropogenic climate change.

The construction of the residential area and associated infrastructure will not in itself contribute to anthropogenic climate change. The implementation of energy minimisation in the design of housing and in the planning of infrastructure would aim to limit greenhouse emissions as a result of the proposal, in the short and long-term.

- Alteration of natural flow regimes.

The proposal is unlikely to modify the existing hydrology of the swamp forest and *Lepironia* swamp on the site, as most of this groundwater-dependent ecosystem will be conserved. There are no intermittent streams or drainage lines on the site.

- Predation by the feral cat.

The proposed development may increase predation on fauna by cats. However this impact may be ameliorated by the retention of adequate habitat connections and encouragement of responsible ownership of cats.

- Predation by the fox.

The proposed development may increase predation on fauna by the fox. It is recommended to implement a feral animal management plan that will aim to control fox populations on the site.

- Competition and grazing by the feral European rabbit.

The proposed development may increase the occurrence of the European rabbit in the study area, due to the clearance of vegetation. It is recommended to implement a feral animal management plan that will aim to control rabbit populations on the site.

- Removal of dead wood and dead trees.

Clearance of vegetation is likely to remove dead wood and dead trees from areas designated for residential development on the site. Some dead trees may contain hollows suitable as roost and den sites for fauna such as the squirrel glider and greater broad-nosed bat. It is therefore recommended that pre-clearance surveys be conducted prior to the removal of dead trees containing hollows.

At present there are six threatening processes listed under schedule 6 of the FM Act 1994. These are listed in *Table 4.2*.

Table 4.2. Threatening Processes listed in the FM Act 1994

Threatening Process	Applicable to Project
Hook and line fishing in areas important for the survival of threatened fish species.	No
The degradation of native riparian vegetation along NSW water courses.	No
The installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams.	No
The introduction of fish to fresh waters within a river catchment outside their natural range.	No
The removal of large woody debris.	**Yes**
The current shark-meshing program in NSW waters.	No

Residential development on the site would not cause the introduction of fish to fresh waters within a river catchment outside their natural range or the removal of large woody debris from any aquatic habitat. Native riparian

vegetation along watercourses will not be cleared thus no degradation will result. Large woody debris will be removed from a freshwater pond on the site, although given the isolation of this pond, and the infestation with exotic mosquitofish, it is unlikely to represent habitat for native fish species.

h) Whether any threatened species or ecological community is at the limit of its known distribution.

- powerful owl

The powerful owl occurs in south-eastern Australia on the coastal side of the ranges from south-west Victoria to Yeppoon, Queensland, extending west to the Pilliga scrub (Garnett 1992).

- masked owl

The masked owl typically occurs in forest and woodland in a broad coastal strip around southern Australia from Cooktown to Pilbara, Western Australia. It also occurs inland along wooded watercourses (Garnett 1992).

- glossy black cockatoo

The glossy black cockatoo is thinly distributed throughout its range, which extends throughout the forested ranges of the east coast from eastern Victoria to Rockhampton, Queensland and as far west as Riverina and Pilliga Scrub (Garnett 1992).

- swift parrot

The swift parrot breeds only in Tasmania, and occurs as a visitor throughout south-eastern New South Wales and Victoria from March to November (Garnett 1992). Sometimes recorded from south-eastern Queensland and as far west as Adelaide.

- regent honeyeater

The regent honeyeater occurs from north of Brisbane south to Wilsons Promontory and as far west as Adelaide with most records are concentrated at Adelaide, central and north-eastern Victoria and central-eastern New South Wales (Franklin et al. 1989).

- Australasian bittern

The Australasian Bittern occurs in Tasmania, south-eastern and south-western Australia (Marchant and Higgins 1990). In the south-east, it occurs from south-east Queensland to South Australia (Garnett 1992).

- little bentwing-bat

The little bentwing-bat occurs in the coastal ranges of eastern Australia from the central coast of New South Wales to Cape York in Queensland (Kennedy 1990), hence a local population would be near the southern limit of the species' known distribution.

- eastern bentwing-bat

The eastern bentwing-bat is widely distributed and common throughout eastern Australia from Cape York Peninsula, through eastern Queensland and NSW, Victoria to far eastern South Australia. In New South Wales, it is found from coastal areas to western slopes of the Dividing Range (Dwyer 1969).

- large-footed myotis

The large-footed myotis has an extensive coastal distribution from southern-eastern Australia around the east coast to northern Western Australia.

- greater broad-nosed bat

The distribution of the greater broad-nosed bat extends along the coast from Maryborough in Queensland to Orbost in Victoria (Klippel 1992).

- eastern freetail-bat

The eastern freetail-bat is confined to eastern Australia from Cooktown to south-west Victoria and inland to the western slopes of the Great Dividing Range (Menkhorst and Knight 2001).

- large-eared pied bat

Primarily confined to the western slopes of the Great Dividing Range from Queensland border to approximately Canberra (Klippel 1992).

- squirrel glider

The squirrel glider occurs along the eastern coast of Australia from eastern South Australia to Cairns in northern Queensland (Klippel 1992). In New South Wales, the species is patchily distributed along the Great Dividing Range, inland to the Pilliga and Coonabarabran, and along the coastal region from south of Sydney to the Queensland border (Austeco 1994).

- koala

The koala occurs in a scattered distribution along the east coast of Australia and inland areas from Eyre Peninsula to Townsville (Klippel 1992). In New South Wales, the species occurs principally on the central and north coast, coastal ranges and adjacent slopes with scattered records on the north-west plains and south coast (Reed et al. 1990).

- spotted-tailed quoll

The spotted-tailed quoll occurs along the south-east coast of Australia extending from south Queensland to Tasmania (Klippel 1992). The species is not at its limit of known distribution.

- grey-headed flying-fox

The species occurs along the east coast from Bundaberg in Queensland to Melbourne in Victoria.

- wallum froglet

The wallum froglet is distributed along coastal regions from Fraser Island in south-east Queensland through to the Kurnell Peninsula, New South Wales, and the local population is not at the southern limit of the known distribution of the species.

- *Callistemon linearifolius*

Callistemon linearifolius is known mainly from the Georges River to Hawkesbury River, north to Nelson Bay and west to Yengo National Park. The species is therefore at the northern limit of its distribution.

- black cod

The black cod has been recorded from the temperate and subtropical waters of the southwestern Pacific. In Australia their range extends from southern Queensland to Kangaroo Island (SA). New South Wales is the centre of the species' distributional range and provides the largest area of its distributional range (Sanger 1999).

- green sawfish

The region around Fullerton Cove is near the southern end of its distribution. The green sawfish occurs mainly in the tropics from Broome to southern Queensland although specimens have been recorded as far south as Sydney and one individual has been collected from Jervis Bay and from Glenelg, South Australia.

- grey nurse shark

The grey nurse shark is found in tropical and temperate waters in the Indian and western Pacific Oceans, and has been recorded from all states of Australia except Tasmania.

4.2.2 *Conclusion to Eight-part Test*

The proposed development will remove potential foraging and roosting habitat associated with approximately 3.3 and 0.2 hectares of coastal sand apple-blackbutt forest and swamp mahogany – paperbark forest, respectively. The development footprint has been designed to avoid and protect habitat for a number of threatened species, and to avoid clearance of regionally significant vegetation communities. Development is therefore unlikely to have a significant impact on local populations of the threatened species identified on the site and adjacent area.

4.2.3 *Environment Protection and Biodiversity Conservation Act 1999*

Threatened Species, Populations and Ecological Communities

The threatened species with a moderate to high likelihood of occurring on the site or in its vicinity, based on the availability of suitable habitat, include swift parrot, regent honeyeater, Australian painted snipe, green and golden bell frog, large-eared pied bat, spotted-tailed quoll, long-nosed potoroo and grey-headed flying-fox (see *Table 4.6*). The nature and extent of a likely impact to these species from the proposed subdivision has been assessed below in accordance with criteria described by Environment Australia (2000).

"An action has, will have, or is likely to have a significant impact on a threatened species if it does, will, or is likely to:"

a) lead to a long-term decrease in the size of an important population of a species,

It has been assumed that these species, which have the potential to occur on the site, do not represent important populations (ie if they were to occur they would not be necessary for the species' long-term survival and recovery).

- swift parrot and regent honeyeater

Potential foraging habitat for the swift parrot and regent honeyeater is proposed to be conserved, as swamp mahogany in approximately 0.1 hectares of swamp forest will be retained on the site. Local populations are unlikely to exist in the locality as the species are migratory. No swift parrots or regent honeyeaters were recorded during field surveys. Individual groups in the migrating population are unlikely to be affected by the proposal, as foraging resources will be conserved on the site. The potential loss of approximately 0.2 hectares of potential foraging habitat in swamp forest is not considered to be significant.

- Australian painted snipe

Potential foraging and nesting habitat for the Australian painted snipe is present in *Lepironia* swamp on the site. This species was not recorded on the

site, and there are no records of the species in the locality. However, the proposal is not likely to contribute to a reduction in the size of any population.

- green and golden bell frog

Potential breeding habitat is present throughout the wetlands on the site, although there are no recent records in the locality. The species was not recorded at two small ponds in the sand mined area and *Lepironia* swamp, despite targeted searches following heavy rainfall. Given that 0.2 hectares of *Lepironia* swamp will be retained on the site, the loss of a small area of potential habitat (<0.01 hectares) is not likely to contribute to a reduction in the size of any population. Extensive areas of wetland occur south and south-west of the site, which provides alternative habitat for the green and golden bell frog. It is not known if the species occupies these wetlands, although no individuals were recorded by General Flora and Fauna (2004).

- large-eared pied bat

The large-eared pied bat roosts in caves and tunnels, and forages over dry sclerophyll forests and woodland. As there is no roosting habitat present on the site, the proposed development is unlikely to disrupt the breeding and hibernation cycles of this species. The site provides potential foraging habitat, although similar habitats occur in the vicinity of the site, and approximately 0.1 hectares of swamp forest and 1.0 hectare of open forest will be conserved on the site. Therefore, the proposal is unlikely to lead to the long-term decrease in the size of an important population.

- spotted-tailed quoll

Potential habitat for the spotted-tailed quoll is provided by swamp forest and open woodland. However, no individuals have been recorded during the survey effort on the site, and it is unlikely that the site comprises the home range of any individuals. The proposed development will only result in a marginal reduction in the potential foraging habitat for the species, which has a large home range (Mansergh 1983). Therefore, the proposal is unlikely to lead to a reduction in the size of a population that may occur in the locality.

- long-nosed potoroo

The long-nosed potoroo was not recorded on the site during surveys conducted previously and by ERM. Approximately 3.0 hectares of potential habitat will be available for residential development in disturbed heathland that is regenerating coastal sand apple–blackbutt forest. However, given that 1.1 hectares of open forest and swamp forest will be conserved, and the area of alternate habitat surrounding the site, the proposal is not likely to lead to the long-term decrease in the size of a population of long-nosed potoroo.

- grey-headed flying-fox

The site does not provide roosting habitat for the grey-headed flying-fox as this species roosts in specific camps, the nearest being Fullerton Cove. The site provides seasonal foraging resources for this species, in the form of eucalypt and paperbark blossoms and nectar, which will be conserved within approximately 0.1 hectares of swamp forest. Given the absence of roosting habitat, the extent of alternative foraging habitat in the vicinity of the site, and the mobile nature of the species, the proposal is unlikely to lead to the long-term decrease in the size of a population of grey-headed flying-fox.

b) reduce the area of occupancy of an important population

No known habitat for an important population is to be removed. The proposed residential development would require the loss of vegetation that has the potential to support foraging habitat for the swift parrot, regent honeyeater, green and golden bell frog, spotted-tailed quoll, large-eared pied bat and long-nosed potoroo. The removal of this vegetation, however, is unlikely to reduce the area of occupancy of an important population, and is considered to be marginal foraging habitat for these species.

c) fragment an existing important population into two or more populations

Populations of threatened species that may exist on the site are unlikely to be fragmented due to the retention of a north-south corridor of swamp forest along the old Soldiers Point Road, and retaining habitat around the *Lepironia* swamp. Mobile fauna such as the large-eared pied bat and grey-headed flying-fox will be able to traverse the site regardless of the proposed development.

d) adversely affect habitat critical to the survival of the species

Potential habitat for the threatened species on the site is not regarded as critical to the survival of the species.

e) disrupt the breeding cycle of an important population

Roost sites for the large-eared pied bat and den sites for the spotted-tailed quoll will not be disturbed as a result of the proposal. The swift parrot breeds only in Tasmania and the regent honeyeater breeds west of the Hunter Valley. No camp sites of the grey-headed flying-fox are present on the site. *Lepironia* swamp will be conserved on the site, providing secure protection for potential breeding habitat of the green and golden bell frog, and potential foraging habitat for the Australian painted snipe.

f) modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The amount of clearing that would be required to accommodate residential development within the proposed development footprint would require the loss of approximately three hectares of remnant and regenerating coastal sand apple–blackbutt forest. Although this vegetation is habitat for threatened

species, more extensive and higher quality remnants are present in the southern section of the site. The loss of approximately 0.2 hectares of swamp mahogany–paperbark forest will be offset by the retention of 0.1 hectares in the southern section of the site that provides connectivity to the wildlife corridor along old Soldiers Point Road. The implementation of a weed and feral animal management plan will maintain or improve the quality of habitats on the site.

g) result in invasive species that are harmful to a threatened species becoming established in the threatened species habitat

The proposed residential development is likely to introduce new animals such as household pets onto the site, however, with the promotion of responsible pet ownership, these impacts may be minimised. The implementation of a feral animal management plan would aim to reduce the likelihood of feral animal populations increasing on the site, including foxes, rabbits, pigs and wild dogs. A weed management plan would aim to control exotic perennial grasses and weeds such as bitou bush, particularly in areas susceptible to weed invasion, such as road edges and asset protection zones. Community education programs may also be beneficial in educating home-owners on responsible garden waste management.

h) interfere substantially with the recovery of the species

The proposed development will not interfere with the recovery of any of the threatened species.

As a local population of threatened species would not be significantly impacted by the proposed development, no further assessment under the EPBC Act is warranted.

Migratory Species

Migratory species with a moderate to high likelihood of occurring on the site or in its vicinity, based on the availability of suitable habitat, include the swift parrot, regent honeyeater, white-throated needletail, white-bellied sea-eagle and Latham's snipe (see *Table 4.6*). The nature and extent of a likely impact to these species from the proposed subdivision has been assessed below in accordance with criteria described by Environment Australia (2000).

"An action has, will have, or is likely to have a significant impact on a migratory species if it does, will, or is likely to:"

Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species

- swift parrot and regent honeyeater

Swift parrots and regent honeyeaters follow the flowering of trees such as eucalypts and banksias. Potential foraging habitat for both species is proposed to be conserved, as swamp mahogany in approximately 0.1 hectares of swamp forest will be retained on the site. Local populations are unlikely to exist in the locality as the species are migratory. No swift parrots or regent honeyeaters were recorded on the site during field surveys. Individual groups in the migrating population are unlikely to be affected by the proposed development, as foraging resources will be conserved on the site.

- white-throated needletail

The white-throated needletail rests and feeds at high altitudes, and roosts in trees in forested hill country. They breed in the northern hemisphere prior to migrating to Australia in late October from Asia. Foraging and roosting habitat does not occur on the site, and the loss of approximately 3.5 hectares of open forest and swamp forest is not considered to be important habitat for the species.

- white-bellied sea-eagle

The white-bellied sea-eagle inhabits coastal areas and beside large lowland rivers and lakes (Schodde and Tidemann 1993). Its nest is a huge structure of sticks, 30 metres or more above the ground in a tall tree (Schodde and Tidemann 1993). Potential foraging and roosting habitat for the white-bellied sea-eagle occurs on the site, however nesting habitat has not been recorded during current or previous ecological investigations. Therefore, the white-bellied sea-eagle is unlikely to be nesting on the site. Potential nest trees will be conserved within swamp forest and open woodland in the southern section of the site.

- Latham's snipe

Latham's snipe is occasionally found on saline or brackish wetlands, but mostly on freshwater wetlands, particularly those with rank sedges, rushes and grasses (Smith 1991). The species usually leaves a wetland when it dries out or becomes flooded (Smith 1991). It shelters amongst dense wetland vegetation and breeds in Japan. Latham's snipe may occasionally use wetlands on the site as foraging habitat. However, given that *Lepironia* swamp will be conserved, and buffers established around it, the proposal is not likely to modify such habitat.

b) result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat of the migratory species.

The proposed development of residential land is likely to introduce new animals such as household pets onto the site, however, with the promotion of responsible pet ownership, these impacts may be minimised. The implementation of a feral animal management plan would aim to reduce the likelihood of feral animal populations increasing on the site. A weed

management plan would aim to control exotic perennial grasses and weeds such as bitou bush. Community education programs may also be beneficial in educating home-owners on responsible garden waste management.

c) seriously disrupt the life cycle (breeding, feeding, migration or nesting behaviour) of an ecologically significant proportion of the population of the species.

Only minor, seasonal or temporary breeding, feeding, migration and/or nesting sites for migratory species potentially occur on the site and will not be significantly disturbed. Mitigation measures would ensure that no indirect impacts to important migratory species habitat occur. Therefore, disruptions to the life cycle of an ecologically significant proportion of the population of these species are unlikely to occur.

As a local population of migratory species would not be significantly impacted by the proposed rezoning, no further assessment under the EPBC Act is warranted.

4.2.4 Port Stephens Comprehensive Koala Plan of Management 2001

All developments in the Port Stephens LGA are required to comply with performance criteria listed in the appendix of the Port Stephens CKPoM (Port Stephens Council 2001). The general aims and objectives of these performance criteria are:

- to ensure that the koala population in the Port Stephens LGA is sustainable over the long-term;
- to protect koala habitat areas from any development which would compromise habitat quality or integrity;
- to ensure that any development within or adjacent to koala habitat areas occurs in an environmentally sensitive manner;
- to encourage koala habitat rehabilitation and restoration;
- maintain interconnection between areas of Preferred and Supplementary Koala Habitat and minimise threats to safe koala movements between such areas;
- to ensure that development does not further fragment habitat areas either through the removal of habitat or habitat links or through the imposition of significant threats to koalas;
- to provide guidelines and standards to minimise impacts on koalas during and after development, including any monitoring requirements; and

- to provide readily understandable advice to proponents preparing development applications and for Council officers involved in the assessment of those applications.

The CKPoM *Appendix 4 - Performance Criteria for Development Application* has been used to assess the appropriateness of the proposed development by demonstrating consistency with the objectives of the performance criteria. The proposed development **must**:

a) Minimise the removal or degradation of native vegetation within Preferred Koala Habitat or Habitat Buffers.

The retention of approximately 0.1 hectares of preferred koala habitat and a 30 metre habitat buffer will conserve and protect koala habitat on the site, despite the loss of 0.2 hectares of preferred koala habitat. In ensuring "no net loss" of preferred koala habitat, it is recommended that the proponent contribute to the rehabilitation of preferred koala habitat along the old Soldiers Point Road. This measure is proposed by General Flora and Fauna (2004) to offset potential impacts arising from the construction of two access roads through the corridor.

b) Maximise retention and minimise degradation of native vegetation within Supplementary Koala Habitat and Habitat Linking Areas.

The remaining vegetation on the site has been mapped as supplementary koala habitat. The proposed development will remove approximately 3.3 hectares of coastal sand apple–blackbutt forest that is supplementary koala habitat. The proposed development footprint has been designed to minimise the loss of supplementary koala habitat and retain approximately 1.0 hectare in the southern section of the site that links to the corridor of preferred koala habitat west of the site.

c) Minimise the removal of any individuals of preferred koala food trees, where they occur on a development site. In the Port Stephens LGA these tree species are swamp mahogany (Eucalypts robusta), Parramatta red gum (Eucalypt parramattensis) and forest red gum (Eucalyptus tereticornis) and hybrids or any of these species. An additional list of tree species that may be important to koalas based on anecdotal evidence is included in Appendix 8.

Swamp mahogany is the preferred koala food tree that is present on the site. Several trees will need to be removed from the swamp forest within the proposed development footprint. However, no koala activity was recorded around these trees, evidenced by the lack of pellets. Swamp mahogany trees located within 30 metres of the *Lepironia* swamp will be protected within a habitat buffer around preferred koala habitat and an asset protection zone. Koala activity was recorded at these trees. Other tree species likely to be important for koalas on the site, such as smooth-barked apple, blackbutt and red bloodwood will be retained in these areas as well.

d) Make provision, where appropriate, for restoration or rehabilitation of areas identified as Koala Habitat including Habitat Buffers and Habitat Linking Areas over Mainly Cleared Land. In instances where Council approves the removal of koala habitat (in accordance with dot points 1-4 of the above waive clause), and where circumstances permit, this is to include measures which result in a "net gain" of koala habitat on the site and/or adjacent land.

The proposed development will remove a small area of preferred koala habitat. Despite the protection of 0.1 hectares of preferred habitat in the southern section of the site, the loss of any amount needs to be offset to ensure "no net loss" of preferred koala habitat. As discussed in *a)*, this may take the form of contributing towards the rehabilitation of the corridor of preferred koala habitat along old Soldiers Point Road. Rehabilitation of this corridor will ensure connectivity between preferred koala habitat in Wanda Wetlands Reserve and south to Tilligerry Nature Reserve, and around the edge of Cromartys Bay to Stony Ridge Reserve.

e) Make provision for long term management and protection of koala habitat including both existing and restored habitat.

The long term management and protection of koala habitat on the site will be provided for by provision of a habitat buffer over supplementary koala habitat and provision of bushfire hazard reduction area between the buffer and the development footprint. The groundcover in the disturbed area will be rehabilitated and monitored as part of the development phase. Restored habitat along the koala movement corridor west of the site will be monitored to ensure no adverse impacts result from the proposed construction of access roads, and monitored to ensure increased water levels in the drain do not result in dieback or death of swamp mahogany (see General Flora and Fauna 2004).

f) Not compromise the potential for safe movement of koalas across the site. This should include maximising tree retention generally and minimising the likelihood that the proposal would result in the creation of barriers to koala movement, such as would be imposed by certain types of fencing.

The protection of preferred koala habitat in the southern section of the site that links to a corridor of preferred habitat along old Soldiers Point Road will maintain connectivity for koala movement to the Stage Two area and preferred habitat in Tilligerry Nature Reserve. The development footprint is proposed to be restricted to east of the old Soldiers Point Road and will therefore not affect the integrity of the koala corridor. It is not expected that koalas move through the development footprint as no evidence was found to support their usage of the site. Furthermore, there are only several swamp mahogany trees that are likely to be removed.

Any movement through the development area should not be compromised by the creation of barriers such as inappropriate fencing. Generally it is recommended in the CKPoM that no fencing be used if dogs are prohibited

within a proposed development, in order to allow koalas to move through the area. Where fencing is required, suitable design specifications for fencing would include:

- fences where the bottom of the fence is a minimum of 200 millimetres above ground level that would allow koalas to move underneath;

- fences that facilitate easy climbing by koalas. For example, sturdy chain mesh fences, or solid style fences with timber posts on both sides at regular intervals of approximately 20 metres; or

- open post and rail or post and wire (definitely not barbed wire on the bottom strand).

If dog ownership is permitted, then fencing of a type that would be required to contain dogs should be restricted to the designated building envelope.

g) Be restricted to identified envelopes which contain all buildings and infrastructure and fire fuel reduction zone. Generally there will be no clearing on the site outside these envelopes. In the case of applications for subdivision, such envelopes should be registered as a restriction on the title, pursuant to the Conveyancing Act 1919.

Development will be restricted to the identified building envelopes, infrastructure and asset protection zone. There will be no clearing in the habitat area in the southern portion of the site. Implementation of fire reduction strategies will minimise the likelihood of fires in preferred koala habitat and habitat linking areas.

h) Include measures to effectively minimise the threat posed to koalas by dogs, motor vehicles and swimming pools by adopting the minimum standards outlined in the CKPoM.

If dogs are permitted owners should be made aware of their responsibility and should be encouraged to erect fencing to ensure dogs are kept within the confines of backyards and are not permitted to roam free (see criteria *f*).

Maximum vehicle speeds within the development are recommended to be less than 40 kilometres per hour.

The risk of mortality to koalas by drowning in backyard pools can be minimised by fencing the pool or placing a length of rope in the pool that is secured at one end.

Three vegetation communities are present on the site, including coastal sand apple–blackbutt forest, swamp mahogany–paperbark forest and *Lepironia* swamp. Swamp mahogany–paperbark forest on the site has conservation significance due to the presence of preferred koala feed tree species, seasonal foraging resources for threatened birds and mammals, and seasonal wetland habitat for the wallum froglet. The *Lepironia* swamp on the site is representative of the endangered ecological community Sydney Freshwater Wetlands in the Sydney Basin Bioregion and contains a population of wallum froglets. No threatened flora were recorded on the site or are likely to occur, based on database searches, habitat assessment and field surveys. Hollow-bearing trees comprise the most important fauna habitat on the site, particularly for threatened fauna that was recorded such as the squirrel glider and tree-roosting microchiropteran bats. The squirrel glider was recorded in Stage 1 and Stage 2 areas, and a local population (ie one or more family groups) is likely to be dependent on habitats in these areas.

Preferred koala habitat is present where swamp mahogany–paperbark forest occurs on the site, and the site is likely to form part of the home range of a socially stable breeding population. The remaining areas are 50 metre buffer over preferred koala habitat and supplementary koala habitat.

The site is part of a narrow local corridor of remnant vegetation from Wanda Wetlands Reserve across Soldiers Point Road and south through the Stage Two area to Tilligerry Nature Reserve around Cromartys Bay. Koalas and squirrel gliders are most likely to use this corridor, which is an important link between local populations.

The proposed development will remove potential foraging and roosting habitat for several threatened species. However, the development footprint has been designed to protect habitat for threatened species and ecological communities, mainly in the southern section of the site. Provided the recommended mitigation measures are implemented, there is not likely to be a significant impact on threatened species, populations or ecological communities, or their habitats.

Measures proposed to minimise potential direct and indirect impacts of the proposal on threatened species and ecological communities include:

- implementation of a weed management plan (targeting bitou bush and exotic grasses);
- implementation of an erosion and sediment control plan;
- implementation of a feral animal management plan;
- retention of *Lepironia* swamp and fringing swamp mahogany–paperbark forest, with a minimum 30 metre habitat buffer;

- retention of hollow-bearing trees where possible, especially within Asset Protection Zones and the southern section of the site;

- where retention is not possible, pre-clearing surveys of hollow-bearing trees to be conducted by a suitably qualified wildlife professional;

- landscaping of residential properties in sympathy with surrounding native vegetation;

- implement a community education program aimed at educating home-owners on responsible pet ownership (if dog and cat ownership is permitted) and responsible garden waste management;

- protection of the fauna corridor along old Soldiers Point Road by erecting a barrier between the development footprint and the road;

- restricting vehicle speeds within the development footprint to less than 40 kilometres per hour;

- preventing runoff being directed from construction areas into low-lying areas in the southern section of the site where *Lepironia* swamp occurs; and

- contribute to the rehabilitation of preferred koala habitat along the old Soldiers Point Road.

REFERENCES

Austeco Environmental Consultants Pty Limited (1994) *Fauna Impact Statement*. In: **Environmental Impact Statement - Proposed Toll Road Coolongolook to Possum Brush**. Prepared by Mitchell McCotter for Roads and Traffic Authority.

Bell S A J (1997) **Tomaree National Park Vegetation Survey. A Fire Management Document.** Report prepared for NSW National Parks and Wildlife Service.

Bennett A F, Lumsden L F, Alexander J S A, Duncan P E, Johnson P G, Robertson P and Silveira C E (1991) *Habitat use by arboreal mammals along an environmental gradient in north-eastern Victoria*. **Wildlife Research** 19: 125-146.

Blakers M, Davies S J F, and Reilly P N (1984) **The Atlas of Australian Birds**. Royal Australasian Ornithologists Union. Melbourne University Press.

Callaghan J, Leathley S and Lunney D (1994) **Port Stephens Koala Management Plan**. Draft. Port Stephens Council and National Parks and Wildlife Service.

Clements A M, Rodd A N, Lim I, Clulow J and Hoye G (1992) *Flora and Fauna Report*: part of the **Environment Assessment of Fern Bay, New South Wales**. Prepared for Port Stephens Shire Council. Anne Clements & Associates Pty Ltd, North Sydney.

Conacher Travers (1998) **Flora and Fauna Assessment Report. Proposed residential development project Stage 16 and 17, Lot 59 DP 831253 Kanimbla Drive, Salamander Bay.** Prepared for Salamander Projects Pty Ltd.

CRA Unit, National Parks and Wildlife Service (2000) **Vegetation Survey, Classification and Mapping. Lower Hunter and Central Coast Region**. Version 1.2. For the Lower Hunter and Central Coast Regional Environment Management Strategy. April 2000.

Davey S M (1993) *Notes on the Habitat of Four Australian Owl Species*. In **Australian Raptor Studies**. Ed. P. Olsen. Australian Raptor Association, Royal Australian Ornithologists Union, Melbourne. pp. 126-142.

Debus S J S (1994) **Aspects of the Biology, Conservation and Management of Threatened Forest Owls and Raptors in Northern New South Wales**. Thesis submitted for Master of Science in Zoology, University of New England, Armidale.

Debus S and Chafer C J (1994) *The Powerful Owl Ninox strenua in New South Wales*. **Australian Birds 28 Supplement**: S21-S38.

Debus S J S and Rose A B (1994) *The Masked Owl Tyto novaehollandiae in New South Wales*. **Australian Birds (supplement**) 28: 40-64.

Dwyer P D (1969) *Population ranges of Miniopterus schriebersii in south-eastern Australia*. **Australian Journal of Zoology** 17: 665–668.

Edgar R and Belcher C (1995) *Spotted-tailed Quoll Dasyurus maculatus*. In **The Mammals of Australia**. Ed. R. Strahan. Australian Museum / Reed Publications, Chatswood.

Ehmann H (1996) *Wallum Froglet*. In **Threatened Frogs of New South Wales: Habitats, Status and Conservation** edited by Harald Ehmann. Frog and Tadpole Study Group Inc, Sydney. pp. 47-54.

Environment Australia (2000) **Administrative Guidelines for determining whether an action has, will have, or is likely to have a significant impact on a matter of national environmental significance under the Environment Protection and Biodiveristy Conservation Act 1999.** Environment Australia website.

EPA (1997) **New South Wales State of the Environment 1997.** Environment Protection Authority, NSW.

ERM (2004a) **Proposed rezoning Lot 2 DP 847022 Salamander Way. Ecological Assessment**. Prepared for Port Stephens Council.

ERM (2004b) **Proposed Development of Lot 32 DP533796 and Lots 152, 157, 158, 159 and 160 DP27047 Salamander Bay. Flora and Fauna Assessment**. Report prepared for Port Stephen Veterans and Citizens Aged Care Ltd.

ERM (2005) **Salamander Waters Estate – Stage Two. Ecological Review**. Report prepared for Hill PDA.

ERM Mitchell McCotter (1999) **Salamander Bay Waste Transfer Station. Environmental Impact Statement.** Prepared for Port Stephens Council.

ERM Resource Planning (1995) **Fauna Impact Statement for proposed residential development at Wanda Avenue, Salamander Bay**. Prepared for Port Stephens Council.

Franklin D C, Menkhorst P W and Robinson J L (1989) **Ecology of the Regent Honeyeater *Xanthomyza phrygia***. Emu 89: 140-154.

Garnett S (1992) **Threatened and Extinct Birds of Australia. RAOU Report No. 82**. Prepared for Australian National Parks and Wildlife Service. Royal Australasian Ornithologists Union, Victoria.

General Flora and Fauna (2004) **Flora and Fauna Assessment. Lot 59, DP 831253 360 Soldiers Point Road, Salamander Bay**. Prepared for Port Stephens Council.

Gunninah Consultants (1996 revised 1997). **Fauna and Flora Assessment, Proposed Residential Development, Nelson Bay Road, Fern Bay.**

Gunninah Consultants (1995) **Salamander Residential Development Stages 24 & 25, Lot 2 DP 847022, Salamander Way. Fauna Impact Statement**. Prepared for Salamander Projects Pty Ltd.

Hager T C and Benson J S (1994) **Review of the conservation status of vegetation communities in New South Wales. Part 3: Assessment of the conservation status of forest plant communities in north eastern New South Wales**. Report to the Australian Heritage Commission.

Harden G J (Ed.) (1992) **Flora of New South Wales. Volume 3**. New South Wales University Press.

Harden G J (Ed.) (1993) **Flora of New South Wales. Volume 4**. New South Wales University Press, Sydney.

Harden G J (Ed.) (2000) **Flora of New South Wales. Volume 1, Revised Edition.** New South Wales University Press.

Harden G J (Ed.) (2002) **Flora of New South Wales Volume 2, Revised Edition**. New South Wales University Press.

HBOC (2003) Hunter Region of New South Wales. **Annual Bird Report. Number 11** (2003). Hunter Bird Observers Club Inc.

HBOC (2002) Hunter Region of New South Wales. **Annual Bird Report. Number 10** (2002). Hunter Bird Observers Club Inc.

Hollands D (1991) **Birds of the Night: Owls, Frogmouths and Nightjars of Australia**. Reed Books Pty Ltd, Balgowlah.

House, S. (2003) **Lower Hunter and Central Coast Regional Biodiversity Conservation Strategy, Technical Report, Digital Aerial Photo Interpretation and Updated Extant Vegetation Community Map, May 2003**. Lower Hunter and Central Coast Regional Environmental Management Strategy (LHCCREMS).

Hoye G A and Richards G C (1995) *Greater Broad-nosed Bat Scoteanax rueppellii.* In **The Mammals of Australia**. Ed. R. Strahan. Australian Museum / Reed Publications, Chatswood. pp. 527-528.

Hyem E L (1979) **Observations on owls in the Upper Manning River District, NSW**. Corella 3: 17-25.

Kavanagh R (1991) *The target species approach to wildlife management: gliders and owls in the forests of southeastern New South Wales*. In **Conservation of Australia's Forest Fauna**. Ed Lunney, D. Royal Zoological Society of New South Wales. Surrey Beatty and Sons Pty Ltd. pp 377-384.

Kavanagh R P (1990) **Survey of Powerful and Sooty Owls in south-eastern New South Wales**. Forestry Commission of New South Wales, Beecroft.

Kavanagh R P (1988) *The impact of predation by the powerful owl, Ninox strenua, on a population of the greater glider, Petauroides volans*. **Australian Journal of Ecology** 13: 445-450.

Klippel K (1992) **Wildlife Data Search: Threatened Animal Species of New South Wales**. Total Environment Centre Inc. Breakout Press, Sydney.

Kennedy M (1990) **Australia's Endangered Species. The Extinction Dilemma**. Simon Schuster Australia.

Lunney, D., Phillips, S., Callaghan, J., and Coburn, D. (1998) **Determining the distribution of koala habitat across a shire as a basis for conservation: a case study from Port Stephens**, New South Wales. Pacific Conservation Biology 4: 186-196.

Mansergh I (1983) The Status, Distribution and Abundance of Dasyurus maculatus (Tiger Quoll) in Australia, with particular reference to Victoria. **Australian Zoologist** 21: 109-121.

Marchant S and Higgins P J (1993) **Handbook of Australian, New Zealand and Antarctic Birds. Volume 2: Raptors to Lapwings**. RAOU. Melbourne Oxford University Press.

Matthei L E (1995) **Soil Landscapes of the Newcastle 1:100 000 Sheet Report**. Department of Land and Water Conservation, Sydney.

Menkhorst P W and F Knight (2001) **A Field Guide to the Mammals of Australia**. Oxford University Press, Sydney.

Menkhorst P W, Weavers B W and Alexander J S A (1988) *Distribution, Habitat and Conservation Status of the Squirrel Glider, Petaurus norfolcensis (Petauridae: Marsupialia) in Victoria*. **Australian Wildlife Research** 15: 59-71.

Mitchell P (1990) *The home ranges and social activity of koalas - a quantitative analysis*. In **Biology of the Koala**. Ed Lee, A K, Handasyde, K A and Sanson, G D. Surrey Beatty and Sons Pty. Limited. pp 171-187.

Murray M, Bell S and Hoye G (2002) **Flora and fauna survey guidelines: lower Hunter central coast region 2002**. Lower Hunter & Central Coast Regional Environmental Management Strategy, Callaghan.

Myerscough P and Carolin R (1986) **The vegetation of the Eurunderee sand mass, headlands and previous islands of the Myall Lakes area, New South Wales**. Cunninghamia 1: 399-466.

NPWS (2000) **Sydney Freshwater Wetland Complex. Final Determination** Listing. National Parks and Wildlife Service 2000.

Phillips S and Callaghan J (1995) **The Spot Assessment Technique for Determining the Significance of Habitat Utilisation by Koalas**. Australian Koala Foundation.

Port Stephens Council (2001) **Port Stephens Council Comprehensive Koala Plan of Management** (CKPoM), June 2001. Prepared by Port Stephens Council with the Australian Koala Foundation.

Reed P C, Lunney D and Walker P (1990) *A 1986-1987 survey of the Koala Phascolarctos cinereus (Goldfuss) in New South Wales and an ecological interpretation of its distribution*. In **Biology of the Koala**. Ed Lee, A K, Handasyde, K A and Sanson, G D Surrey Beatty and Sons Pty. Limited. pp 55-74.

Schodde R and Mason I J (1980) **Nocturnal birds of Australia**. Landsdowne, Melbourne.

Smith P (1991) **The Biology and Management of Waders (Suborder Charadrii) in NSW**. Species Management Report No. 9. NSW National Parks and Wildlife Service.

Suckling G C (1995) *Squirrel Glider Petaurus norfolcensis* In **The Mammals of Australia**. Ed. R. Strahan. Australian Museum / Reed Publications, Chatswood. pp. 234-235.

Thackway R and Cresswell I D (eds.) (2000) **An Interim Biogeographic Regionalisation for Australia: A Framework for Establishing the National System of Reserves**, Version 5.1. Department of Environment and Heritage, Canberra.

Tidemann C R (1999) *Biology and management of the Grey-headed Flying-fox, Pteropus poloiocephalus*. **Acta Chiropterologica** 1: 151-164.

Watt A (1993) **Conservation Status and Draft Management Plan for *Dasyurus maculatus* and *D. hallucatus* in Southern Queensland**. Final Report to the Queensland Department of Environment and Heritage and the Department of the Environment, Sport and Territories.

Annex A

Plant Species Recorded on the Site

Table A.1 Plant Species Recorded on the Site

Scientific Name	Common Name	Open Forest		Swamp Forest	(various communities)
		Site 1	Site 2	Site 1	Opportunistic
APIACEAE					
Actinotis helianthi	flannel flower				✓
**Hydrocotyle bonariensis*	pennywort	✓		✓	
Trachymene incisa					✓
Xanthosia pilosa	woolly xanthosia		✓		
ASTERACEAE					
**Chrysanthemoides monilifera* subsp. *rotundata*	bitou bush	✓		✓	
BLECHNACEAE					
Blechnum indicum				✓	
CASSYTHACEAE					
Cassytha glabella	slender devil's twine		✓		
CASUARINACEAE					
Casuarina glauca	swamp she-oak			✓	
CONVOLVULACEAE					
**Ipomea cairica*	mile-a-minute				✓
CYPERACEAE					
Baumea rubiginosa	soft twig-rush			✓	
Eleocharis sphacelata	tall spike-rush				✓
Gahnia clarkei		✓		✓	
Lepironia articulata					✓
DAVALLIACEAE					
(*CC) *Nephrolepis cordifolia*	fishbone fern				✓
DENNSTAEDTIACEAE					
Pteridium esculentum	bracken	✓	✓	✓	
DICKSONIACEAE					
Calochlaena dubia	common ground fern			✓	

Scientific Name	Common Name	Open Forest		Swamp Forest	(various communities)
DILLENIACEAE					
		Site 1	Site 2	Site 1	Opportunistic
Hibbertia obtusifolia			✓		
Hibbertia vestita			✓		
EPACRIDACEAE					
Brachyloma daphnoides	daphne heath				✓
Epacris pulchella	coral heath		✓		
Leucopogon margarodes			✓		
Monotoca elliptica	tree broom-heath	✓	✓		
EUPHORBIACEAE					
Breynia oblongifolia	coffee bush				✓
Glochidion ferdinandi subsp. *ferdinandi*	cheese tree				✓
Ricinocarpos pinifolius	wedding bush		✓		
FABACEAE					
Faboideae					
Aotus ericoides	aotus	✓	✓		
Bossiaea heterophylla					✓
Bossiaea rhombifolia		✓	✓		
Daviesia corymbosa		✓			
Dillwynia retorta	heathy parrot pea		✓		
* *Erythrina* X *sykesii*	coral tree				✓
Glycine clandestina		✓		✓	
Jacksonia scoparia	dogwood		✓		
Kennedia rubicunda	dusky coral pea	✓		✓	
Platylobium formosum	handsome flat-pea		✓		
Mimosoideae					
Acacia longifolia var. *longifolia*	Sydney golden wattle				✓
Acacia suaveolens			✓		
Acacia ulicifolia	prickly moses		✓		
GLEICHENIACEAE					

Scientific Name	Common Name	Open Forest		Swamp Forest	(various communities)
Gleichenia microphylla	coral fern			✓	
		Site 1	Site 2	Site 1	Opportunistic
HALORAGACEAE					
Gonocarpus teucrioides	germander raspwort		✓		
LILIACEAE					
Thysanotus tuberosus	fringe lily		✓		
Tricoryne elatior	yellow rush-lily				✓
LOMANDRACEAE					
Lomandra longifolia	spiny-headed mat-rush	✓			
MALVACEAE					
**Sida rhombifolia*	Paddy's lucerne			✓	
MYRTACEAE					
Angophora costata	smooth-barked apple	✓	✓	✓	
Callistemon citrinus	crimson bottlebrush				✓
Corymbia gummifera	red bloodwood	✓	✓		
Eucalyptus pilularis	blackbutt	✓	✓		
Eucalyptus robusta	swamp mahogany			✓	
Leptospermum laevigatum	coast tea tree				✓
Leptospermum polygalifolium	lemon-scented tea tree	✓		✓	
Melaleuca quinquenervia	broad-leaved paperbark			✓	
Melaleuca styphelioides	prickly-leaved paperbark				✓
PHILYDRACEAE					
Philydrum lanuginosum	woolly frogmouth				✓
POACEAE					
Andropogon virginicus	whisky grass			✓	
* *Briza maxima*	quaking grass				✓

Scientific Name	Common Name	Open Forest		Swamp Forest	(various communities)
Cynodon dactylon	common couch	✓			
		Site 1	**Site 2**	**Site 1**	**Opportunistic**
Eragrostis brownii					✓
Imperata cylindrica var. *major*	blady grass	✓		✓	
**Pennisetum clandestinum*	kikuyu	✓			
**Rhynchelytrum repens*	red natal grass				✓
Themeda australis	kangaroo grass	✓	✓		
POLYGALACEAE					
Comesperma ericinum	heath milkwort				✓
PHORMIACEAE					
Dianella revoluta		✓	✓	✓	
PITTOSPORACEAE					
Billardiera scandens	appleberry		✓		
(CC*) *Pittosporum undulatum*	pittosporum				✓
PROTEACEAE					
Banksia integrifolia					✓
Banksia serrata	old man banksia	✓	✓		
Conospermum ellipticum	white match-heads				✓
Persoonia lanceolata					✓
Persoonia levis	smooth geebung	✓	✓	✓	
RESTIONACEAE					
Restio tetraphyllus	cord rush	✓		✓	
RUBIACEAE					
Pomax umbellata	pomax	✓	✓		
SANTALACEAE					
Exocarpus cupressiformis	cherry ballart				✓
SAPINDACEAE					
Dodonaea triquetra	large-leaf hop-bush	✓			
SMILACACEAE					
Smilax glyciphylla	sweet sarsaparilla	✓			

Scientific Name	Common Name	Open Forest		Swamp Forest	(various communities)
THYMELAEACEAE					
		Site 1	Site 2	Site 1	Opportunistic
Pimelia linifolia	rice flower		✓		
TREMANDRACEAE					
Tetratheca ericifolia		✓	✓		
VERBENACEAE					
* *Lantana camara*	lantana				✓
* *Verbena bonariensis*					✓

1. Introduced species.
2. *CC considered a weed species on the NSW central coast.
3. Open forest = coastal sand apple – blackbutt forest
4. Swamp forest = swamp mahogany – paperbark forest
5. Site 1 = Stage One
6. Site 2 = Stage Two

Annex B

Vegetation Community Descriptions

B.1 COASTAL SAND APPLE – BLACKBUTT FOREST

This community occurs as a small remnant in the northern section of the site (see *Photograph C.1*). Within this remnant, the dominant canopy species are smooth-barked apple (*Angophora costata*) and blackbutt (*Eucalyptus pilularis*) up to 18 metres in height, with a projected vegetative cover of approximately 25%. The understorey is dominated by old man banksia (*Banksia serrata*) and smooth geebung (*Persoonia levis*) up to 3 metres in height, with a vegetative foliage cover of approximately 3%. The ground layer is composed of a variety of plant life forms, dominated by bracken (*Pteridium esculentum*), sweet sarsaparilla (*Smilax glyciphylla*), cord rush (*Restio tetraphyllus*), with grasses such as kangaroo grass (*Themeda australis*) and blady grass (*Imperata cylindrica*). The ground layer varies between 0.5 to 1.5 metres in height, with a projected foliage cover of up to 30%. There is a moderate level of weed infestation from edge effects as a result of the old Soldiers Point Road.

In the disturbed areas of the site, this community occurs as a heath-like regenerating community (see *Photograph C.2*). Where a mid-storey exists, it is dominated by coast tea-tree (*Leptospermum laevigatum*) 2 to 3 metres in height. Smooth-barked apple up to 14 metres in height are scattered in this area. A shrub understorey of heathy parrot-pea (*Dillwynia retorta*), Sydney golden wattle (*Acacia longifolia*), *Persoonia lanceolata*, *Aotus ericoides* and old man banksia occurs 0.5 to 2 metres in height, with varying projected foliage cover. Some more heathy areas support *Epacris pulchella*, *Bossiaea rhombifolia* and *Hibbertia obtusifolia*.

B.2 SWAMP MAHOGANY – PAPERBARK FOREST

This community occurs as a small remnant patch adjacent to remnant coastal sand apple – blackbutt forest (see *Photograph C.3*), and as a narrow ecotone between *Lepironia* swamp and coastal sand apple – blackbutt forest in the southern section of the site. The canopy overstorey is dominated by swamp mahogany and broad-leaved paperbark (*Melaleuca quinquenervia*) up to 16 metres in height, with a projected foliage cover of approximately 40%. The understorey is dominated by *Blechnum indicum* and coral fern (*Gleichenia microphylla*) up to 1.5 metres in height with a projected foliage cover of approximately 30%. The ground layer is composed of cord rush and *Gahnia clarekei* up to 1.5 metres in height with a projected foliage cover of approximately 20%. There is a moderate level of weed presence in this community, such as Paddy's lucerne (*Sida rhomifolia*), pennywort (*Hydrocotyle bonariensis*) and bitou bush (*Chrysanthemoides monilifera* subsp. *rotundata*).

B.3 LEPIRONIA SWAMP

This community occurs in a wetland in the southern section of the site (see *Photograph C.4*). It is dominated by sedges such as *Lepironia articulata* and *Baumea rubiginosa* up to 2 metres in height, with a projected foliage cover of over 80%. The occasional broad-leaved paperbark occurs throughout. Other sedges such as cord rush and ferns such as *Blechnum indicum* are present. There is no herb layer. This wetland is permanently inundated with a water depth of up to 0.5 metres.

Annex C

Photographs

Photograph C.1

Coastal sand apple-blackbutt forest (remnant).

Photograph C.2

Coastal sand apple-blackbutt forest (regenerating).

Photograph C.3

Swamp mahogany-paperbark forest.

Photograph C.4

Lepironia swamp.

Photograph C.5

Freshwater ponds remaining following cessation of sandmining.

Photograph C.6

Fauna movement corridor (old Soldiers Point Road): Wanda Wetlands Reserve to Tilligerry Nature Reserve.

Annex D

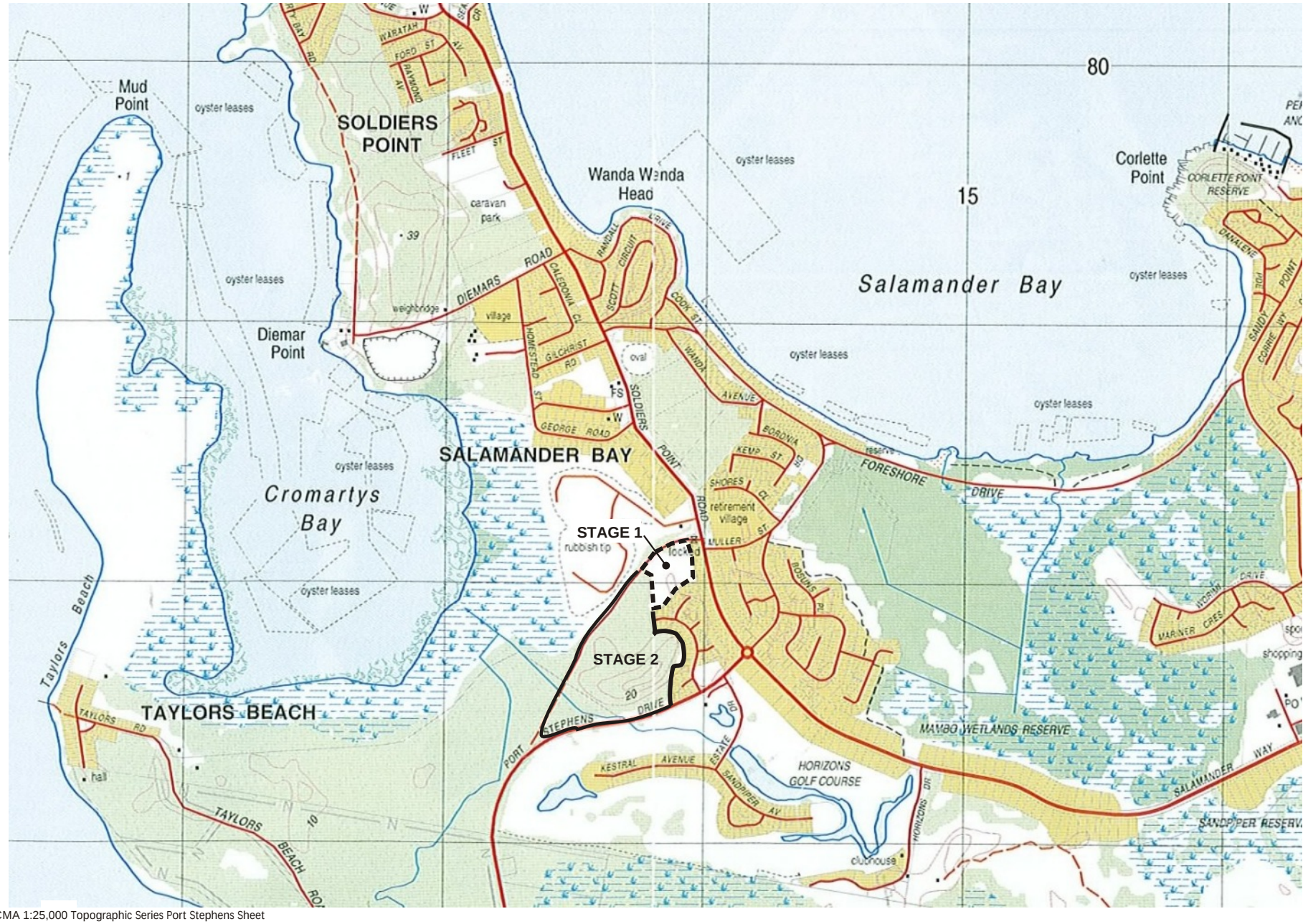
Fauna Species List

Table D.1 Fauna Species List, October 2004

Scientific Name	Common Name
AMPHIBIANS	
HYLIDAE	
Litoria fallax	dwarf tree frog
Litoria jervisiensis	Jervis Bay tree frog
Litoria peronii	Peron's tree frog
MYOBATRACHIDAE	
Crinia signifera	common eastern froglet
Crinia tinnula[V]	wallum froglet
Limnodynastes dumerilii	eastern banjo frog
Limnodynastes ornatus	ornate burrowing frog
Limnodynastes peronii	striped marsh frog
Paracrinia haswelli	Haswell's frog
Uperoleia laevigata	smooth toadlet
REPTILES	
SCINCIDAE	
Egernia major	land mullet
Lampropholis guichenoti	
VARANIDAE	
Varanus varius	lace monitor
BIRDS	
ANATIDAE	
Chenonetta jubata	Australian wood duck
ARTAMIDAE	
Cracticus torquatus	grey butcherbird
Gymnorhina tibicen	Australian magpie
CACATUIDAE	
Calyptorhynchus funereus	yellow-tailed black-cockatoo
CLIMACTERIDAE	
Cormobates leucophaeus	white-throated treecreeper
CORACIIDAE	
Eurystomus orientalis	dollarbird
CUCULIDAE	
Cuculus pallidus	pallid cuckoo
DICAEIDAE	
Dicaeum hirundinaceum	mistletoebird
DICRURIDAE	
Rhipidura fuliginosa	grey fantail
Rhipidura leucophrys	willie wagtail
HALCYONIDAE	
Dacelo novaeguineae	laughing kookaburra
Todiramphus sanctus	sacred kingfisher
MALURIDAE	
Malurus cyaneus	superb fairy-wren
Malurus lamberti	variegated fairy-wren
MELIPHAGIDAE	
Acanthorhynchus tenuirostris	eastern spinebill
Anthochaera lunulata	little wattlebird
Manorina melanocephala	noisy miner
Lichenostomus chrysops	yellow-faced honeyeater
Phylidonyris nigra	white-cheeked honeyeater
ORIOLIDAE	
Oriolus sagittatus	olive-backed oriole
PARDALOTIDAE	
Acanthiza lineata	striated thornbill

Scientific Name	Common Name
Acanthiza pusilla	brown thornbill
Pardalotus striatus	striated pardalote
Sericornis frontalis	white-browed scrubwren
PASSERIDAE	
Neochmia temporalis	red-browed finch
PHALACROCORACIDAE	
Phalacrocorax sulcirostris	little black cormorant
PODARGIDAE	
Podargus strigoides	tawny frogmouth
PSITTACIDAE	
Trichoglossus chlorolepidotus	scaly-breasted lorikeet
Platycercus eximius	eastern rosella
Trichoglossus haematodus	rainbow lorikeet
RALLIDAE	
Gallinula tenebrosa	dusky moorhen
STRIGIDAE	
Ninox novaeseelandiae	southern boobook
Ninox strenua[V]	powerful owl
SYLVIIDAE	
Acrocephalus australis	Australian reed-warbler
ZOSTEROPIDAE	
Zosterops lateralis	silvereye
MAMMALS	
DASYURIDAE	
Antechinus stuartii	brown antechinus
MURIDAE	
Rattus lutreolus	swamp rat
PHALANGERIDAE	
Trichosurus vulpecula	common brushtail possum
PHASCOLARCTIDAE	
Phascolarctos cinereus[V]	koala
PETAURIDAE	
Petaurus norfolcensis[V]	squirrel glider
Pseudocheirus peregrinus	common ringtail possum
PTEROPODIDAE	
Pteropus poliocephalus[V]	grey-headed flying-fox
VESPERTILIONIDAE	
Chalinolobus morio	chocolate wattled-bat
Miniopterus australis[V]	little bentwing-bat
Myotis adversus[V]	large-footed myotis
Scotorepens orion	eastern broad-nosed bat
Vespadelus vulturnus	little forest bat

1. E = endangered; V = vulnerable species listed in TSC Act.



Source: CMA 1:25,000 Topographic Series Port Stephens Sheet

ERM

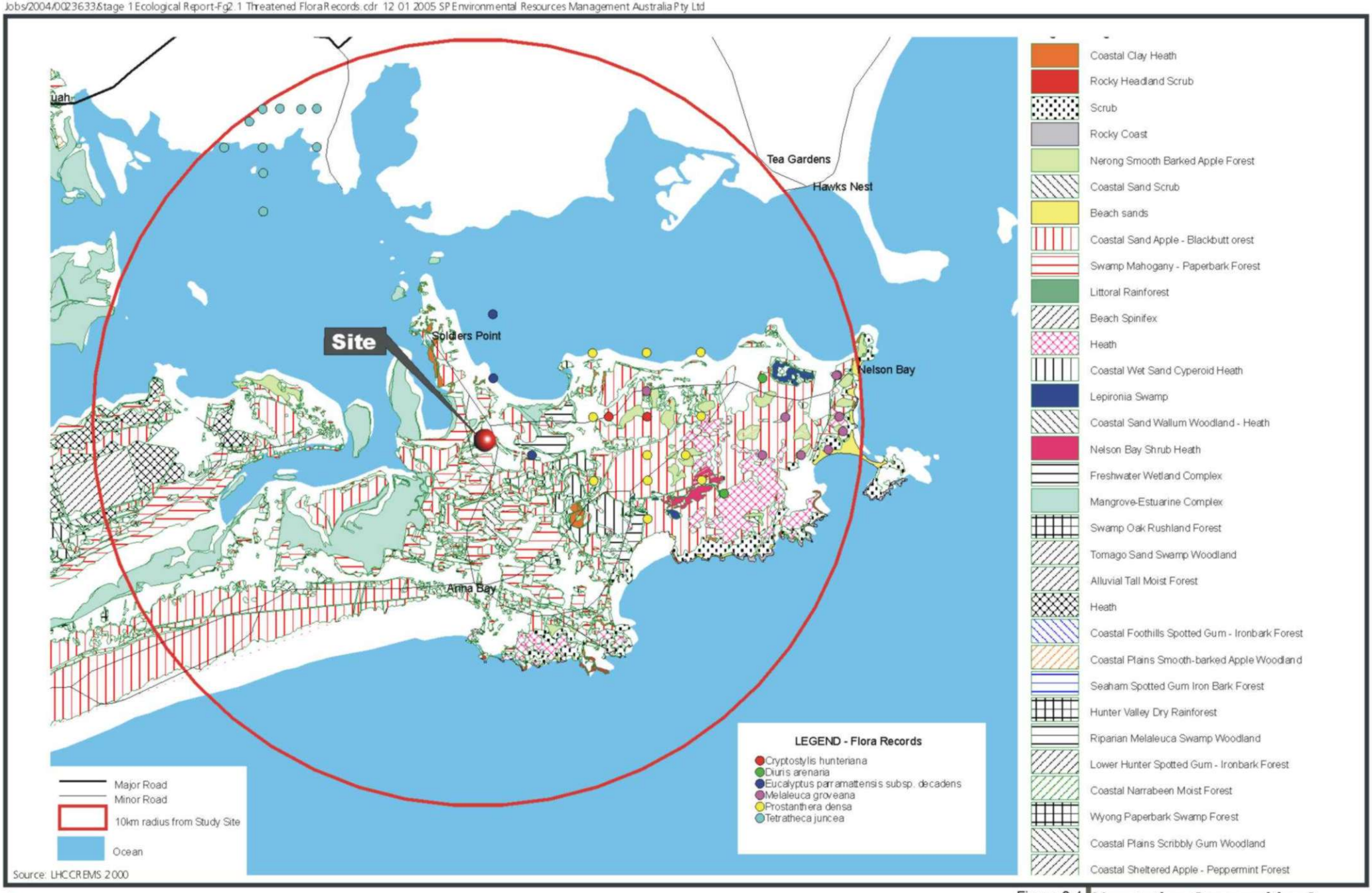
0 500m

Approximate Only

Site

Figure 1.1 Locality Plan

Hill PDA - Soldiers Point Road, Salamander Bay NSW



ERM

0 2km

Approximate Only

Figure 2.1 **Vegetation Communities & Threatened Flora Records**

Hill PDA - Soldiers Point Road, Salamander Bay NSW

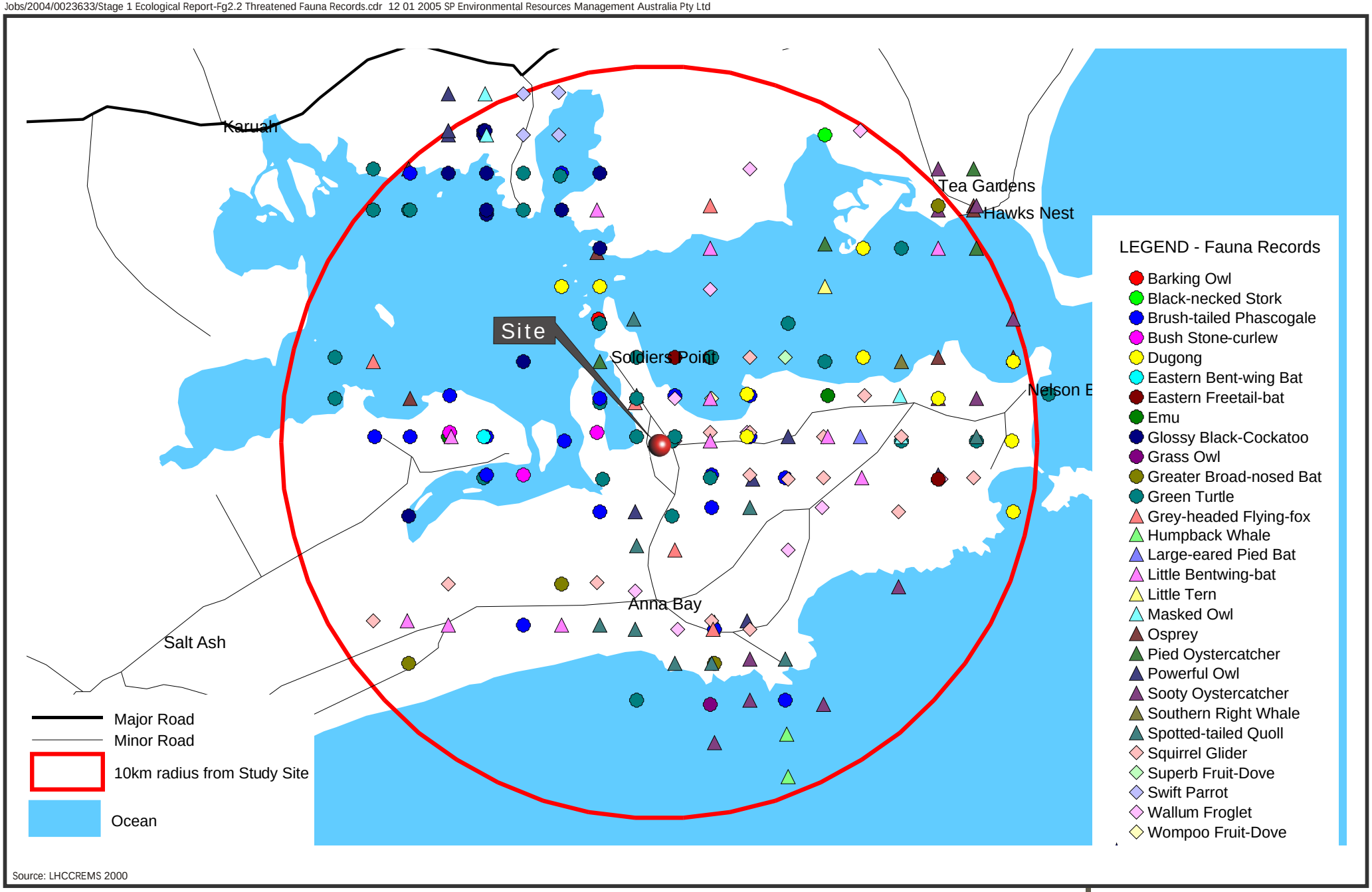
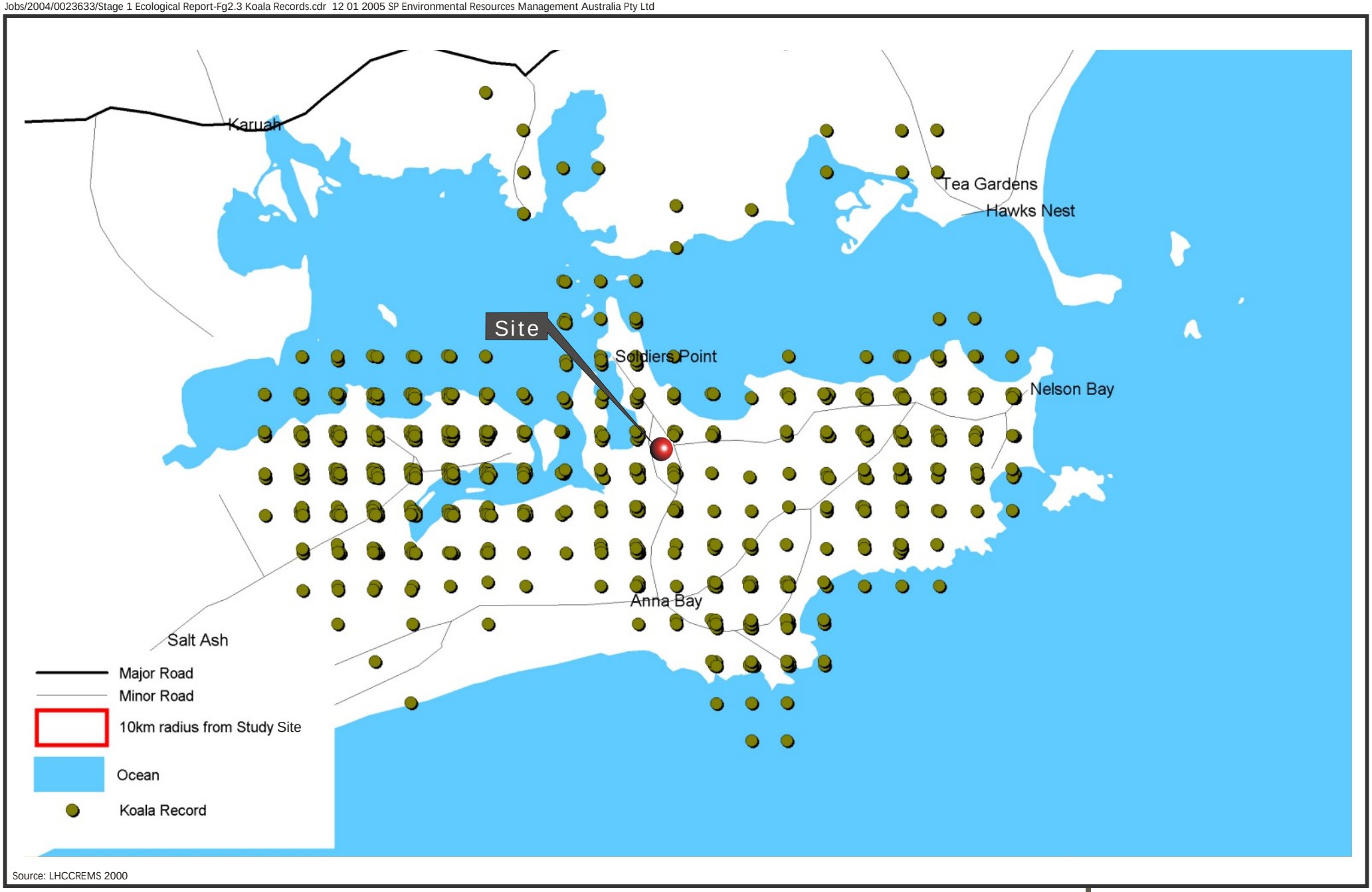


Figure 2.2 Threatened Fauna Records

ERM

Figure 2.4 Survey Effort

Hill PDA - Soldiers Point Road, Salamander Bay NSW



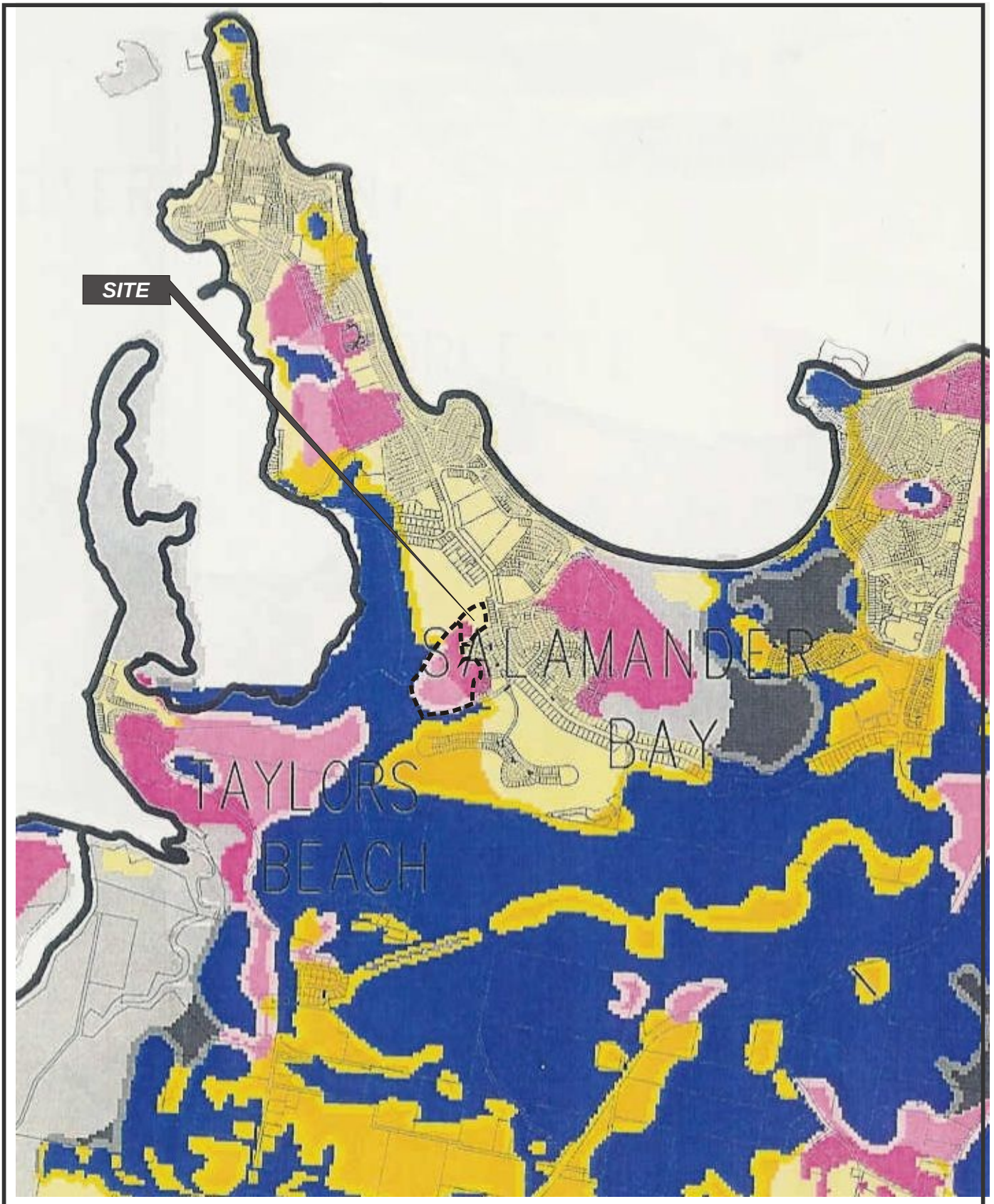
Source: LHCCREMS 2000

ERM

0 2km

Approximate Only

Figure 2.3 Koala Records



Source: Port Stephens Council 2001

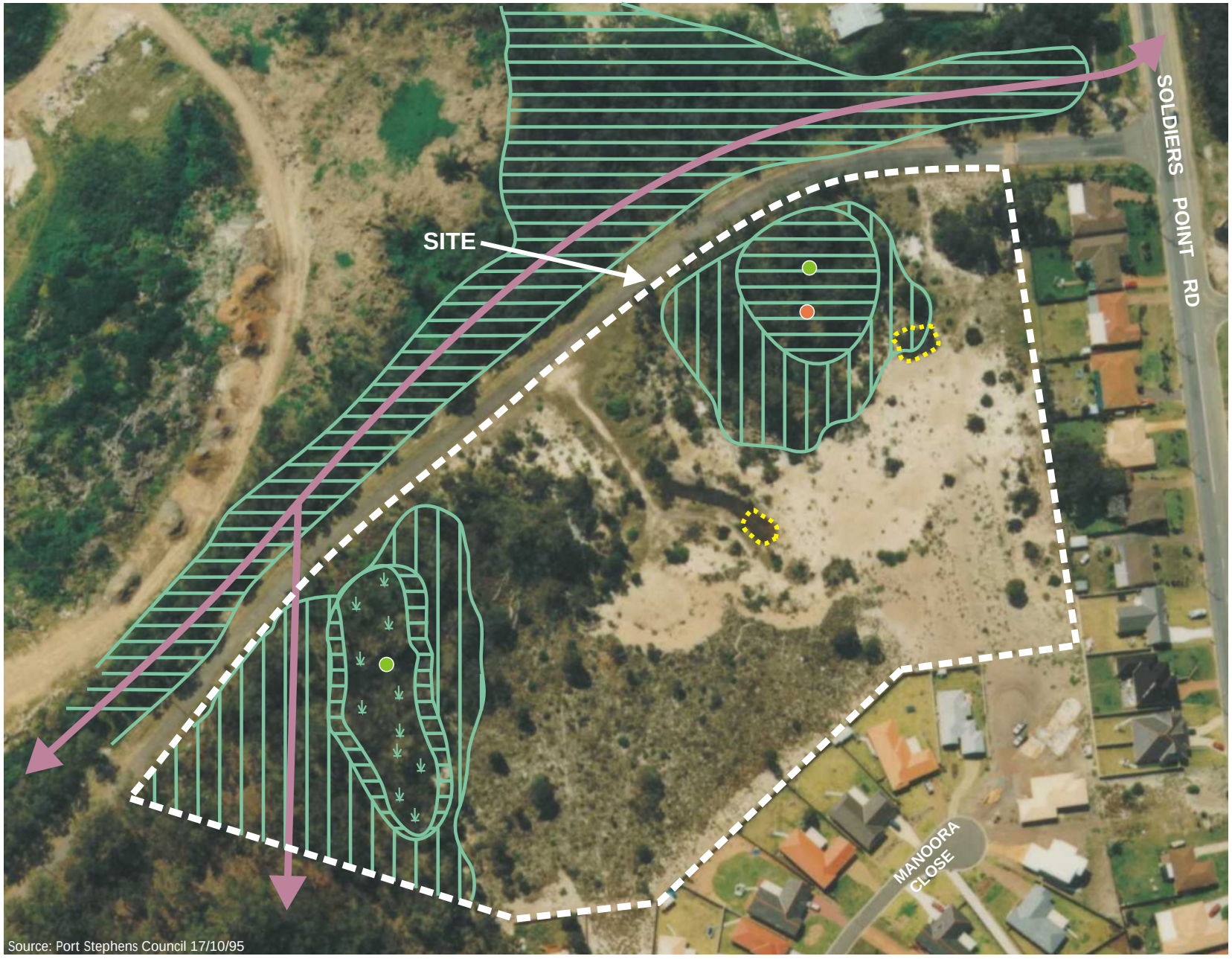
Figure 2.5 Koala Habitat Mapping

ERM

0 1km

Approximate Only

Hill PDA - Soldiers Point Road, Salamander Bay NSW



Legend

- Wallum Froglet
- Squirrel Glider
- Movement Corridor
- Swamp mahogany-paperbark forest
- Lepironia Swamp
- Coastal sand- apple blackbutt forest
- Freshwater Ponds

NB: The remainder of the site is regenerating coastal sand apple-blackbutt forest.

ERM

0 40m

Approximate Only

Figure 3.1 Survey Results

Hill PDA - Soldiers Point Road, Salamander Bay NSW

Legend

- Preferred Koala Habitat
- 50m Buffer to Preferred Koala Habitat

NOTE: Remainder of Site is Supplementary Koala Habitat

ERM

0 40m

Approximate Only

Figure 3.2 Koala Habitat

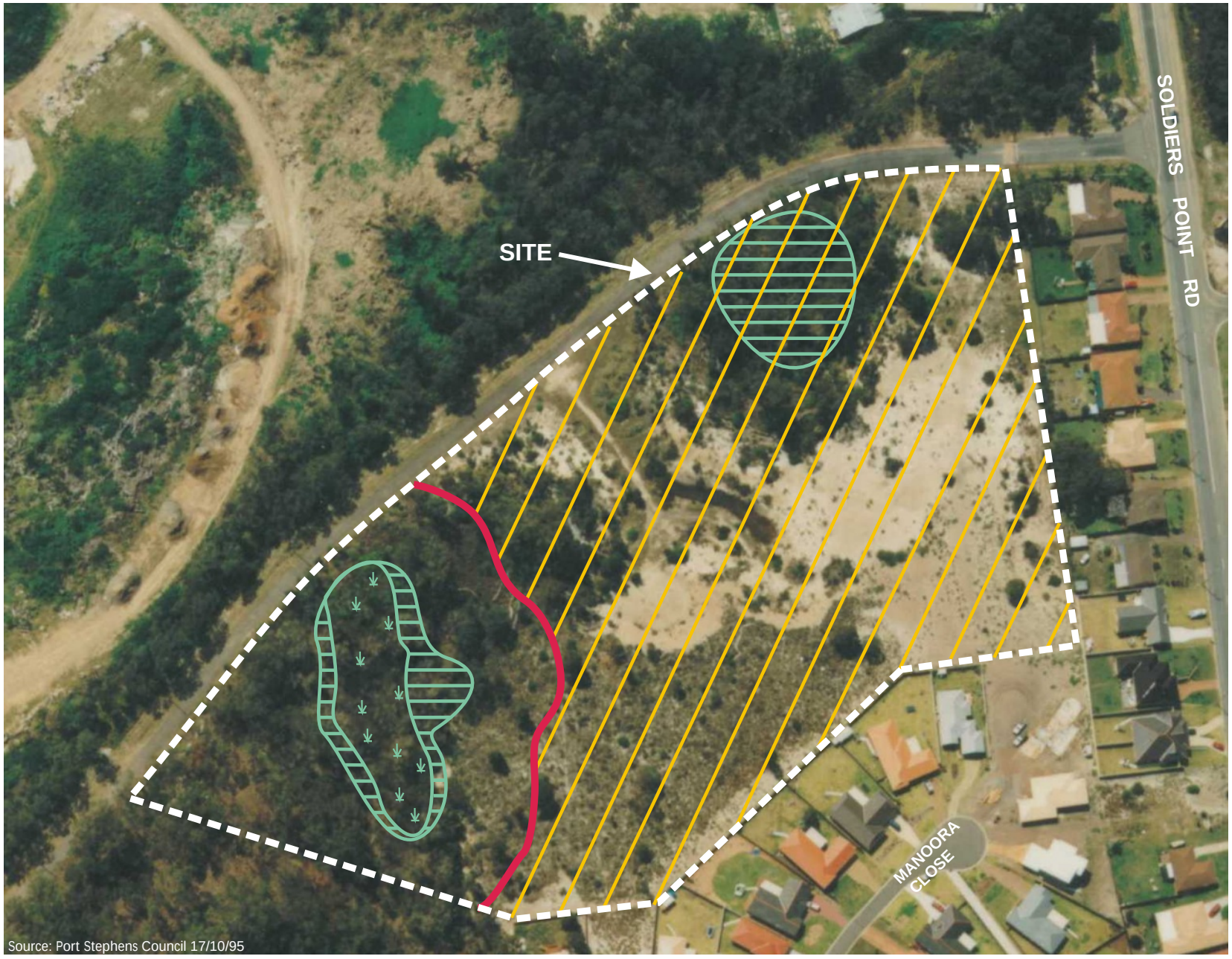
Hill PDA - Soldiers Point Road, Salamander Bay NSW

Source: Port Stephens Council

0 160m
Approximate Only

Figure 3.3 Fauna Movement Corridors & Surrounding Reserves

Hill PDA - Soldiers Point Road, Salamander Bay NSW



Legend

- Preferred Koala Habitat
- Lepironia Swamp
- 30m Habitat Buffer
- Maximum Development Footprint

ERM

0 40m

Approximate Only

Figure 4.1 Proposed Development Footprint

Hill PDA - Soldiers Point Road, Salamander Bay NSW