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A FLORA AND FAUNA SURVEY OF LOT 4 DP615261, LOT 1 DP374315, AND PART OF CROWN RESERVES R82555 AND R754444, OCEAN DRIVE, LAKE CATHIE

PREPARED FOR KING AND CAMPBELL PTY LTD, PORT MACQUARIE

July 2010

FIGURES

TABLES

GLOSSARY

Assessment guidelines: means assessment guidelines issued and in force under section 94A of the *Threatened Species Conservation Act 1995* or, subject to section 5C of the *Fisheries Management Act 1994*

Abundance: means a quantification of the population of the species or community

Affected species: means subject species likely to be affected by the proposal

Conservation status: is regarded as the degree of representation of a species or community in formal conservation reserves

Critical habitat: the area declared to be critical habitat under Part 3 of the *Threatened Species Conservation Act 1995*

DECCW: Department of Environment and Climate Change and Water

Development: the erection of a building on that land, the carrying out of work in, on, over or under that land, the use of that land or of a building or work on that land, and the subdivision of that land

Ecological community: an assemblage of species occupying a particular area

Endangered ecological community ("EEC"): an ecological community specified in Part 1 of Schedule 1 of the *Threatened Species Conservation Act 1995*

Endangered population: a population specified under Part 1 of Schedule 1 of the *Threatened Species Conservation Act 1995*

Endangered species: a species listed under Schedule 1 of the *Threatened Species Conservation Act 1995*

EPA Act: *Environmental Planning and Assessment Act, 1979*

Habitat: an area or areas occupied, or periodically or occasionally occupied by a species, population or ecological community and includes any abiotic component

Locality: the area within a 5 km radius of the study site

GLOSSARY

Recovery and threat abatement plan: a plan to promote the recovery of threatened species, population or an ecological community with the aim of returning the species, population, or ecological community to a position of viability in nature. The purpose of the threat abatement plan is to manage key threatening processes with a view to their abatement, amelioration or elimination

SEPP: State Environmental and Planning Policy

Significant species: means species not listed under the *Threatened Species Conservation Act 1995* but considered to be of regional or local significance

Study area: is the subject site and any additional areas which are likely to be affected by the proposal, either directly or indirectly

Subject site: the area which is proposed for development or activity

Subject species: those threatened species which are considered known or likely to occur in the study area

Threatened species: a species listed in Part 1 or 4 of Schedule 1 or in Schedule 2 of the *Threatened Species Conservation Act 1995*

Threatening process: means a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities

TSC Act: *Threatened Species Conservation Act 1995*

Vulnerable species: A species listed under Schedule 2 of the *Threatened Species Conservation Act 1995* or when a fish, listed under the *Fisheries Management Act 1994*

SUMMARY

- This flora and fauna study was prepared on behalf of King and Campbell Pty Ltd for the Concept Plan and Project Application of Lot 4 DP 615261, Lot 1 DP 374315 and part of Crown Reserves R82555 and R754444, Lake Cathie, NSW.
- A flora and fauna survey was initially undertaken at the site from 25 to 28 February 2002. This included a floristic survey and analysis and a systematic fauna trapping survey over three nights. Over 10 additional surveys and site inspections have been undertaken up to the present date. These confirmed vegetation boundaries and updated the 2002 survey, investigated alternative beach access routes, included a fish survey of Duchess Creek and complied with matters raised in the Director General's Specifications for the development.
- Eight vegetation associations in four communities were recorded. The most significant of these was littoral rainforest gazetted under the State Environmental and Planning Policy No. 26 (Littoral Rainforest No. 116). Littoral rainforest is listed as an Endangered Ecological Community.
- One threatened plant species, the rough-shelled bush-nut was recorded at the site. However, this was a planted specimen located in an old orchard. The rough-shelled bush nut has not been recorded in the wild south of the Clarence River.
- Additional threatened plants may be recorded in the littoral rainforest which is largely outside of the Applicant's land. The littoral rainforest and proposed buffers will be preserved, buffered and managed by qualified bush regenerators.
- One vulnerable bat, the common blossom bat, was trapped at the site while foraging on coast banksias. Another two vulnerable species, the grey-headed flying fox and the little bent-wing bat were also recorded. Other vulnerable species which have suitable habitat components at the site include the osprey, the rose-crowned fruit-dove, the wompoo fruit-dove, the barred cuckoo-shrike, the glossy black cockatoo, the masked and powerful owls, the greater broad-nosed bat, the large bent-wing bat and the fishing bat. The potential impact of the proposal on these species is negligible and has been addressed in this report.

SUMMARY

- This report recommends land management proposals which will enhance and maintain the littoral rainforest into the future. These include a substantial littoral rainforest buffer and the reafforestation of this buffer, fencing along the western perimeter of the littoral rainforest buffer, upgrading the existing beach access by the provision of an elevated boardwalk, drainage works and stormwater management facilities to enhance water quality and landscaping with native plantings throughout the site.
- Bushland regeneration works, including weed control, is proposed for the site and the adjoining littoral rainforest. A report has been prepared by with respect to these activities by Wild Things Native Gardens. This report describes establishing a nursery using locally sourced seeds, species selection, management and monitoring.
- A statutory assessment of the proposal was undertake by addressing the matters raised in Section 9 of the Department of Planning Director General's Specifications for projects assessed under Part 3A of the *Environmental Planning and Assessment Act, 1979*. This assessment also includes addressing environmental matters raised in correspondence from the Department of Planning in their letter dated 22 June 2010 and addressing the *Environment Protection and Biodiversity Conservation Act, 1999*.

1.0 INTRODUCTION

A number of flora and fauna surveys have been undertaken for King and Campbell Pty Ltd over eight years to inform a Concept Plan and Project Application for land identified as Lot 1, DP 374315, Lot 4 DP 615261 and part of Crown Reserves R82555 and R754444, Ocean Drive, Lake Cathie (the "site") (Fig. 1).

Part of the site and Crown lands to its east are mapped as Littoral Rainforest No. 116 under the State Environmental and Planning Policy (SEPP) No. 26 (Littoral Rainforests). The aim of the Littoral Rainforest Policy is *"to provide a mechanism for the consideration of applications for development …… with a view to the preservation of those areas in their natural state"*. The Policy applies to vegetated land mapped along the frontages of Lots 1 and 4 (the littoral rainforest core) and to land within 100 m from the outer edge of the subject line (the littoral rainforest buffer zone) (Fig. 1).

A systematic flora and fauna survey was undertaken at the site in February 2002 in order to identify and make recommendations to protect its natural values. This survey concentrated on the littoral rainforest, although vegetation assessments and standardised fauna survey methods were applied over the whole of the site. Approximately ten additional site visits have been undertaken between 2002-2010 including additional vegetation surveys and a fish survey.

1.1 Statutory requirements

This application is determined under Part 3A of the *Environmental Planning and Assessment Act, 1979*. Accordingly, the Director General of the

Department of Planning ("DoP") has written to the Applicant and advised that the following matter with respect to flora and fauna need to be addressed:

9. Flora and Fauna

9.1 Identify the potential impacts of the proposed development on the SEPP 26 littoral rainforest, particularly with regard to surface and groundwater hydrology and quality and public access to the beach and edge effects. Outline measures for the ongoing management and protection of the SEPP 26 vegetation.

9.2 Outline potential impacts on aquatic and terrestrial flora and fauna, endangered ecological communities and their habitats (within the meaning of the Threatened Species Conservation Act, 1995 and the Fisheries Management Act 1994). Provide measures for their conservation, where relevant, including the consideration of compensatory habitat.

9.3 Outline measures for the conservation of any existing wildlife corridor values and/or connective importance of any vegetation on the subject land.

9.4 Address measures to protect and manage the riparian corridor and adjacent aquatic habitats.

In addition to the above, the Department of Environment, Climate Change and Water (then the Department of Environment and Climate Change) advised the DoP that an environmental assessment must follow the DECC's draft guidelines for threatened species assessment (July 2005) and the following matters must be addressed:

a. a field survey should be conducted and documented in accordance with the guidelines.

b. Likely impacts on threatened species and their habitat need to be assessed, evaluated and reported on (Step 3 of the guidelines).

c. The EA must describe the actions that will be taken to avoid impacts, or to mitigate unavoidable impacts of the project on threatened species and their habitat. This should include an assessment of the effectiveness and reliability of the measures and any residual impacts after these measures are implemented.

d. Step 4 of the draft guidelines requires that where measures to avoid or mitigate are not possible, offset strategies need to be considered.

e. The EA must clearly state whether it meets each of the key thresholds set out in Step 5 of the draft guidelines.

f. The EA must consider the corridor values or any connective importance of any vegetation on the subject land.

2.0 RELEVANT STUDIES

There are a number of studies or reports which relate to the site and environs. These include:

- Biolink 2007 *Area 14, Stage 1B, Ecological Assessment, Lot 1 DP 374315 and Lot 4 DP 615261,* A report for Port Macquarie Hastings Council. The Biolink report included threatened species and endangered ecological community listings proximal to or at the site since the Parker 2002 survey and littoral rainforest or setbacks. It also included a review of the Martens' groundwater management and monitoring;

- Brennan, P March 2006 Supplementary comments on littoral rainforest buffers and edge effects including buffer treatment and management;
- Darkheat Eco-consultancy 2002 *Flora and fauna survey of middle rock littoral rainforest, lake Cathie.* A report to Port Macquarie Hastings Council;
- ERM Mitchell McCotter Pty Ltd 1994 *Bonny Hills/Lake Cathie ecological study.* A report to Hastings Council. This ecological assessment included a flora survey and an assessment of the attributes of the site for fauna. No systematic fauna survey was undertaken, but predictions of occurrence were provided;
- ERM Mitchell McCotter Pty Ltd 1994 *Regeneration strategy.* A report prepared for King and Campbell Pty Ltd. This report was commissioned by King and Campbell Pty Ltd to provide a regeneration strategy for land previously cleared on Lot 4 DP 615261, Lake Cathie;
- ERM Mitchell McCotter Pty Ltd 1995 *Lake Cathie, SEPP 26 buffer assessment.* A report to Hastings Council. This report addressed potential land use impacts in the area within 100 m of the littoral rainforest and suggested a suitable buffer. ERM Mitchell McCotter relied on a single visit on 5 December 1995, a literature search and correspondence between a number of experts in specific disciplines;
- Jelliffe Environmental Pty Ltd 2002 *Stormwater quality and management report.* A report to King and Campbell Pty Ltd;
- King and Campbell Pty Ltd 2006 The rezoning application (draft LES), associated revegetation plan and proposed planning agreement;
- Peter Parker Environmental Consultants Pty Ltd 2002, *A Flora and Fauna Survey of Lot 4 DP 615261 and Lot 1 DP 374315, Ocean Drive, Lake Cathie*. A report to King and Campbell Pty Ltd; and
- Peter Parker Environmental Consultants Pty Ltd 6 March 2006, *Supplementary comments*. A report on proposed littoral rainforest buffer treatment;
- Peter Parker Environmental Consultants Pty Ltd 20 June 2007, *Supplementary comments on riparian rainforest;*

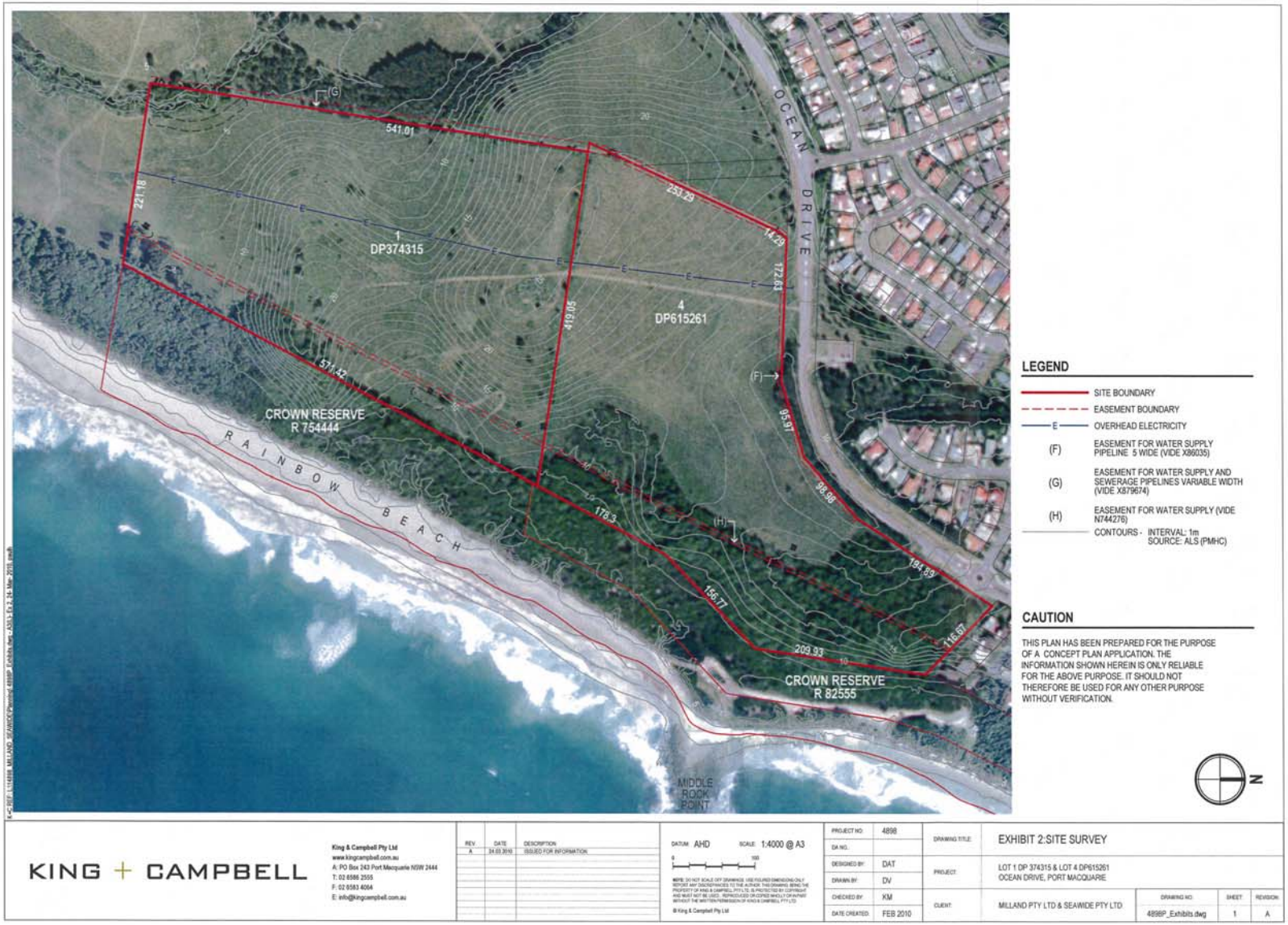


Fig. 1: Location illustrating the site and adjoining littoral rainforest

3.0 FIELD SURVEYS

A systematic flora and fauna survey was undertaken at the site from 25 to 28 February 2002. This included three nights of fauna trapping (25, 26 and 27 February 2002) and, despite it being undertaken prior to any formal guidelines being prepared, was generally in compliance with the methodology outlined in the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* produced by the Department of Environment and Conservation, November 2004 (now Department of Environment, Climate Change and Water) (See Appendix 3 for extract of trapping effort required in DEC guidelines).

Methods in the 2002 survey varied in order to maximise results (Table 1, Fig. 2). This included setting harp-nets in gullies or flyways for megachiropteran and microchiropteran bats, using Elliott traps, hair-tube traps and cage traps in the littoral rainforest, undertaking spotlight surveys in areas of blossoming banksias and open grassland and establishing two lines of pit-fall traps over a variety of ecotones in the littoral rainforest.

Table 1: Survey methods (Fig. 2)

Standardised survey method	2002 survey
Bat acoustical sampling	25-27 February (three nights)
Bat harp-net	25-27 February (three nights)
Bat mist-net	25 February (one night)
Bird play-back calls	25-27 February (three nights)
Bird transects	25-27 February (day and night)
Cage traps	25-27 February (three nights)
Elliott traps	25-27 February (150 trap-nights)
Frog call detection	25-27 February (three nights)
Hair-tube traps	25-27 February (150 trap-nights)
Litter searches	opportunistic
Pitfall traps	25-27 February (30 trap-nights)
Scat analysis	opportunistic
Spot lighting	25-27 February (three nights)

3.1 Weather

The weather experienced during the survey is illustrated in Table 2.

Table 2: Weather recorded during systematic survey in 2002

Date	Day	Evening
25 February	Drizzle (1.5 mm), clearing by 1300 hrs, north-east winds to 8 knots	Drizzle, 6.5 mm rain recorded to 900 hrs
26 February	Drizzle, overcast, 25^{0}C at 1530 hrs, easterly breezes, 28^{0}C at 1700 hrs	23 ^{0}C 9.20, 0.5 mm overnight rain. Min overnight temperature 18.5^{0}C
27 February	Warm clear, slight easterly breeze	Full moon. Min overnight temperature 20.6 ^{0}C
28 February	Overcast 25^{0}C at 900 hrs, clearing 27 ^{0}C 1300 hrs	No overnight rain. Overnight temperature 21.7 ^{0}C

3.2 Vegetation

3.2.1 Air photo interpretation and field surveys

Vegetation mapping was initially undertaken prior to the commencement of fauna sampling. Vegetation was mapped over a coloured aerial photograph at

a scale of approximately 1:5000 (Hastings Council) and vegetation patterns were ground truthed for accuracy (Fig. 3). More recent aerial photos have been reviewed since the survey was undertaken to confirm that vegetation boundaries have not changed significantly from those mapped in 2002 (eg., see Fig. 1). Vegetation along the western margin of the littoral rainforest was surveyed by King and Campbell Pty Ltd surveyors.

3.2.2 Vegetation classification, structure and floristics

The vegetation classification system adopted for this survey is based on Walker and Hopkins (1990). This system describes the components of the association in the following order:

- the first species is usually the most abundant in the tallest stratum;
- a second species is chosen when it is always present in the tallest stratum. In the absence of a tallest stratum species the most abundant species in the next most conspicuous stratum is chosen. For those associations where several species dominate, these are listed in order of abundance;
- a third species is chosen from any stratum, usually a ground cover or shrub layer. It is used as an indicator species;
- the forest type refers to the distances between the crowns of adjacent trees (Table 3); and
- the height of the tallest stratum is defined by the terms 'low', 'mid-high', or 'tall' (Table 4).

3.2.3 Vegetation transects

Vegetation associations were initially surveyed and mapped between 25 and 28 February 2002 by walking in meandering transects throughout the site. Areas of vegetation were repeatedly inspected during both the vegetation and the fauna survey. The littoral rainforest was surveyed by transects that

extended from the southern boundary of Lot 1 to near the northern boundary of Lot 4. Opportunistic observations and collections of plant specimens were undertaken beyond these transects during the fauna survey. The grassland areas at the site were accessed by vehicle and small forested patches were inspected on foot.

Additional surveys were undertaken on 30 May 2007, 10 December 2007 and 29 June 2010. The 30 May 2007 resurveyed the vegetation along Duchess Creek, the 10 December 2007 survey surveyed several potential locations for boardwalks through the littoral rainforest to Rainbow Beach and the 29 June 2010 survey re-examined the boardwalk location ultimately selected, the vegetation along Duchess Creek, the grassland and location of the rough-shelled bush nut and vegetation along Ocean Drive in the north-west of the site. Approximately seven additional site inspections were undertaken at various time between 2002 and 2010. These were undertaken to advise on revegetation on the western side of the littoral rainforest, on planning and amelioration works or to inspect bore log locations. The recommendations of these inspections have ultimately been incorporated into the final project design.

The following features of the vegetation were noted during the vegetation surveys:

- dominant trees, shrubs and ground covers in each strata (Table 3);
- major plant species in the association;
- tree heights and foliage cover; and
- any threatened species.

Table 3: Structural formation classes defined by growth form and crown separation (after Walker and Hopkins 1990)

Crown separation	Closed or dense	Mid-dense	Sparse	Very sparse	Isolated plants	Isolated clumps
Field criteria	Touching-overlapping	Touching-slight separation	Clearly separated	Well separated	Isolated	Isolated
Growth form						
Tree	Closed forest	Open forest	Woodland	Open woodland	Isolated trees	Isolated clumps of heath shrubs
Heath shrub	Closed heathland	Heathland	Open heath	Sparse heath	Isolated heath shrubs	Isolated clump of heath shrubs
Sedge	Closed sedgeland	Sedgeland	Open sedgeland	Sparse sedgeland	Isolated sedges	Isolated clump of sedges
Sod grass	Closed sod grassland	Sod grassland	Open sod grassland	Sparse sod grassland	Isolated sod grasses	Isolated clumps of sod grasses

Table 4: Height classes and names of various growth forms for non-rainforest associations (after Walker and Hopkins 1990)

Height m	Trees, vines	Shrubs, heath shrubs, chenopod shrubs, mallee (tree or shrub form)	Tussock and hummock grasses, forbs, rushes, sedges, ferns	Sod grasses, mosses, lichens, liverworts
20.01-35.01	*Extremely tall*	*NA*	*NA*	*NA*
12.01-20	*Tall*	*NA*	*NA*	*NA*
6.01-12	*Mid-high*	*Extremely tall*	*NA*	*NA*
3.01-6	*Low*	*Very tall*	*Extremely tall*	*NA*
1.01-3	*Dwarf*	*Tall*	*Tall*	*Extremely tall*
0.51-1	*NA*	*Low*	*Mid-high*	*Tall*
0.26-0.5	*NA*	*Low*	*Mid-high*	*Tall*
<0.25	*NA*	*Dwarf*	*Low*	*Low*

3.3 Fauna

3.3.1 Aims

Fauna surveys were designed to record vertebrate fauna using the site and specialist techniques targeted threatened species known to occur in the study area. Fauna survey techniques were generally consistent with the methodologies described in the DECC draft survey guidelines (2004) (see Table 5 and Appendix 3).

3.3.2 Methods

3.3.2.1 Frogs

Spotlighting and listening for frog calls was conducted over three nights (25 – 27 February 2002) and opportunistically during the day. Conditions were ideal with rainy periods and showers experienced throughout the survey. Additional surveys were conducted on an opportunistic basis during site visits over the past eight years. Frog calls were detected on 30 June 2007, 10 December 2007 and on 29 June 2010. No additional species were detected during these surveys to those recorded in the 2002 survey.

3.2.2.2 Reptiles

Foot-based searching and pit-fall trapping was conducted over three days from 25 –27 February 2002. Reptile searches were undertaken in different habitats, including along tracks and potential shelter sites among leaf litter and logs and in the branches of trees and following up inspections were undertaken opportunistically as described in section 3.3.2.1.

3.2.2.3 Birds

Birds were identified visually and aurally during post-dawn and evening transects in the 2002 survey and opportunistically over the following eight years (Fig. 2). Transects of approximately 40 minutes duration were undertaken in the 2002 survey. These were on the evenings of 25 – 27 February and the mornings of 26 - 28 February 2002.

Play-back calls, broadcast through a loudspeaker/hailer were used to identify the presence of cryptic or nocturnal species. Calls of the grass owl, masked owl and powerful owl were broadcast shortly after dusk and at random times between 1800 hours (dusk) and 1900 hours on 26 and 27 February 2002 (Fig. 2).

Table 5: Threatened species for which suitable habitats occur at or proximal to the study site (Source DECCW database)

Common name	Scientific name	Habitat and sampling method
Plants		
White-flowered wax plant	*Cynachnum elegans*	Dry, littoral or subtropical rainforest and occasionally in scrub or woodland, targeted searches
Birds		
Barred cuckoo-shrike	*Coracina lineata*	Rainforest specialist fond of fruiting figs. Observation and call
Glossy black cockatoo	*Calyptorhynchus lathami*	She-oak woodlands, observation and call detection
Masked owl	*Tyto novaehollandiae*	Open woodland and forest. Play-back call
Osprey	*Pandion haliaetus*	Coastal foreshores and estuaries. Observation
Powerful owl	*Ninox strenua*	Open woodland and forest. Play-back call
Rose-crowned fruit-dove	*Ptilinopus regina*	Rainforest specialist. Observation and call
Wompoo fruit-dove	*Ptilinopus magnificus*	Obligate rainforest specialist. Observation and call
Mammals		
Common blossom bat	*Syconycteris australis*	Coastal banksias woodland and rainforest. Mist and Harp-net
Fishing bat	*Myotis adversus*	Forages over water bodies, Anabat and harp net
Greater broad-nosed bat	*Schoteanax rueppellii*	Open woodland and forest. Anabat and harp net
Grey-headed flying fox	*Pteropus poliocephalus*	Coastal banksias woodland and rainforest. Observation, spotlight and call
Large bent-wing bat		Open woodland, forest and rainforest. Anabat and harp net
Little bent-wing bat	*Miniopterus australis*	Open woodland, forest and rainforest. Anabat and harp net

3.3.2.4 Mammals

A mammal survey was conducted using a spotlight, pit-fall traps, Elliott traps, hair-tube traps, harp-nets, a mist-net, ultrasonic detection devices (Anabat 11), the collections of scats and day-time observations.

Hair-tube traps

A total of 25 hair-tube traps was set in two transects at the site over three nights (150 trap-nights) (25 - 28 February 2002).

Elliott and cage traps

Twenty five Elliott type "A" traps (25 x 3 x 2 = 150 trap-nights) were set along the same two transects as the hair-tube traps in order to confirm the results of the hair-tube trap analysis and detect species that may have been under-sampled or not sampled with hair-tube traps. These were set from 25 to 28 February 2002. Five cage traps were set along the same two transect lines (5x3 = 15 cage-trap nights). Hair-tube, Elliott and cage traps were baited with a mixture of peanut butter and oats containing vanilla essence and sardines.

Pit-fall traps

Pit-fall traps utilised 5 x 20 litre plastic buckets in two transects joined by a 30 m x 0.3 m high drift fence that was positioned to direct fauna into the traps. Pit-fall traps were set on 25 February and retrieved on 28 February 2002 (10 x 5 = 50 trap-nights). Traps were inspected daily throughout this period and any animals captured were released in the proximity of the trap-line.

Spotlighting

Nocturnal sampling was undertaken, using a hand-held 55 watt halogen spotlight, along the trap-line transect and along tracks within and around the site (Fig. 2).

Day-time searching

Day-time searching for reptiles and skinks focused on the littoral rainforest. Observations of birds and macropods included the littoral rainforest and grasslands.

Bat survey

Sampling for megachiropteran and microchiropteran bats utilised harp-nets, a mist net and ultrasonic detection devices. Two Austbat harp-nets were set along flyways on 25 February and one was set on 26 February 2002 (3 trap-nights). Three Anabat II detection devices were set to detect bat activity over all vegetation associations over three nights: 25 to 28 February 2002 (3 x 3 = 9 acoustical detector nights).

Bat calls were recorded on a 45 minute tape using a detector, a timing device and a tape recorder. Calls were analysed by this consultant.

Spotlighting and audible calls

Flying-foxes were recorded by spotlighting potential food trees and by the identification of their characteristic social calls. Spotlighting for bats was also undertaken throughout the study area, especially among flowering coast banksias.

Fish survey

A fish survey was undertaken by two observers using spotlights in 2002 in the far north west of the site and extending onto Ocean Drive road reserve. This survey effort was extended following a request from the Department of Planning ("DoP") to survey Duchess Creek where it passes through the site. The 2010 survey used five baited fish traps set for one night and 30 minutes of spotlight sampling on 29 June 2010. This effort was considered sufficient as only 85 m of the creek enters the site and the creek was broken into a number of small pools containing algae flocks and the water level was less than 30 cm in depth.

Peter Parker

Project: Ocean Drive, Lake Cathie — Client: King and Campbell

Fig. 2: Survey methods

North

Source: Field Survey Peter Parker — Date: 2002 - 2010 — Scale metres: 0 — 100

4.0 RESULTS

4.1 Vegetation associations and communities

Eight vegetation associations in four communities was recorded and mapped (Table 6).

Table 6: Vegetation associations (Fig. 3)

Littoral rainforest

Lophostemon confertus (brushbox), *Acronychia imperforata* (beach acronychia), *Cupaniopsis anarcardioides* (tuckeroo) simple notophyll littoral rainforest

Acacia melanoxylon (blackwood), *Commersonia bartramia* (brown kurrajong), *Chrysanthemoides monilifera* spp. *rotundata* (bitou bush) simple notophyll (regrowth) littoral rainforest

Forest

Eucalyptus siderophloia (grey ironbark), brushbox, *Lantana camara* (lantana) tall open forest

Callistemon saligna (pink-tipped bottlebrush), *Melaleuca quinquenervia* (broad-leaved paperbark), *Gahnia clarkei* (tall saw-sedge) low to mid-high open forest

Broad-leaved paperbark, *Casuarina glauca* (swamp she-oak) mid-high open forest

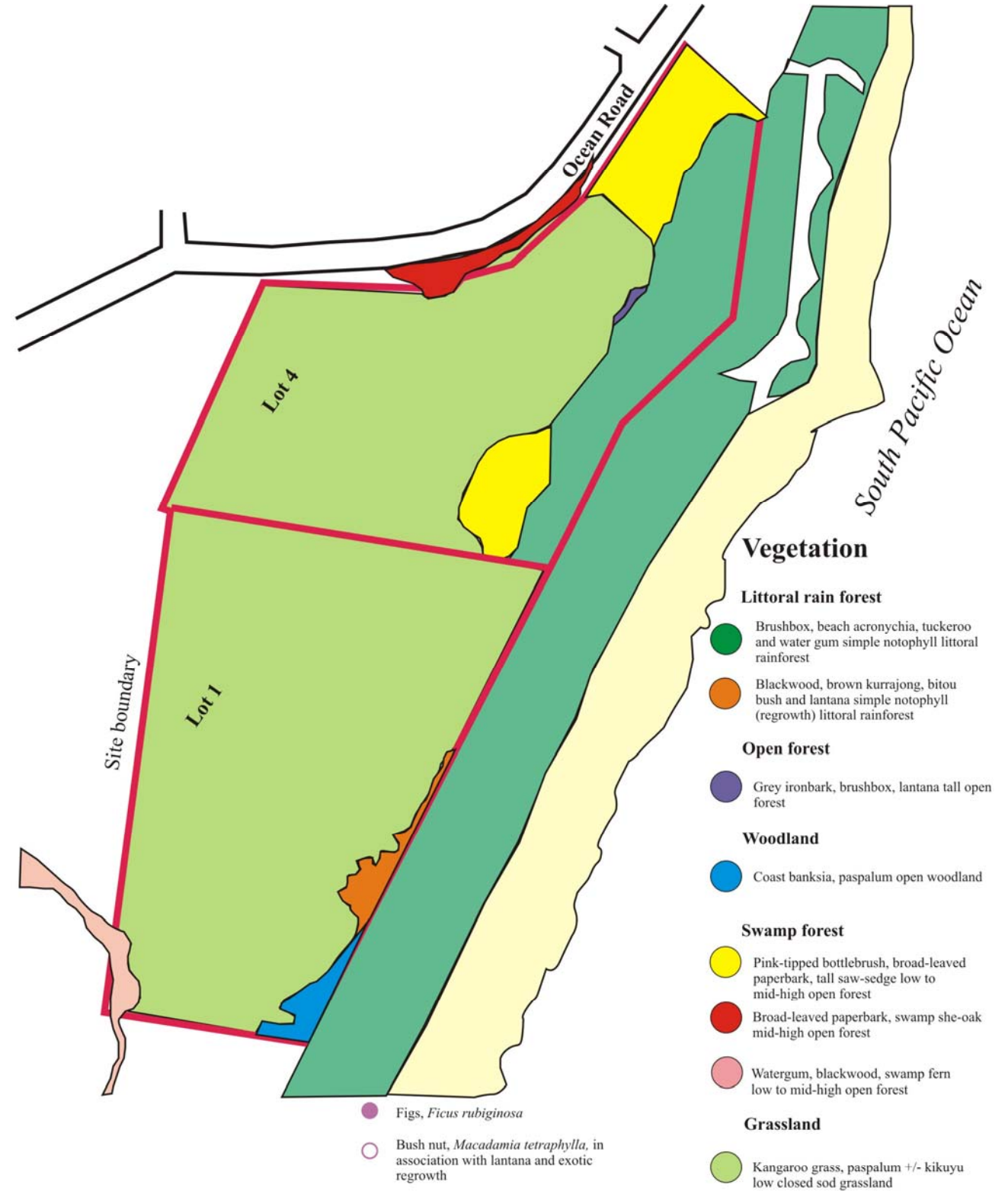
Woodland

Banksia integrifolia var. *integrifolia* (coast banksia), *Paspalum dilatatum* (paspalum) mid-high open woodland

Tristaniopsis laurina (watergum), blackwood, *Blechnum indicum* (swamp fern) low to mid-high woodland to open forest

Grassland

Sporobolus indicus var. capensis (Parramatta grass), paspalum +/- *Pennisetum clandestinum* (kikuyu) and *Themeda australis* (kangaroo grass) low closed sod grassland



Peter Parker

Project: Ocean Drive, Lake Cathie

Client: King and Campbell

Fig. 1: Vegetation

North

Source: Field Survey Peter Parker

Date: 2002-2010

Scale metres: 0 — 100

Plate 1: Littoral rainforest at the site fronting Rainbow Beach, January 2010

Plate 2: Surf beach in front, January 2010

Plate 3: Slashed grassland with broad-leaved paperbark on road frontage, January 2010

Plate 4: Slashed grassland extends from Ocean Drive to the ridge-top

Plate 5: Under the canopy of the littoral rainforest

Plate 6: Duchess Creek on the south-western boundary

Plate 7: Grassland dominates the development site (June 2010)

Plate 8: Rough-shelled bush nut at old homestead site (June 2010)

Plate 9: Vegetation on eastern side of Duchess Creek (June 2010)

Plate 10: Pool in Duchess Creek sampled using fish traps (June 2010)

Plate 11: Striped gudgeon sampled from Duchess Creek (June 2010)

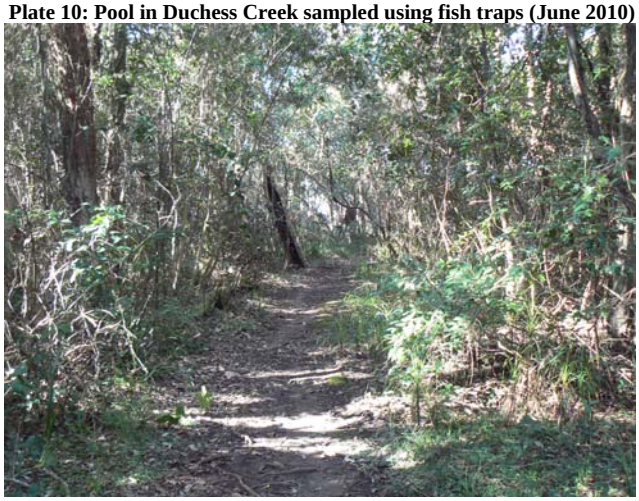


Plate 12: Location of proposed boardwalk through littoral rainforest (June 2010)

4.1.1 Littoral rainforest

Lophostemon confertus (brushbox), *Acronychia imperforata* (beach acronychia), *Cupaniopsis anarcardioides* (tuckeroo) simple notophyll littoral rainforest

Littoral rainforest was the most significant vegetation association recorded at and adjacent to the site in terms of its statutory protection, biodiversity and location in relation to adjoining vegetated areas (Plate 5). This association is discussed later in this report. However, most of the littoral rainforest is located in Crown land east of the site (Fig. 1) and the only development proposed within this association is an elevated timber boardwalk located over an existing access track (Plate 12). It is proposed that qualified bush regenerators will undertake weed control within the littoral rainforest and this proposal is reported separately in the s.3A application.

Upper storey:

Brushbox, beach acronychia, tuckeroo, saw-tooth banksia, water-gum and broad-leaved paperbark

Mid storey:

Tuckeroo, beach acronychia, water-gum and broad-leaved lilly pilly

Understorey and ground cover:

Tall sawsedge, duboisia, mat rush, basket grass and austral sarsparilla

Acacia melanoxylon (blackwood), *Commersonia bartramia* (brown kurrajong), *Chrysanthemoides monilifera* spp. *rotundata* (bitou bush) simple notophyll (regrowth) littoral rainforest

A small area of regenerating littoral rainforest was recorded westward of the association described above. This is within the SEPP 26 littoral rainforest on Lot 1 and comprised mainly of pioneer species and exotics.

Upper storey:

Blackwood and brown kurrajong

Mid storey:

Lantana and bitou bush

Understorey and ground cover:

Winter senna and bitou bush

4.1.2 Forest

Eucalyptus siderophloia (grey ironbark), brushbox, *Lantana camara* (lantana) tall open forest

Several eucalypts and brushbox combined to form a small area of tall open forest at the site (Fig. 3). This vegetation association was likely to be once widespread and occupy most of the site prior to European settlement.

Upper storey:

Grey ironbark and brushbox

Mid storey:

Blackwood and red ash

Understorey and ground cover:

Hardenbergia, devil's twine and blackwood

Callistemon saligna (pink-tipped bottlebrush), *Melaleuca quinquenervia* (broad-leaved paperbark), *Gahnia clarkei* (tall saw-sedge) low to mid-high open forest

Swamp forest dominated by pink-tipped bottlebrush was recorded in the regeneration area in Lot 4. This areas was planted by the land owner Graham Cunning to compensate for vegetation inappropriately removed some 20 years ago. These plantings are well advanced and buffer the littoral rainforest located to its east.

Upper storey:

Pink-tipped bottlebrush and broad-leaved paperbark

Mid storey:

Pink-tipped bottlebrush, tall saw-sedge ± water-gum

Ground cover:

Ferns and sedges

Broad-leaved paperbark, *Casuarina glauca* (swamp she-oak) mid-high open forest

A small area of broad-leaved paperbark dominated forest was recorded fronting Ocean Drive (Plate 3). This association was located mainly within the road reserve with some natural regeneration occurring within Lot 4. The native fish striped gudgeon (*Gobiomorphus australis*) (Plate 11) was recorded in a drainage way fronting the roadside edge of Ocean Drive in the Parker 2002 survey suggesting a riparian connection with water bodies to the west.

Upper storey:

Broad-leaved paperbark and swamp she-oak

Mid storey:

Broad-leaved paperbark

Understorey and ground cover:

Sedges

Tristaniopsis laurina (watergum), blackwood, *Blechnum indicum* (swamp fern) low to mid-high open forest

Water-gum dominated the banks of Duchess Creek in a small association measuring less than 50 m in length (Plate 9). It was impacted by cattle grazing and weed infestation in the 2002 survey but by 2010 cattle had been removed. Biolink (2007) considered that this vegetation association should be mapped as littoral rainforest as it supports a number of littoral rainforest species. The vegetation was resurveyed after Biolink's comments and it is agreed that littoral rainforest species do occur. However, it has been mapped as an open forest due to its fragmented and open canopy and the scale of mapping adopted compared with the small area of rainforest species versus non-rainforest species. It is likely that littoral rainforest species would predominate as rainforest understorey species emerge and the canopy closes over time (Plates 6 and 9).

Upper storey:

Watergum, coast banksia (emergents), blackwood, beach acronychia, lilly pilly, and fig

Mid storey:

Watergum, lilly pilly, coast banksia, two-veined hickory and senna

Understorey and ground cover:

Cordyline, typha, gahnia, matrush, White's passionflower, lantana, slender knotweed, sedges, ferns and pasture grasses along the margin

4.1.3 Woodland

Banksia integrifolia var. *integrifolia* (coast banksia), *Paspalum dilatatum* (paspalum) mid-high open woodland

Banksia woodland was recorded as scattered trees and clumps of trees in the south-eastern corner of Lot 1. Ecologically, coast banksia is a significant feed tree for the common blossom bat (see Law 1994) which was captured at the site.

Upper storey:

Coast banksia

Mid storey:

Coast banksia

Understorey and ground cover:

Pasture grasses

4.1.4 Grassland

Sporobolus indicus var. capensis (Parramatta grass), paspalum +/- *Pennisetum clandestinum* (kikuyu) and *Themeda australis* (kangaroo grass) low closed sod grassland

Parramatta grass and paspalum dominated the upper slopes of the site whereas kangaroo grass, paspalum and kikuyu were recorded on the flats and areas

around an old homestead. This association was grazed by livestock and the grey kangaroo in the 2002 survey. It has been regularly slashed since the 2002 survey (Plates 1 and 2) after stock were removed.

4.2 Fauna

4.2.1 Reptiles

The eastern grass skink, *Lampropholis delicata* was conspicuous and common in the littoral rainforest. Other species recorded included the three-toed skink, *Saiphos equalis*, the eastern water dragon, *Physignathus lesueurii*, the lace monitor, *Varanus varius* and the eastern brown snake, *Pseudonaja textiles.* A number of other species are expected to occur at the site due to the variety of habitats available (see Appendix 2).

4.2.2 Frogs

Five frog species were recorded at the site during the fauna survey. These were the eastern dwarf frog, *Litoria fallax*, the common eastern froglet, *Crinia signifera*, the brown-striped frog, *Limnodynastes peronii*, the red-backed toadlet, *Pseudophryne coriacea* and the dusky toadlet, *Uperlois fusca.*

Two of the above frog species were recorded in pit-fall traps. These were the common eastern froglet and the brown-striped frog.

Other frog species expected to occur at the site include the rocket frog, *Litoria nasuta* and the Peron's tree frog, *L. peronii*.

4.2.3 Birds

The site supported a variety of forest birds and open country species. Moreover, the survey was undertaken during the coast banksia flowering

period which proved ideal for assessing the value of this habitat type for nectarivorous avifauna (Appendix 2).

Characteristic woodland species that occupied the site throughout the survey period included, in order of abundance, flocks of the rainbow lorikeet, *Trichoglossus haematodus,* and the scaly-breasted lorikeet, *Trichoglossus chlorolepiotus,* the brush (little) wattlebird, *Anthochaera chrysoptera,* the noisy friarbird, *Philemon corniculatus,* the grey fantail, *Rhipidura fuliginosa,* and the willie-wagtail, *Rhipidura leucophrys*.

Less conspicuous species within the littoral rainforest, included the eastern yellow robin, *Eopsaltria australis*, Lewin's honeyeater, *Meliphaga lewinii*, the eastern whipbird, *Psophodes olivaceus,* the grey shrike-thrush, *Colluricincla harmonica* and the spangled drongo, *Dicrurus bracteatus.*

Species that characterised the grasslands or more open country included Richard's pipit, *Anthus novaeseelandiae,* the Australian magpie, *Gymnorhina tibicen,* the masked lapwing, *Vanellus miles,* the Australian magpie lark, *Grallina cyanoleuca,* the bar-shouldered dove, the willie wagtail, the grey butcherbird, *Cracticus torquatus,* the pied butcherbird, *Cracticus nigrogularis,* the torresian crow, *Corvus orru* and Richard's pipit, *Anthus novaeseelandiae.*

No vulnerable birds species were recorded.

4.2.4 Mammals

Hair-tube and Elliott trap surveys provided a broad picture of habitat usage by small to medium sized mammals. The northern brown bandicoot, *Isoodon macrourus,* the introduced black rat, *Rattus rattus*, and the brown antechinus, *Antechinus stuartii,* provided hair samples in traps set in the littoral rainforest.

The usage of the site by the northern brown bandicoot was also apparent from the numerous diggings and a day-time observation.

Of the macropods, the eastern grey kangaroo, *Macropus giganteus,* was the most conspicuous with up to 19 individuals counted at the site on 27 February 2002. However, the swamp wallaby, *Wallabia bicolor,* was also observed.

The bush rat, *Rattus fuscipes*, was the most abundant species captured in Elliott traps although the brown antechinus was also recorded (Tables 7 and 8).

Table 7: Elliott trap results (south transect)

Date (2002)	***Rattus fuscipes*** No of individuals & trap number	***Antechinus stewartii***
26 February	**3**: 1;2;23	
27 February	**3**: 3;21;24	**1**: 19
28 February	**3**;21	**2:** 19;23

Table 8: Elliott trap results (north transect)

Date (2002)	***Rattus fuscipes***	***Antechinus stewartii***
26 February	**4**: 4;7;20;25	**4**: 13;14;18;21
27 February	**5**: 2;6;7;11;25	**6**: 12;14;18;21;22;24;
28 February	**3**: 2;10;25	**4**: 11;19;23;24

Dogs were observed accompanying their owners walking through the site to the beach on all survey-days in 2002 and on all follow-up surveys.

The most significant mammal recorded was the vulnerable common blossom bat, *Syconycteris australis*. This species was captured in a mist-net set among the coast banksias for 20 minutes on 25 February 2002. The coast banksia woodland is located adjacent to the littoral rainforest in the south of Lot 1 (Fig. 1). Another vulnerable bat species, the grey-headed flying fox, *Pteropus poliocephalus,* was recorded flying over the site on a number of occasions.

Two other species were captured at the site using harp-nets. These were the eastern forest bat, *Vespadelus pumilus* and the little forest bat, *Vespadelus vulturnus.*

A total of four microchiropteran bat species were detected using echo-locating devices. These were the vulnerable little bent-wing bat, *Miniopteris australis*, the eastern horse-shoe bat, *Rhinolophus megaphyllus*, the eastern broad-nosed bat, *Scotorepens orion* and most likely the lesser long-eared bat, *Nyctophilus geoffroyi*, although this species call is indistinguishable from Gould's long eared bat, *Nyctophilus gouldi* (Reinhold *et al.*, 2001).

Other species recorded in similar habitats to those occurring at the site include the greater broad-nosed bat, *Scoteanax rueppellii*, and the white-striped mastiff bat, *Nyctinomus australis* (see Appendix 2).

Koala habitat

An assessment of potential koala habitat was undertaken pursuant to the requirements of State Environmental and Planning Policy No. 44 (SEPP 44) (Koala Habitat Protection). No koala food trees were recorded. Thus, potential koala habitat does not occur at the site.

Fishery habitat

The fish survey only recorded the striped gudgeon (Plate 11). However, it is expected that eels (*Anguilla* spp.) would migrate through Duchess Creek periodically in spite of the low water level and poor water quality.

5.0 DISCUSSION

5.1 Plants of conservation significance

The rough-shelled bush nut, *Macadamia tetraphylla,* was the only threatened plant recorded which is listed under the *Threatened Species Conservation Act 1995* (TSC Act). However, the rough-shelled bush nut was planted as an orchard tree in the vicinity of ruins located approximately 150 m west of the littoral rainforest (Plate 8) and is only known in the wild north of the Clarence River (Harden 2002). In this context, this species has little ecological value. Darkheat (2002) report the white-flowered wax plant, *Cynanchum elegans,* as occurring in the littoral rainforest. While this species was not recorded suitable habitat occurs at the site. This species is a small climbing plant with twining stems to 1 m long. It occurs in dry, littoral or subtropical rainforest and occasionally in scrub or woodland (National Parks and Wildlife Service 2002).

5.2 Vegetation of conservation significance

Littoral rainforest 116 occurs as a Crown Land frontage to Lot 1 and is located partly within Lot 4. This rainforest is of State significance being gazetted under SEPP 26 and is listed as an Endangered Ecological Community under Schedule 3 of the *Threatened Species Conservation Act, 1995.*

This association is one of the largest littoral rainforest remnants in the local area, is relatively weed free and not affected by cattle grazing or other anthropocentric impacts to any extent.

Reafforestation and the management of plantings within the littoral rainforest buffer zone at Lot 4 in the north of the site (Fig. 1) is well advanced with established plantings providing a complete canopy cover in parts of the planting area.

Littoral rainforest 116 stands out from many other remnants along the NSW coastline in both its size, species diversity, small mammal assemblages and the virtual absence of rubbish dumping. This remnant has benefited from litter removed from the site by the land owner over a number of years (Graham Cunning pers. com.).

5.3 Habitat enrichment and corridors

The canopy of littoral rainforest 116 is intact with few discernable breaks or gaps. This is not atypical of rainforests where a dense understorey of trees in the shrub layer will grow rapidly to fill canopy gaps.

Several management initiatives will improve the long-term conservation viability of this rainforest remnant and the fauna assemblages contain therein. These are as follows:

- Provide a substantial littoral rainforest buffer. Since the 2002 survey and recommendations were undertaken, the hydrology of the site has been investigated (Martens and Associates 2007) and buffers designed and mapped by King and Campbell Pty Ltd which include vegetation and hydrological requirements. The littoral rainforest buffer and proposed revegetation is illustrated in Fig. 4 and 5 and biofiltration is illustrated in Fig. 6.
- Improve the shape of the littoral rainforest by decreasing the edge-to-area ratio. This can be facilitated by plantings along the western boundary;

- Works with neighbouring landowners to the south to enhance the littoral rainforest along its entire length. Incorporate the coast banksia woodland in the south-east corner into the littoral rainforest using additional plantings and bush regeneration techniques and emphasise coast banksias in the landscaping of the site. Properly constructed and managed, this corridor will provide feeding resources for the common blossom bat, assist in fauna passage for the more cryptic animal species and provide for greater biodiversity;
- Provide a 20 m riparian buffer along the water course in the west and work with neighbouring landowners to enhance the riparian connection and widen the wildlife corridor where it passes through the site. Engage bushland regenerators to undertake weed control;
- Construct an elevated walkway to the beach along the existing pathway and improve drainage or minimise erosion by rip-rap filters or similar structures. Weed infestations and erosion in the littoral rainforest were attributed to stormwater passage; and
- Protective fencing should be incorporated along the western edge of a planted buffer to the littoral rainforest. Fencing will also define the forested edge and limit human intrusion.

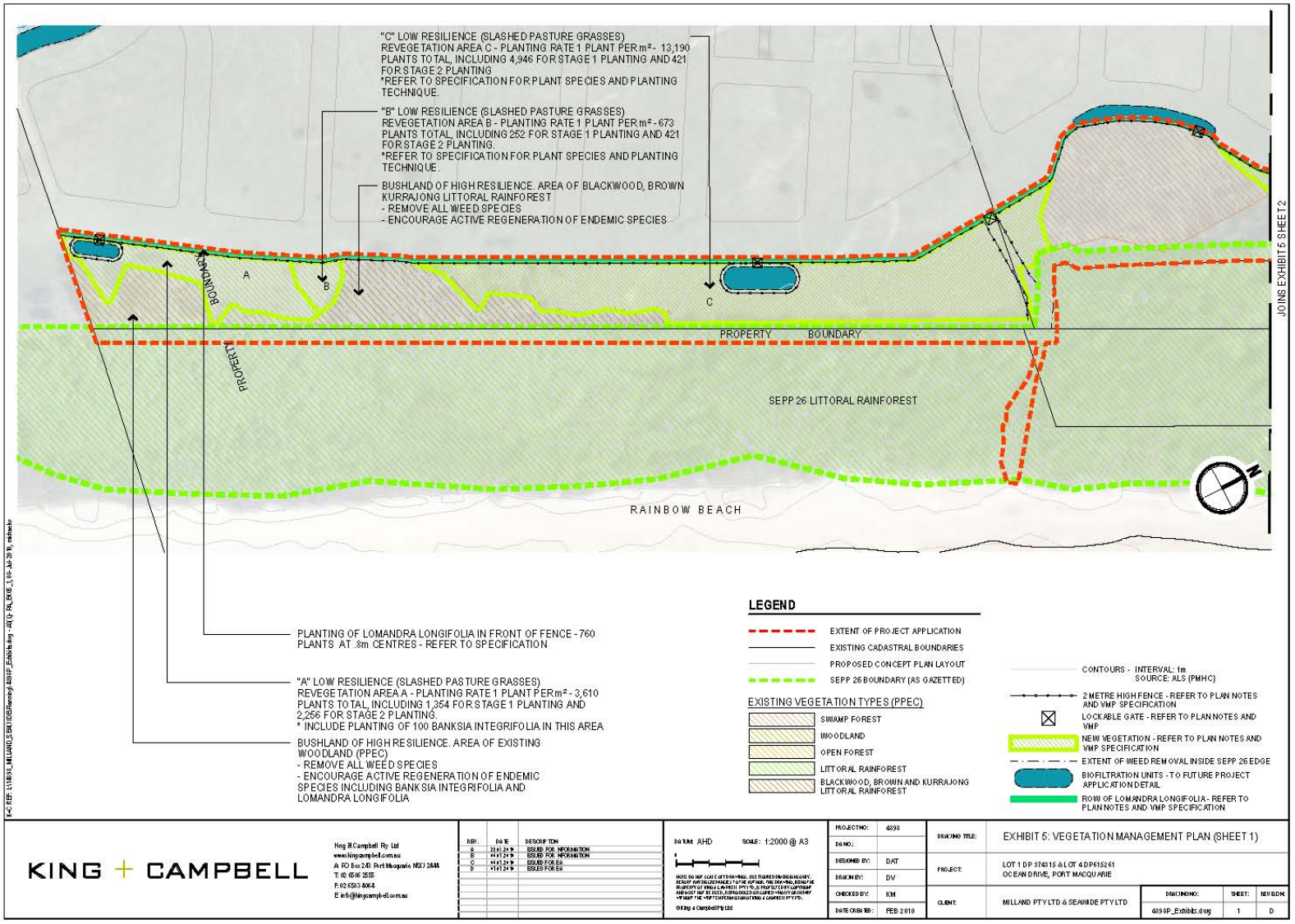


Fig. 4: Littoral rainforest protection and buffer treatment, southern part of site (Source: King and Campbell Pty Ltd)

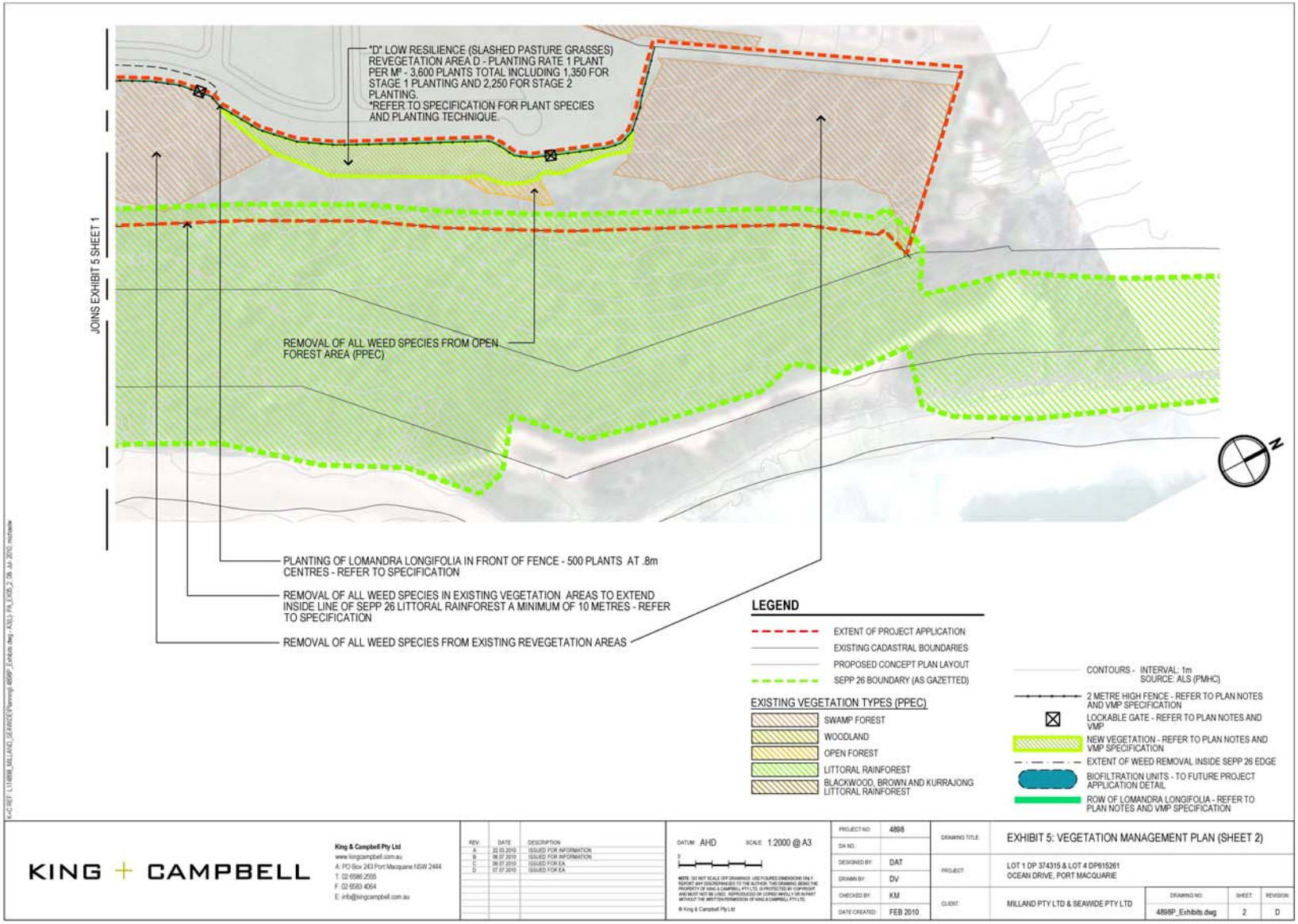


Fig. 5: Littoral rainforest protection and buffer treatment, northern part of the site (Source: King and Campbell Pty Ltd)

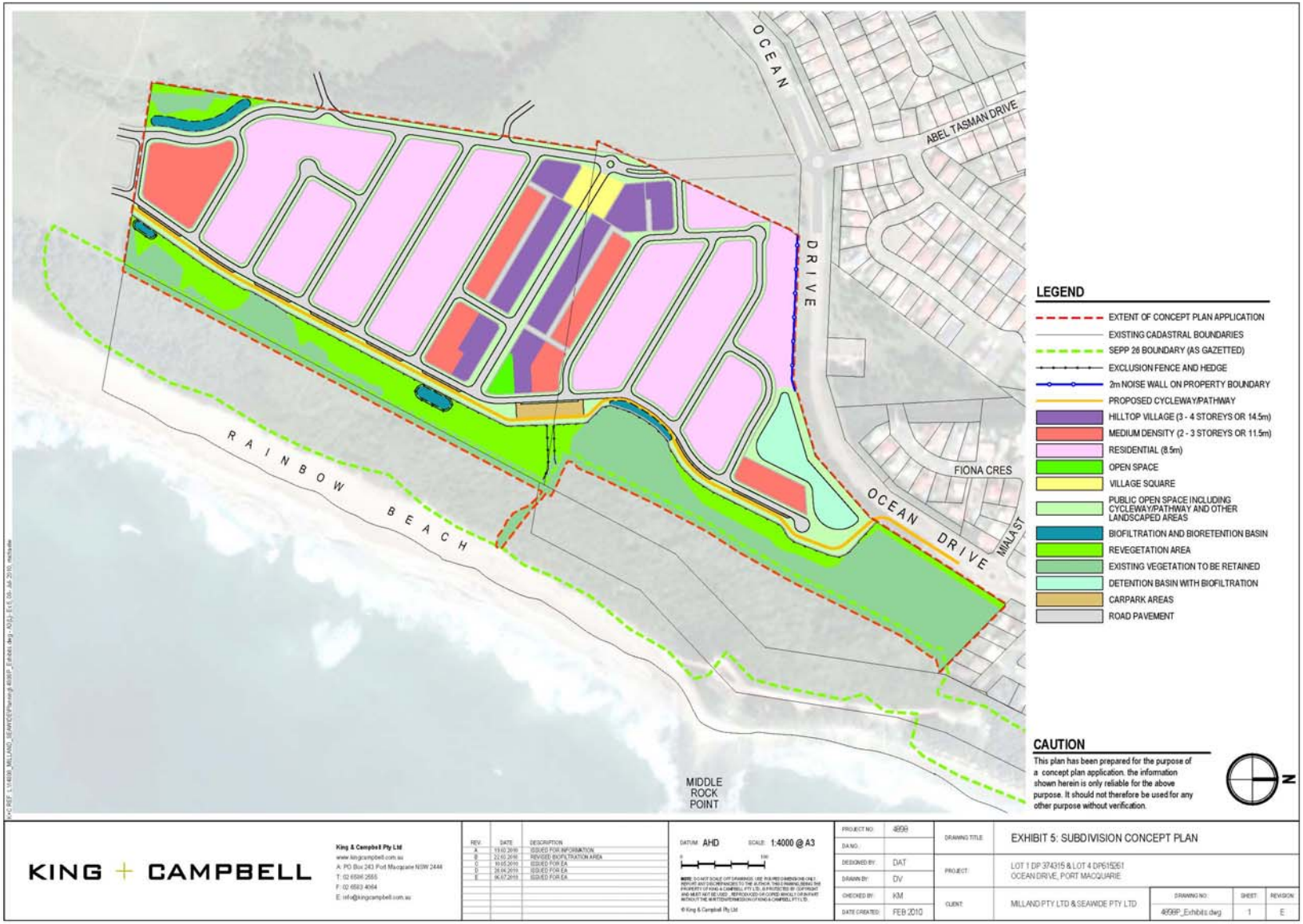


Fig. 6: Proposed subdivision and biofiltration facility (Source: King and Campbell Pty Ltd)

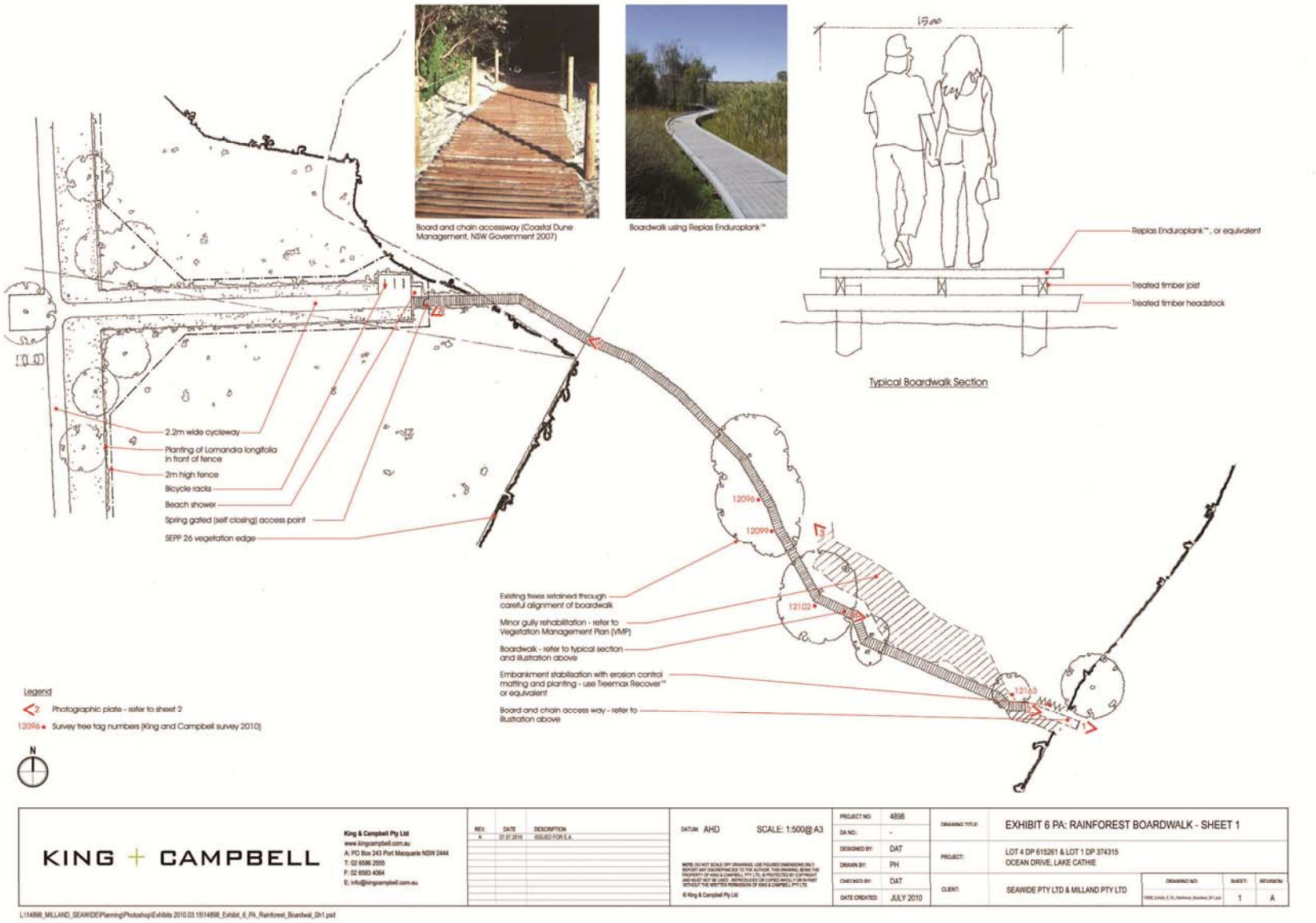


Fig. 7: Proposed boardwalk through littoral rainforest (Source: King and Campbell Pty Ltd)

PHOTOGRAPHIC PLATE No. 1: Path access at beach. Some minor bank stabalisation required using Treemax Recover™ or equivalent and planting in accordance with Vegetation Management Plan (VMP)

PHOTOGRAPHIC PLATE No. 2: Access path across gully. Boardwalk to board and chain accessway will transition at base of photo

PHOTOGRAPHIC PLATE No. 3: Existing eroded minor gully to be rehabilitated - refer to Vegetation Management Plan (VMP)

PHOTOGRAPHIC PLATE No. 4: Boardwalk to be aligned carefully between these two trees

PHOTOGRAPHIC PLATE No. 5: Typical character and width of existing path access. The boardwalk is to be aligned along the path

PHOTOGRAPHIC PLATE No. 6: Existing path entry into SEPP 26 Rainforest

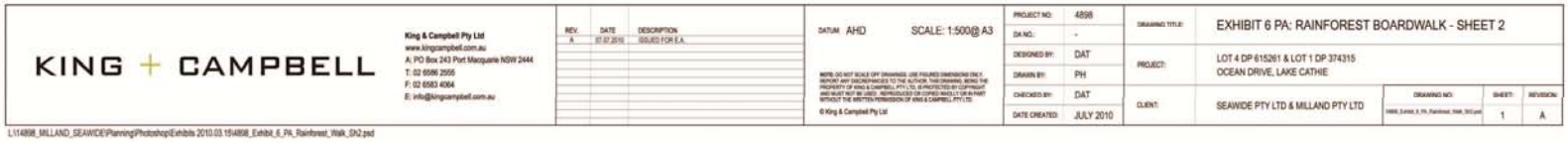


Fig. 8: Location of proposed boardwalk through littoral rainforest

5.4 Threatened species

One vulnerable plant, the rough-shelled bush nut and three vulnerable vertebrate species, the common blossom bat, the grey-headed flying fox and the little bent-wing bat were recorded during the 2002 fauna survey. The common blossom bat forages on coast banksia and roosts in littoral rainforest (see Law 1993; 1994). The littoral rainforest is likely to be an important local roosting site and the coast banksia woodland a recognised feeding site. Coast banksia is limited to a small woodland in the south-east corner of Lot 1. It is recommended that extensive replanting of this species be undertaken to enhance common blossom bat feeding opportunities.

The grey-headed flying fox is widely distributed and may feed within the littoral rainforest and on paddock figs while the little bent-wing bat is a wide-ranging cave-roosting insectivorous species. The planting and management proposals recommended in this report are unlikely to significantly enhance the habitat of either of these two species. A number of other vulnerable species may occur at the site or in the vicinity of the proposal. These are listed in Table 5 and further addressed in Appendix 4 (7-part test).

6.0 STATUTORY CONSIDERATIONS

This proposal is subject to Part 3A (Major infrastructure and other projects) of the *Environmental Planning and Assessment Act, 1979* ("EPA Act"). Accordingly, Part 4 and Part 5 of the EPA Act do not, except as provided by this Part, apply to or in respect of an approved project.

6.1 Director General's specifications, flora and fauna

The DoP required the following environmental matters to be addressed:

9.1 Identify the potential impacts of the proposed development on the SEPP 26 littoral rainforest, particularly with regard to surface and groundwater hydrology and quality and public access to the beach and edge effects. Outline measures for the ongoing management and protection of the SEPP 26 vegetation.

6.1.1 Management and protection of the littoral rainforest

The littoral rainforest has been mapped and considerable buffering, including buffer planting and fencing, has been incorporated into the design of this proposal (Figs. 4 and 5). Landscaping throughout the development precinct will utilise native species of littoral rainforest affinity. Wild Things Native Gardens has been engaged by the Applicant to provide a report on the management of the vegetation in the context of bushland regeneration rather than landscaping.

The single existing public access point to the beach has been retained and will be upgraded to ameliorate existing impacts of erosion and weed infestation. No additional access points are contemplated. A vegetation survey was undertaken by this consultancy with a view to locate an additional access point. However, King and Campbell Pty Ltd was advised that a further access point could not be supported and would be difficult to justify due to the excessive removal of rainforest required.

The management and protection of the littoral rainforest is a major environmental contribution of this proposal. Currently there is little

management and the grassland is slashed up to the littoral rainforest edge. This management will be replaced by buffer planting and weed control. The existing degraded access will be replaced by an elevated boardwalk and a bushland regeneration team will be engaged to manage weeds within the littoral rainforest.

Following the 2002 systematic flora and fauna survey, Dr Peter Brennan was engaged to peer review the report and to provide his comments on littoral rainforest protection. Dr Brennan completed his PhD on the impacts of edge effects on littoral rainforest.

6.1.2 Peer review of 2002 survey report and recommendations of Dr Brennan

"When rainforest is fragmented due to the clearing of vegetation, the remnant forest is often subjected to edge effects that can have negative impacts on the remaining plants and animals in the remnant. Edge effects can be placed in two categories; those stemming from changes in the microclimate near the edges of the remnant and those that result from human activity in the cleared areas surrounding the remnant (the matrix). Buffers are often advocated as a management tool to reduce or nullify edge effects and thus ameliorate these negative impacts. For buffers to be effective, their design should be specific to the ecology and physical environment of the site and should address potential effects from proposed land uses in the surrounding matrix. Designing appropriate buffers requires not only the determination of an appropriate width for the buffer but also the determination of what features (e.g. plantings or fencing) should be incorporated into the buffer. This section of the report assesses potential edge effects that may stem from the proposed residential development of the

site and discusses the design of an appropriate buffer to protect littoral rainforest 116."

History and condition of the rainforest edge

"ERM Mitchell McCotter (1995) have analyzed past aerial photography to reconstruct the history of vegetation clearance on the site. This analysis revealed that nearly all of the present rainforest edge in the southern half of the site (Lot 1 DP 374315) had been cleared before 1976 while the edge in the northern half of the site (Lot 4 DP 615216) was cleared in stages between 1976 and 1986. Thus the existing edge has been exposed for a substantial period of time (between 16 and more than 26 years). Microclimatic edge effects are greatest immediately following the creation of an edge as the vegetation and fauna respond to a new microclimate that is usually drier, warmer and windier. In tropical and subtropical rainforests however, the vegetation along a newly created edge quickly responds with increased growth of lianas and lateral branches in existing trees and increased germination and growth of seedlings and saplings (see e.g. Longman & Jenik 1974, Lovejoy et al. 1986, Williams-Linera 1990 and Camargo & Kapos 1995). This has the effect of "sealing" the edge and allowing the microclimate close to the edge to quickly return to a condition similar to that existing prior to the edge creation.

An inspection of the western edge of littoral rainforest 116 revealed that it conformed to the above model and that a microclimate typical of the interior of the rainforest existed right up to the boundary of the rainforest. The edge appears stable and the vegetation along the boundary is in good condition with weed invasion being limited to the first few metres.

Wind and salt spray

The prevailing wind direction at the site is from the south-east, with northeast winds also common during late spring and early summer. Strong westerly winds blow periodically during winter and early spring. The littoral rainforest on the site seems to be resilient to the drying effect of these westerly winds probably because the vegetation relies on the high water table

The current western edge of the littoral rainforest is on the lee side of the salt-laden south-east and north-east winds and as a result the vegetation on this edge is not obviously affected by salt spray.

The construction of buildings taller than the existing rainforest canopy and close to the western edge of the rainforest could cause some turbulence which would lead to an increase in salt deposition along this edge. Since tall buildings are not proposed for the site, there should be no significant increase in salt deposition.

Hydrology and runoff

Housing developments adjacent to rainforest have the potential to affect infiltration rates and the incidence of surface run-off. It is most important that any proposed development not lead to a change in the level of the watertable under the littoral rainforest. A significant increase in the level of the watertable would lead to a change towards swamp forest while a significant decrease in the level of the watertable would lead to the development of a drier forest type on the site.

It is also important to ensure that untreated surface run-off from the developed area of the site does not flow into the rainforest. Such run-off can cause erosion and sedimentation and increase the level of nutrients in the

forest thus facilitating the growth of weeds, in addition to directly carrying the seed of weed species into the forest. At present, erosion and the associated spread of weed species resulting from stormwater runoff is only evident along an informal path through the littoral rainforest that is used by the public to access the beach. Therefore, any residential development on the site should incorporate a stormwater management system that maintains the level of the watertable under the rainforest and prevents surface flows into the rainforest both during and after construction. Such a system would typically utilise drains, swales and retention ponds. An elevated walkway and rip-rap filters or similar structures should be constructed along the existing pathway through the littoral rainforest in order to prevent further erosion and the introduction of weeds in this area.

Noise and light

Residential developments adjacent to rainforests can result in increased noise and night-time light levels that may negatively impact some rainforest fauna. No species that are known to be particularly sensitive to moderate increases in noise or light were identified during the fauna survey. In addition, noise effects on this site would be reduced because the prevailing winds blow from the forest towards the proposed development site and because there already exists a relatively high level of background noise from the surf.

It would however, be prudent to plant a buffer of trees at least 10 metres wide along the existing edge and to direct street lights in the buffer zone away from the forest in order to reduce light penetration into the forest.

Domestic and feral animals

Feral animals such as foxes, dogs and cats can prey on ground-dwelling and ground-utilising fauna in small rainforest remnants, putting populations at risk. No feral animals were detected during the fauna survey of the site but it is probable that such animals are present in the vicinity, given the large amount of forest cover to the west of the site. Residential development on the site should reduce the incidence of feral animal incursion into the rainforest as these animals are much less likely to traverse a residential area as opposed to the existing grassland.

Domestic dogs and cats can also prey on or disturb ground-dwelling and ground-utilising rainforest fauna. Domestic dogs accompanying their owners were observed using the existing access through the rainforest to the beach. As residential development around the site expands, the incidence of domestic dogs and cats in the vicinity will increase and the proposed residential development on the site will further add to this. Incursion of domestic dogs and cats into the rainforest is much more likely where backyards directly abut either the rainforest or a revegetated buffer.

Design features in the buffer can greatly decrease the likelihood of domestic animal incursion into the rainforest. These features should include the following.

- *Protective fencing should be incorporated along the western edge of a planted buffer to the littoral rainforest. Fencing should be approximately 1200 mm in height so as not to restrict the movement of macropods from the rainforest but to restrict access by dogs and cats.*
- *Abutting the protective fencing on its western side should be a low, thick hedge about 1.5m wide and consisting of plant species with spines or thorns.*
- *A cleared public area including such features as a road and grassed*

areas should separate houses from the hedge and fencing. It is important to maintain grassed areas in the buffer between the houses and the fence so as to provide a food source for the macropods which utilise the rainforest and its margins for cover.

Human intrusion

Probably the greatest threat to littoral rainforests located between the beach and residential developments is the unregulated clearing of the forest by residents whose houses abut the forest. This usually takes two forms. First, residents will clear paths through the forest adjacent to their property to provide direct access to the beach. Such clearing is particularly destructive of rainforest remnants as it opens the canopy, resulting in increased light levels and also provides a path for the overland flow of water which together result in a significant invasion of weeds into the core of the rainforest. Currently the canopy of littoral rainforest 116 adjacent to the site is intact with few discernable breaks or gaps except for the existing access path and this is a major reason for the very limited presence of weeds at the moment.

The second form of clearing involves residents extending their yards that directly abut the forest. The clearing can either involve total clearance of the canopy and understorey vegetation or simply the removal of understorey vegetation to produce a park-like environment. Once one resident starts to clear the forest adjacent to their house in order to extend their yard, other residents tend to follow suit. This can lead to the loss of a significant area of forest and the break-down of the closed edge of the forest, changing the microclimate near the edge and facilitating the invasion of the forest by weeds.

These forms of clearing can be prevented by incorporating physical barriers such as the fence and thorny/spiky hedge already described, and a hardened and moderately well used public space between the residential lots and the buffer plantings. A road/bicycle path is ideal for this purpose. Such a road should be designed to have a low speed limit and relatively low usage levels by cars so as to minimise the risk of native fauna being hit.

Rubbish dumping

The dumping of large items of rubbish can physically damage plants around the edge of rainforest remnants and contribute to the breaking down of the edge structure. However, a greater danger comes from the dumping of garden waste into rainforest, as such waste often contains the seeds and propagules of weed species. Such dumping of garden waste is again most common where residential lots directly abut the rainforest or vegetated buffer, allowing residents to dump their garden wastes unseen. At present, the littoral rainforest is free of rubbish.

The design features described above to limit human access into the rainforest will also help prevent the dumping of garden waste and other rubbish. Another essential design feature is to ensure that the houses adjacent to the buffer face towards the buffer road. This will increase public surveillance of the buffer and combined with signs warning against the dumping of rubbish or garden wastes will deter both residents and visitors from dumping.

Fire

While fires seldom burn through rainforests because of the moist microclimate and lack of fire promoting plant species, they can cause significant plant mortality and damage around the edges of remnants and

facilitate weed invasion. Repeated fires can thus cause significant incremental damage to the rainforest. At present, the vegetation in the grassland adjoining the rainforest is low and thus there is little chance of fire damaging the rainforest. However, in the absence of residential development on the site, it is not certain that in the future this grass will be kept low. If the grass was allowed to grow taller in the future there would be a fire risk to the rainforest edge. Thus the proposed residential development will reduce the likelihood of fire damaging the rainforest and the road and mown grass swale described above will act as a fire break between the residential estate and buffer plantings.

The following additional measures should be undertaken in order to minimise potential impacts on the littoral rainforest and to enhance the ecology of the site and the neighbouring areas.

- *Signs should be erected along the proposed buffer road warning against the dumping of rubbish and garden wastes.*
- *Houses adjoining the buffer should face towards the buffer to increase surveillance and thus reduce the possibility of illegal dumping.*
- *Street lights in the buffer zone should be directed away from the forest in order to reduce light penetration.*
- *An elevated and fenced walkway should be constructed along the existing access track through the littoral rainforest. The fence should allow for the passage of small ground-dwelling native fauna. Rip-rap filters or similar structures should also be constructed in this area to improve drainage and minimise erosion.*
- *The proposed development should incorporate a stormwater management system that maintains the level of the watertable under the rainforest and prevents surface flows into the rainforest both during and after construction.*

6.1.3 Groundwater management

The surface and groundwater hydrology and quality in relation to the SEPP 26 Littoral Rainforest has been addressed by Martens & Associates in their Area 14 Stage 1B Groundwater Study, Lake Cathie, NSW, Amendment 1 (July 2010). Martens & Associate has also assessed the potential impacts of the proposed Concept Plan Application on groundwater conditions within or near to the SEPP 26 Rainforest and concluded that the proposed vegetated setback with an average of 40 metre planted distance was appropriate and unlikely to cause any significant impacts on the groundwater conditions below the existing littoral rainforest. Martens & Associates recommended locations of stormwater biofiltration/detention/stormwater infiltration/groundwater recharge pits in the three sub-catchments proposed (Fig. 6). Martens & Associates made recommendations with respect to stormwater quality management and the associated recharge of groundwater systems to ensure that groundwater conditions post development are as similar as possible to the existing conditions in the SEPP 26 Rainforest. Martens & Associates recommended that the revegetation work be undertaken as soon as possible to ensure that the maximum evapo-transporation rates are achieved as early as possible in the development process. Full details of Martens & Associates Groundwater Study are contained in Appendix D of the Concept Plan Application.

9.2 Outline potential impacts on aquatic and terrestrial flora and fauna, endangered ecological communities and their habitats (within the meaning of the Threatened Species Conservation Act, 1995 and the Fisheries Management Act 1994). Provide measures for their

conservation, where relevant, including the consideration of compensatory habitat.

6.1.4 Potential impacts on aquatic habitats and conservation measures

A flora, fauna and fisheries survey was undertaken to identify the biological characteristics of the site. The results of this survey are documented in this report. The site contains some 85 m of Duchess Creek. A fish survey was undertaken in June 2010 using spotlights and baited fish traps. One native fish species, the striped gudgeon, was recorded. An assessment pursuant to the *Fisheries Management Act 1994* has been undertaken and is reported in Appendix 5. It is proposed that treated stormwater will be directed in Duchess Creek. This is likely to be beneficial as Duchess Creek, at the time of survey, featured a number of fragmented pools and was not flowing. Improving water flows and fish passage are two key elements in river management. However, water quality will need to be ensured and appropriate erosion mitigation measures need to be in place (see Plates 13 and 14 for suitable discharge location and erosion mitigation measure).

Plate 13: Suitable location for stormwater discharge into Duchess Creek

Plate 14: Broken rock to eliminate scour used by Council along Ocean Drive may prove suitable for stormwater discharge outlet into Duchess Creek

The potential impacts of residential development adjacent to littoral rainforest were addressed by Dr Brennan (above) and include public access and vegetation removal, edge effects (eg., spread of garden plants, introduced fauna (eg., dogs and cats) and, urban runoff.

9.3 Outline measures for the conservation of any existing wildlife corridor values and/or connective importance of any vegetation on the subject land.

6.1.5 Conserving and enhancing wildlife corridors

This proposal will preserve the littoral rainforest and incorporate planted littoral rainforest buffers, will buffer riparian areas and utilise native plantings extensively throughout the subdivision. It also includes fencing the littoral rainforest and the proposed littoral rainforest buffer, construction of an elevated boardwalk through the littoral rainforest in the location of an existing degraded access track and stormwater and water quality controls to enhance discharge quantity and quality into the littoral rainforest. The littoral rainforest wildlife corridor will be enhanced by additional plantings and assisted natural regeneration along its western boundary. These works will ultimately lead to a decrease in the edge-to-area ratio which is a standard approach to the maintenance and enhancement of biodiversity.

In July 2004, Council adopted the Lake Cathie-Bonny Hills Masterplan which identified an east-west corridor on the land to the south and included Duchess Creek in this corridor (Fig. 9). This proposal is consistent with the Masterplan with respect to wildlife/open space corridors. Moreover, the proposal to enhance the littoral rainforest is consistent with good planning initiatives at a both the local and regional scale.

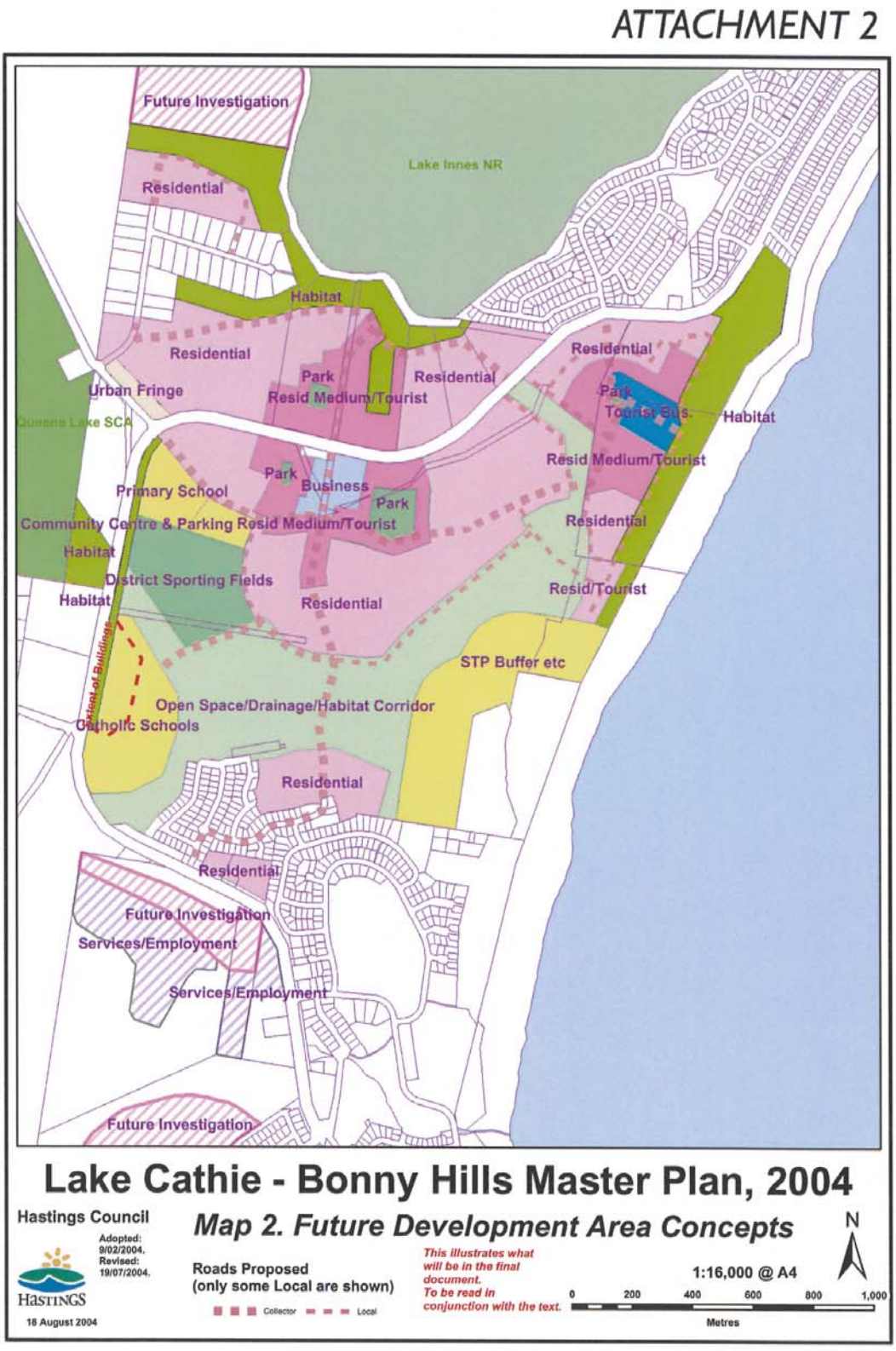


Fig. 9: Lake Cathie-Bonny Hills Masterplan illustrating the site and habitat linkages

9.4 Address measures to protect and manage the riparian corridor and adjacent aquatic habitats.

6.1.6 Protecting and managing riparian corridors

Duchess Creek passes through the south-western corner of the site. No development will occur within 20 of this waterway and weed control using trained bushland regenerators will ensure that this community is adequately restored. Revegetation and stormwater management works are proposed (Fig. 6) to enhance and buffer this waterway. The Duchess Creek corridor will link with the proposed east-west corridor illustrated in the Lake Cathie-Bonny Hills Masterplan (Fig. 9)

6.2 Department of Environment, Climate Change and Water's requirements

The DECCW provided its recommendations with respect to this proposal to the DoP with respect to a request for "Agency Requirements". These were not adopted by the DoP in its Part 3A requirements but have, nevertheless, been discussed below:

DECCW item a.

a. a field survey should be conducted and documented in accordance with the guidelines.

6.2.1 Field survey

A field survey was undertaken and is described in section 3 of this report. A systematic survey was undertaken in 2002 and at least 10 site visits have been undertaken to discuss planning initiatives from 2002 up to the present time.

These include vegetation transects through the littoral rainforest to investigate additional boardwalk locations, a proposal that was abandoned following unacceptable impacts on the littoral rainforest, inspections accompanied by DoP personnel to discuss buffer widths and a fish survey over one night (28 June 2010) along the small part of Duchess Creek which enters the site in the south-west corner following comments on the draft flora and fauna report by the DoP.

DECCW item b.

b. Likely impacts on threatened species and their habitat need to be assessed, evaluated and reported on (Step 3 of the guidelines).

6.2.2 DECC draft guidelines, step 3

Step 3 of the DECC draft guidelines require the description of the proposed development, the undertaking of the nine step process (as identified in Fig. 3.2 of the guidelines), the identification of any threats to biodiversity and an assessment of significance. This report discussed the proposed development and identified and mapped the littoral rainforest. It provided appropriate amelioration by way of substantial buffers and buffer plantings, stormwater controls and habitat linkages to the south. It also identified riparian habitat and proposed buffers which were incorporated into the proposed development. An assessment of significance is contained in Appendix 4.

DECCW item c.

c. The EA must describe the actions that will be taken to avoid impacts, or to mitigate unavoidable impacts of the project on threatened species and their habitat. This should include an assessment of the effectiveness and

reliability of the measures and any residual impacts after these measures are implemented.

6.2.3 Actions to avoid impacts

The flora and fauna report made recommendations with respect to protecting and buffering the littoral rainforest, stormwater management and access to Rainbow Beach. It also made recommendations with respect to landscaping and the use of native plantings and bush regeneration to supplement and enhance the vegetation at the site. The preferred location of the beach access was identified on site on 29 June 2010 and plotted by survey. No trees will require removal for boardwalk construction and the use of sand pillows at the interface of the beach with the littoral rainforest is recommended. These matters are further illustrated in the survey drawings (Figs. 7 and 8)

DECCW item d.

d. Step 4 of the draft guidelines requires that where measures to avoid or mitigate are not possible, offset strategies need to be considered.

6.2.4 Mitigation

This request applies when mitigation measures are not possible. This is not the case with respect to this development as the management actions proposed will improve the viability of the littoral rainforest, the riparian habitat and reduce erosion effects on the littoral rainforest beach accessway.

DECCW item e.

e. The EA must clearly state whether it meets each of the key thresholds set out in Step 5 of the draft guidelines.

6.2.5 DECC draft guidelines, step 5

Step 5 of the *Draft Guidelines* relates to field survey. A field survey was undertaken and the results are presented in this report. Surveys were undertaken during optimal climatic and seasonal conditions and considered migratory species movements, availability of shelter and food resources. A systematic survey was followed by eight years of site inspections (> 10 visits) to ascertain if any significant land use changes had occurred over this period.

DECCW item f.

f. The EA must consider the corridor values or any connective importance of any vegetation on the subject land.

This matter was incorporated into the DoP Director General's Specifications and is discussed in section above.

7.0 REFERENCES

Baudinette, R.V., Wells, R.T., Sanderson, K.J. and B. Clark 1994 Microclimatic conditions in maternity caves of the bent-wing bat, *Miniopterus schreibersii*: an attempted restoration of a former maternity site. *Wild. res.* 21:607-19.

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

Clancy, G.P. 1989 A survey of breeding ospreys, *Pandion haliaetus*, in north-eastern coastal NSW, Corella, 13: 9-14.

Cronin, L. 1991 *Key guide to Australian Mammals.* Reed, Singapore.

Date, E.M., Ford, H.A., and H.F. Recher 1991 Frugivorous pigeons, stepping stones and weeds in northern NSW in *The Role of Corridors*: *Nature Conservation 2.* ed by D.A. Saunders and R. J. Hobbs. Surrey Beatty and Sons: Sydney.

Debus, S.J.S and A.B. Rose 1994 The masked owl, *Tyto novaehollandiae*, in New South Wales. *Aust. Birds*, 28: 40-64.

Department of Environment and Climate Change 2006 *Approved recovery plan for the large forest owls.* DECC Sydney

Dwyer, P.D. 1983a Common bent-wing bat *Miniopterus schreibersii*. Pp 336-337 (In) *The Australian Museum complete book of Australian mammals*. ed by R. Strahan. Angus & Robertson Publishers: Sydney.

Dwyer, P.D. 1983b Little bent-wing bat *Miniopterus australis*. Pp 338-39 in *The Australian Museum Complete Book of Australian Mammals* ed by R. Strahan. Angus & Robertson Publishers: Sydney.

Dwyer, P.D. 1995 Common bent-wing bat *Miniopterus schreibersii*, (In) Strahan (ed) pp. 494-495, *The Australian Museum Complete Book of Australian Mammals* Angus & Robertson and Reed Books, Sydney.

Ferrier, S., Shields, J., Lemckert, F.L., Wilson, P., Mackowski, C. M. and M. Saxon., undated *Fauna Impact Statements - A standard methodology for surveying endangered species*. A joint report for the National Parks and Wildlife Service and New South Wales Forestry Commission.

Fleay, D., 1944 Watching the powerful owl. *Emu* 44: 97-112.

Garnett, S. 1992 *The action plan for Australian birds.* Australian NPWS, Canberra.

Garnett, S. 1993 *Threatened and extinct birds of Australia.* Royal Australasian Ornithologists Union and Australian NPWS. Royal Australasian Ornithologists Union Report No. 82.

Holmes, G. 1987 *Avifauna of The Big Scrub Region*. A report to the Australian National Parks and Wildlife Service.

Hoye, G.A. and G.C. Richards 1995 Greater broad-nosed bat, *Scoteanax rueppellii* (Peters 1866), (In) Strahan (ed) pp. 527-528, *The Australian Museum Complete Book of Australian Mammals* Angus & Robertson and Reed Books, Sydney.

Kavanagh, R.P. 1990 *Survey of powerful and sooty owls in south-eastern NSW*. A report to the World Wildlife Fund (Australia) for Project 120.

Klippel, K. 1992 *Wildlife data search: Threatened animal species of NSW*. Total Environment Centre Inc. Breakout Press: Sydney.

Law B.S. 1993 Roosting and foraging ecology of the Queensland Blossom Bat (*Syconycteris australis*) in northeastern New South Wales: Flexibility in response to seasonal variation. *Wildl. Res.* 20: 419-431.

Law B.S. 1994 *Banksia* nectar and pollen: Dietary items affecting the abundance of the common blossom bat, *Syconycteris australis*, in southeastern Australia. *Australian Journal of Ecology* 19: 425-434.

Law, B.S. and H.J. Spencer 1995 Common blossom bat, *Syconycteris australis* (Peters, 1867). (In) Strahan, R. (ed) *Mammals of Australia* pp. 423-425. The Australian Museum and Reed Books, Sydney.

Longman, K.A. and J. Jenik 1974 Tropical forest and its environment. Longman, Lond.

Lovejoy, T.E *et. al*., 1986 Edge and other effects of isolation on Amazon forest fragments. (In) Soule, E. (ed) *Conservation Biology*. The science of scarcity and diversity pp. 257-285. M. Sunauer, Sunderland Mass.

Morris, A.K., McGill, A.R. and G. Holmes 1981 *Handlist of birds in New South Wales.* NSW Field Ornithologists Club, Sydney.

NPWS 1995 *Vertebrates of upper north-east New South Wales.* A report by the New South Wales National Parks and Wildlife Service to the Natural Resources Audit Council. Publ. National Parks and Wildlife Service.

NPWS 2002 *Threatened species of the upper north coast of NSW, flora.* Publ. NSW NPWS, Coffs Harbour.

Parnaby, H. 1992 An interim guide to the identification of insectivorous bats of south-eastern Australia. *Technical Reports of the Australian Museum* No.8. Pp. 1031-8062.

Pizzey, G and F. Knight 1997 *Field guide to the birds of Australia.* Angus and Robertson, Sydney.

Priestley, S.M. 1992 *An investigation into the species richness of Microchiropteran bats in Big Scrub rainforest remnants*. Thesis for Bachelor of Applied Science. The University of New England Northern Rivers.

Recher, H.M., Date, E. and H. Ford 1995 *The biology management of rainforest pigeons in NSW*. Species management report No. 16. NSW National Parks and Wildlife Service, Sydney.

Richards, G.C. 1983 Large-footed mouse-eared bat *Myotis adversus* (In) *The Australian Museum complete book of Australian mammals* ed by R. Strahan. Angus & Robertson Publishers: Sydney.

Richards, G.C. 1992 *Wingham Management Area Fauna Survey, Part 5: Bats*. Report to the Forestry Commission of New South Wales. December 1991.

Robson, S.K. 1984 *Myotis adversus* (Chiroptera: Vespertilionidae): Australia's fish-eating bat. *Australian Mammalogy* 7(1): 51-52.

Rose, A.B., 1993 Notes on the powerful owl in New South Wales. *Australian Bird* 26:4.

Schodde, R. and I.J. Mason 1980 *Nocturnal Birds.* Lansdowne Ed. Melb.

Simpson, K. and N. Day 1986 *Field guide to the birds of Australia.* Penguin, Australia.

Smith, A.P., S.P. Andrews, G. Gration, D.Quin and B.Sullivan 1995 *Coffs Harbour/Urunga management area EIS, supporting document No. 4, fauna.* A report to State Forests of NSW.

State Forests 1995 *Environmental impact statement for the proposed forestry operations in the Coffs Harbour and Urunga management areas.* A report prepared by State Forests, NSW.

Strahan, R. 1992 *Encyclopaedia of Australian Animals*. The National Photographic Index of Australian Wildlife. The Australian Museum. Angus and Robertson: Sydney.

Tilley, S., 1982 The diet of the powerful owl *Ninox strenua* in Victoria. *Aust. Wildl. Res.* 9:157-75.

Walker, J. and M. S. Hopkins 1990 Vegetation in *Australian soil and land survey field handbook* ed by R. C. McDonald, R. F. Isbell, J. G. Speight, J. Walker and M. S. Hopkins. Inkata Press: Melbourne.

Watt, S.M. 1993 Conservation status and draft management plan for *Dasyurus maculatus* and *Dasyurus hallucatus* in southern Queensland. Final report to the Queensland Department of Environment and Heritage and the Department of Environment, Sport and Territories, Canberra.

Williams-Linera, Guadalupe, 1990 Origin and early development of forest edge vegetation in Panama. Biotropica 22 (3) 235-241.

APPENDIX 1:

VEGETATION

Appendix 1: Vegetation

Scientific name	Common name	littoral rainforest	swampforest	open forest	banksias, regrowth, creek & farm dam	frontal dune complex	grassland
** introduced or naturalised*							
FERNS							
ASPLENIACEAE							
Asplenium australasicum	bird's-nest fern	x					
BLECHNACEAE							
Blechnum cartilagineum	gristle fern	x					
Doodia aspersa	rasp fern	x					
DENNSTAEDTIACEAE							
Hypolepis muelleri	harsh ground fern	x					
Pteridium esculentum	bracken	x			x		x
DICKSONIACEAE							
Calochlaena dubia	common ground fern	x					
POLYPODIACEAE							
Microsorum diversifolium	kangaroo fern	x					
Platycerium bifurcatum	elk-horn fern	x					
Pyrrosia rupestris	rock felt-fern	x					
ANGIOSPERMS (Flowering plants)							
Monocotyledons							
(palms, palm-lilies and cycads)							
AGAVACEAE							
Cordyline stricta	narrow-leaf palm lily	x					
AMARYLLIDACEAE							
Crinum pedunculatum	swamp lily	x	x				
ARACEAE							
Alocasia brisbanensis	cunjevoi	x					
Gymnostachys anceps	settler's flax	x					
ARECACEAE							
Archontophoenix cunninghamiana	bangalow palm	x					
Livistona australis	cabbage palm	x					
ASPARAGACEAE							
**Protasparagus aethiopicus*	asparagus fern	x					
**Protasparagus africanus*	climbing asparagus fern	x					
BAMBUSOIDEAE							
**Bambusa* sp	bamboo				x		
COMMELINACEAE							
Commelina cyanea	scurvy weed	x					
CYPERACEAE							
Cyperus polystachos	bunchy flat sedge		x				x
Eleocharis sphacelata	spike rush				x		
Fimbristylis dichotoma	fringe rush				x		
Gahnia aspersa	red-fruited saw sedge	x					
Gahnia clarkei	tall sawsedge	x					
Isolepis nodosus	a sedge					x	
Lepidosperma laterale	sword sedge	x					
DIOSCOREACEAE							
Dioscorea transversa	native yam	x					

Page 1

Appendix 1: Vegetation

Scientific name	Common name	littoral rainforest	swampforest	open forest	banksias, regrowth, creek & farm dam	frontal dune complex	grassland
* *introduced or naturalised*							
FLAGELLARIACEAE							
Flagellaria indica	whip vine	x					
JUNCACEAE							
Juncus usitatus	tussock rush				x		
MENISPERMACEAE							
Sarcopetalum harveyanum	pearl vine	x					
ORCHIDACEAE							
Calanthe triplicata	Christmas orchid	x					
Cymbidium madidum	northern cymbidum	x					
Dendrobium aemulum	ironbark orchid	x					
PHILYDRACEAE							
Philydrum lanuginosum	wooly frogmouth				x		
POACEAE							
**Axonopus affinis*	broad-leaved carpet grass						x
**Briza maxima*	quaking grass						x
Cynodon dactylon	couch						x
Imperata cylindrica var. *major*	blady grass				x		x
Oplismenus imbecillis	basket grass	x					
**Paspalum dilatatum*	paspalum						x
**Pennisetum clandestinum*	kikuyu						x
**Setaria palmifolia*	palm grass						x
**Setaria sphacelata*	canary seed grass						x
**Sorghum bicolor*	sorghum						x
Spinifex sericeus	hairy spinifex					x	
**Sporobolus indicus* var. *capensis*	Parramatta grass						x
Themeda australis	kangaroo grass						x
RIPOGONACEAE							
Ripogonum album	white supplejack	x					
SMILACACEAE							
Smilax australis	austral sarsparilla	x					
TYPHACEAE							
Typha orientalis	broad-leaved cumbungi				x		
XANTHORRHOEACEAE							
Lomandra hystrix	lomandra	x					
Lomandra longifolia	matrush	x				x	
Dicotyledons							
ANACARDIACEAE							
Euroschinus falcata var. *falcata*	ribbonwood	x					
APIACEAE							
Hydrocotyle bonariensis		x				x	
APOCYNACEAE							
Melodinus australis	southern melodinus	x					
Parsonsia straminea	common silkpod	x					
ASCLEPIADACEAE							
**Asclepias curvassica*	redhead cotton bush				x		
Hoya australis	native hoya	x					

Appendix 1: Vegetation

Scientific name	Common name	littoral rainforest	swampforest	open forest	banksias, regrowth, creek & farm dam	frontal dune complex	grassland
** introduced or naturalised*							
**Gomphocarpus fruiticocus*	narrow-leaf cotton-bush				x		
Tylophora paniculata	thin-leaved tylophora	x					
ASTERACEAE							
**Ageratina adenophora*	crofton weed				x		
**Biddens pilosa*	cobbler's pegs				x		x
**Chrysanthemoides monilifera* spp. *rotundata*	bitou bush				x	x	x
** Hypochoeris radicata*	flatweed						x
CAESALPINIACEAE							
**Senna pendula*	winter senna	x					
**Senna floribunda*	smooth cassia	x					
CAPPARIDACEAE							
Capparis arborea	brush caper berry	x					
CELASTRACEAE							
Cassine australis var. *australis*	red olive plum	x					
CASUARINACEAE							
Casuarina glauca	swamp she-oak		x				
Casuarina equisitifolia var. incarna	horse-tail oak					x	
CELASTRACEAE							
Denhamia celastroides	denhamia	x					
DILLENIACEAE							
Hibbertia scandens	twining guinea flower	x					
Hibbertia vestita	hairy guinea flower				x		
EBENACEAE							
Diospyros australis	black plum	x					
Diospyros fasciculosa	grey ebony	x					
ELAEOCARPACEAE							
Elaeocarpus obovatus	hard quandong	x					
EPACRIDACEAE							
Leucopogon parviflorus	beach beard-heath					x	
Trochocarpa laurina	tree heath			x			
ESCALLONIACEAE							
Quintinia verdonii	grey possumwood	x					
EUPHORBIACEAE							
Alchornea ulicifolia	native holly	x					
Breynia oblongifolia	breynia	x					
Bridelia exaltata	brush ironbark	x					
Claoxyon australe	brittlewood	x					
Drypetes australasica	yellow tulip	x					
Glochidion ferdinandii var. ferdinandii	cheese tree	x			x		
Omalanthus populifolius	bleeding heart				x		
EUPOMATIACEAE							
Eupomatia laurina	bolwarra	x					
FABACEAE							
Subfamily FABOIDEAE							
Hardenbergia violacea	hardenbergia			x			

Appendix 1: Vegetation

Scientific name	Common name	littoral rainforest	swamp forest	open forest	banksias, regrowth, creek & farm dam	frontal dune complex	grassland
** introduced or naturalised*							
LAURACEAE							
Cassytha glabella forma glabella	devil's twine			x			
**Cinnamomum camphora*	camphor laurel	x					
Cinnamomum virens	red-barked sassafras	x					
Cryptocarya triplinervis var. *triplinervis*	three-veined cryptocarya	x					
Cryptocarya rigida	rose maple	x					
Endiandra discolor	rose walnut	x					
Endiandra sieberi	hard corkwood	x					
Litsea reticulata	bollygum	x					
Neolitsea australiensis	green bollygum	x					
LOBELIACEAE							
Pratia purpurascens	common white root	x					
LORANTHACEAE							
Amylotheca dictyopleba	brush mistletoe	x					
MALVACEAE							
**Hibiscus splendens*	pink hibiscus	x					
**Sida rhombifolia*	Paddy's lucerne	x					
MELIACEAE							
Synoum glandulosum	scentless rosewood	x					
MENISPERMACEAE							
Stephania japonica var. *discolour*	snake vine	x			x		
MIMOSOIDEAE							
Acacia sp.				x	x		
Acacia melanoxylon	blackwood	x			x		
Acacia sophorae	beach sally wattle				x	x	
MONIMIACEAE							
Wilkiea heugliana	veiny wilkiea	x					
MORACEAE							
Ficus rubiginosa	rusty fig						x
Ficus watkinsiana	strangler fig	x					
Maclura cochinchinensis	cockspur thorn	x					
MYRSINACEAE							
Rapanaea variabilis	muttonwood	x					
MYRTACEAE							
Acmena hemilampra	broad-leaved lilly pilly	x					
Acmena smithii	lilly pilly	x					
Callistemon saligna	pink-tipped bottlebrush	x	x				
Eucalyptus siderophloia	grey ironbark	x		x			
Lopohostemon confertus	brushbox	x		x			
Melaleuca quinquenervia	broad-leaved paperbark	x	x				
Rhodamnia rubescens	brush turpentine	x					
Rhodomyrtus psidioides	native guava	x					
Tristaniopsis laurina	water-gum	x	x				
MUSACEAE							
**Musa paradisiaca*	banana				x		

Appendix 1: Vegetation

Scientific name	Common name	littoral rainforest	swamp forest	open forest	banksias, regrowth, creek & farm dam	frontal dune complex	grassland
** introduced or naturalised*							
OLEACEAE							
Notelaea longifolia form glabra	large mock-olive	x					
PASSIFLORACEAE							
**Passiflora subpeltata*	White's passionflower		x		x		
PITTOSPORACEAE							
Citriobatus pauciflorus	orange thorn	x					
PLANTAGINACEAE							
**Plantago gaudichaudii*	narrow-leaf plantain				x		x
POLYGONACEAE							
Periscaria strigosa	slender knotweed		x		x		
PROTEACEAE							
Banksia integrifolia var. *integrifolia*	coast banksia	x			x	x	
Banksia serrata	saw-tooth banksia	x					
Macadamia tetraphylla 1(2VC-) 8S	rough-shelled bush nut				x		
Stenocarpus salignus	scrub beefwood	x					
RANUNCULACEAE							
Clematis glycinoides	forest clematis						
Ranunculus inundatus	river buttercup						
RHAMNACEAE							
Alphitonia excelsa	red ash			x			
ROSACEAE							
Rubus hillii	molucca bramble	x					
RUBIACEAE							
Canthium coprosmoides	coast canthium	x					
Morinda jasminoides	morinda	x					
Pomax umbellata	pomax				x		
Psychotria loniceroides	hairy psychotria	x					
RUTACEAE							
Acronychia imperforata	beach acronychia	x					
Acronychia wilcoxiana	silver aspen	x					
**Citrus limon*	bush lemmon				x		
Phebalium squamulosum	silver basswood	x					
SANTALACEAE							
Exocarpus latifolius 8S	broad-leaved ballart	x					
SAPINDACEAE							
Alectryon coriaceus	beach alectryon	x				x	
Arytera divaricata	coogera	x					
Guioa semiglauca	guioa	x					
Sarcopteryx stipata	steelwood	x					
Toechima dasyrrhache	blunt-leaved steelwood	x					
SAPOTACEAE							
Planchonella australis	black apple	x					
SOLANACEAE							
Duboisia myoporoides	duboisia	x					
**Solanum mauritianum*	wild tobacco				x		

Appendix 1: Vegetation

Scientific name	Common name	littoral rainforest	swampforest	open forest	banksias, regrowth, creek & farm dam	frontal dune complex	grassland
** introduced or naturalised*							
**Solanum seaforthianum*	climbing nightshade			x			
STERCULIACEAE							
Commersonia bartramia	brown kurrajong	x			x		
SYMPLOCACEAE							
Symplocos stawellii	white hazlewood	x					
ULMACEAE							
Aphananthe philippinensis	rough-leaved elm	x					
URTICACEAE							
Dendrocnide photinophylla	shining-leaved stinging tree	x					
VERBENACEAE							
Clerodendrum floribundum	smooth clerodendrum	x					
** Lantana camara*	lantana	x	x		x		
**Verbena bonariensis*	purpletop						x
VIOLACEAE							
Viola hederaceae	native violet	x					
VITIDACEAE							
Cissus antarctica	watervine	x					
Cissus hypoglauca	five-leaf water vine	x					
Cissus sterculifolia	long-leaf watervine	x					

APPENDIX 2:

FAUNA

Scientific name * : introduced species; # threatened species	**Common name**	**recorded**	**expected**
MAMMALS			
CANIDAE			
*Canis familaris**	dog	x	
*Vulpes vulpes**	fox		x
DASYURIDAE			
Antechinus stuartii	brown antechinus	x	
EMBALLONONEURIDAE			
Saccolaimus flaviventris#	yellow-bellied sheath-tail bat		x
FELIDAE			
*Felis catus**	feral cat		x
MACROPODIDAE			
Macropus giganteus	eastern grey kangaroo	x	
Wallabia bicolor	swamp wallaby	x	
MOLOSSIDAE			
Nyctinomus australis	white-striped mastiff bat		x
MURIDAE			
*Mus musculus**	house mouse		x
Rattus fuscipes	bush rat	x	
Rattus lutreolus	swamp rat		?
*Rattus rattus**	black rat	x	
PERAMELIDAE			
Isoodon macrourus	northern brown bandicoot	x	
PETAURIDAE			
Pseudocheirus peregrinus	common ringtail possum		?
PHALANGERIDAE			
Trichosurus vulpecula	common brushtail possum		x
PTEROPODIDAE			
Pteropus poliocephalus	grey-headed flying-fox	x	
Syconycteris australis #	Queensland blossom-bat	x	
RHINOLOPHIDAE			
Rhinolophus megaphyllus	eastern horse-shoe bat	x	
TACHYGLOSSIDAE			
Tachyglossus aculeatus	short-beaked echidna		x
VESPERTILIONIDAE			
Chalinolobus gouldii	Gould's wattled bat		x
Miniopteris australis#	little bent-wing bat	x	
Miniopteris schreibersii#	large bent-wing bat		?
Scoteanax rueppellii#	greater broad-nosed bat		x
Scotorepens orion	eastern broad-nosed bat	x	
Vespadelus pumilus	the eastern forest bat	x	
Vespadelus vulturnus	little forest bat	x	
BIRDS			

Scientific name	Common name	recorded	expected
ACANTHIZIDAE			
Gerygone olivacea	white-throated gerygone	x	
Sericornis frontalis	white-browed scrubwren	x	
Sericornis magnirostris	large-billed scrubwren		x
ACCIPITRIDAE			
Accipiter cirrhocephalus	collared sparrowhawk		x
Accipiter fasciatus	brown goshawk		x
Accipiter novaehollandiae	grey goshawk		x
Aquila audax	wedge-tailed eagle		x
Aviceda subcristata	pacific baza		x
Circus approximans	swamp harrier	x	
Circus assimilis	spotted harrier		x
Elanus notatus	black-shouldered kite	x	
Haliaeetus leucogaster	white-bellied sea-eagle	x	
Hieraaetus morphnoides	little eagle		x
Milvus indus	brahminy kite	x	
Milvus sphenurus	whistling kite	x	
AEGOTHELIDAE			
Aegotheles cristatus	Australian owlet-nightjar		x
ALCEDINIDAE			
Alcedo azurea	azure kingfisher		x
Dacelo novaeguineae	laughing kookaburra	x	
Todiramphus macleayii	forest kingfisher		x
Todiramphus sanctus	sacred kingfisher		x
ANATIDAE			
Anas castanea	chestnut teal		x
Anas gibberifrons	grey teal		x
Anas platyrhynchos	mallard		x
Anas superciliosa	Pacific black duck	x	
Chenonetta jubata	maned duck	x	
ANHINGIDAE			
Anhinga melanogaster	darter	x	
APODIDAE			
Aerodramus spodiopygius	white-rumped swiftlet		x
Apus pacificus	fork-tailed swift	x	
Hirundapus caudacutus	white-throated needletail		x
ARDEIDAE			
Ardea ibis	cattle egret		x
Ardea intermedia	intermediate egret		x
Ardea novaehollandiae	white-faced heron	x	
ARTAMIDAE			
Artamus leucorhynchus	white-breasted woodswallow	x	
CAMPEPHAGIDAE			
Coracina novaehollindiae	black-faced cuckoo-shrike	x	
Coracina tenuirostris	cicadabird		x
Lalage leucomela	varied triller	x	
CAPRIMULGIDAE			
Caprimulgus mystacalis	white-throated nightjar		x

Scientific name * : introduced species; # threatened species	**Common name**	recorded	expected
CHARADRIIDAE			
Vanellus miles	masked lapwing	x	
COLUMBIDAE			
Chalcophaps indica	emerald ground-dove		x
Columba leucomela	white-headed pigeon		x
Columba livia *	feral pigeon		x
Geopelia humeralis	bar-shouldered dove		x
Geopelia placida	peaceful dove		x
Geophaps lophotes	crested pigeon	x	
Lopholaimus antarcticus	topknot pigeon		x
Macropygia amboinensis	brown cuckoo-dove		x
Ptilinopus regina#	rose-crowned fruit-dove		x
*Streptopelia chinensis**	spotted turtle-dove	x	
CORACIIDAE			
Eurystomus orientalis	dollarbird	x	
CORVIDAE			
Corvus orru	torresian crow	x	
CRACTICIDAE			
Cracticus nigrogularis	pied butcherbird	x	
Cracticus torquatus	grey butcherbird	x	
Gymnorhina tibicen	Australian magpie	x	
Strepera graculina	pied currawong	x	
CUCULIDAE			
Cacomantis flabelliformis	fan-tailed cuckoo		x
Centropus phasianinus	pheasant coucal		x
Chrysococcyx basalis	horsfield's bronze-cuckoo		x
Chrysococcyx lucidus	shining bronze-cuckoo		x
Chrysococcyx minutillus	little bronze-cuckoo		x
Eudynamys scolopacea	common koel		x
DICAEIDAE			
Dicaeum hirundinaceum	mistletoe bird		x
DICRURIDAE			
Dicrurus bracteatus	spangled drongo	x	
FALCONIDAE			
Falco berigora	brown falcon		x
Falco cenchroides	Australian kestrel		x
Falco longipennis	Australian hobby		x
GRALLINIDAE			
Grallina cyanoleuca	Australian magpie-lark	x	
HIRUNDINIDAE			
Hirundo ariel	fairy martin		x
Hirundo neoxena	welcome swallow	x	
Hirundo nigricans	tree martin		x
MALURIDAE			
Malurus cyaneus	superb fairy-wren		x
Malurus lamberti	variegated fairy-wren	x	

Scientific name * : introduced species; # threatened species	**Common name**	recorded	expected
Malurus melanocephalus	red-backed fairy-wren		x
MEGAPODIIDAE			
Alectura lathami	Australian brush-turkey		x
MELIPHAGIDAE			
Acanthorhynchus tenuirostris	eastern spinebill		x
Anthochaera chrysoptera	brush (little) wattlebird	x	
Lichmera indistincta	brown honeyeater		x
Manorina melanocephala	noisy miner	x	
Meliphaga lewinii	Lewin's honeyeater	x	
Melithreptus albogularis	white-throated honeyeater		x
Myzomela sanguinolenta	scarlet honeyeater		x
Philemon citreogularis	little friarbird	x	
Philemon corniculatus	noisy friarbird	x	
Phylidonyris nigra	white-cheeked honeyeater	x	
MEROPIDAE			
Merops ornatus	rainbow bee-eater		x
MOTACILLIDAE			
Anthus novaeseelandiae	Richard's pipit	x	
ORIOLIDAE			
Oriolus sagittatus	olive-backed oriole	x	
Sphecotheres viridis	figbird		x
ORTHONYCHIDAE			
Psophodes olivaceus	eastern whipbird	x	
PACHYCEPHALIDAE			
Colluricincla harmonica	grey shrike-thrush	x	
Colluricincla megarhyncha	little shrike-thrush		x
Eopsaltria australis	eastern yellow robin	x	
Monarcha melanopsis	black-faced monarch		x
Monarcha trivirgatus	spectacled monarch		x
Myiagra inquieta	restless flycatcher		x
Myiagra rubecula	leaden flycatcher		x
Pachycephala pectoralis	golden whistler	x	
Pachycephala rufiventris	rufous whistler		x
Petroica rosea	rose robin		x
Rhipidura fuliginosa	grey fantail		x
Rhipidura leucophrys	willie-wagtail	x	
Rhipidura rufifrons	rufous fantail		x
PARDALOTIDAE			
Pardalotus striatus	striated pardalote		x
PHALACROCORACIDAE			
Phalacrocorax sulcirostris	little black cormorant		x
Phalacrocorax varius	pied cormorant		x
Phalocrocorax melanoleucos	pied cormorant		x
PHASIANIDAE			
Coturnix ypsilophora	brown quail	x	
PLATALEIDAE			
Threskiornis molucca	Australian white ibis		x

Scientific name * : introduced species; # threatened species	**Common name**	recorded	expected
Threskiornis spinicollis	straw-necked ibis		x
PLOCEIDAE			
Neochmia temporalis	red-browed finch	x	
PODARGIDAE			
Podargus strigoides	tawny frogmouth		x
PSITTACIDAE			
Alisterus scapularis	Australian king parrot		x
Cacatua galerita	sulphur-crested cockatoo		x
Cacatua roseicapilla	galah		x
Calyptorhynchus funereus	yellow-tailed black cockatoo		x
Platycercus eximius	eastern rosella		x
Trichoglossus chlorolepiotus	scaly-breasted lorikeet	x	
Trichoglossus haematodus	rainbow lorikeet	x	
STRIGIDAE			
Ninox boobook	southern boobook		x
SYLVIIDAE			
Megalurus gramineus	little grassbird		x
Megalurus timoriensis	tawny grassbird		x
ZOSTEROPIDAE			
Zosterops lateralis	silvereye		x
REPTILES			
AGAMIDAE			
Physignathus lesueurii	eastern water dragon	x	
Pogona barbata	bearded dragon		x
BOIDAE			
Morelia spilota	carpet python		x
CHELIDAE			
Chelodina longicollis	long-necked tortoise	x	
COLUBRIDAE			
Boiga irregularis	brown tree snake		x
Dendrelaphis punctulata	green tree snake		x
ELAPIDAE			
Demansia psammophis	yellow-faced whip snake		x
Furina diadema	red-naped snake		x
Pseudechis porphyriacus	red-bellied blacksnake		x
Pseudonaja textilis	eastern brown snake	x	
SCINCIDAE			
Anomalopus verreauxii			x
Ctenotus robustus	striped skink		x
Eulamprus quoyii	eastern water skink		x
Lampropholis delicata	eastern grass skink	x	
Lampropholis guichenoti	garden skink		x
Ophioscincus truncatus	yellow-bellied legless lizard		x
Saiphos equalis	three-toed skink	x	
Saproscincus challengeri	challenger skink		x
Tiliqua scincoides	eastern blue-toungued lizard		x

Scientific name * : introduced species; # threatened species	**Common name**	recorded	expected
TYPHLOPIDAE			
Ramphotyphlops nigriscens	a blind snake		x
VARANIDAE			
Varanus varius	lace monitor	x	
AMPHIBIANS			
HYLIDAE			
Litoria fallax	eastern dwarf frog	x	
L. nasuta	rocket frog		x
L. peronii	Peron's tree frog		x
MYOBATRACHIDAE			
Adelotus brevis	tusked frog		x
Crinia signifera	common eastern froglet	x	
Limnodynastes ornatus	ornate burrowing frog		x
Limnodynastes peronii	brown-striped frog	x	
L. tasmaniensis	spotted grass frog		x
L. terraereginae	northern banjo frog		x
Pseudophryne coriacea	red-backed toadlet	x	
Uperlois fusca	dusky toadlet	x	

APPENDIX 3:

DEC DRAFT SURVEY GUIDELINES

Survey methods (source: *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (Department of Environment and Conservation, November 2004).

Method	Effort per stratification unit up to 50 Hectares plus additional effort for every additional 100 ha
Small Elliott traps	100 trap nights over 3-4 consecutive nights
Large Elliott traps	100 trap nights over 3-4 consecutive nights
Arboreal Elliott traps	24 trap nights over 3-4 consecutive nights
Wire cage traps	24 trap nights over 3-4 consecutive nights
Pitfall traps with drift nets	24 trap nights over 3-4 consecutive nights
Hair tubes	10 large and 10 small tubes in pairs for at least 4 days and 4 nights
Arboreal hair tubes	3 tubes in each of 10 habitat trees up to 100 hectares of stratification unit, for at least 4 days and 4 nights
Spotlighting on foot	2 x 1 hour and 1 km up to 200 hectares of stratification unit, walking at approximately 1 km per hour on 2 separate nights
Spotlighting from vehicle	2 x 1 km of track at maximum speed of 5 km per hour, up to 200 hectares of stratification unit, on 2 separate nights
Sand plots	6 soil plots for 4 nights
Call playback	2 sites per stratification unit up to 200 hectares, plus an additional site per 100 hectares above 200 hectares. Each playback site must have the session conducted twice, on separate nights
Stag-watching	Observing potential roost hollows for 30 minutes prior to sunset and 60 minutes following sunset
Search for scats and signs	30 minutes searching each relevant habitat, including trees for scratch marks
Track search	1 km of track search with emphasis on where substrate is soft
Collection of predator scats	Opportunistic collection of predator scats for hair analysis

APPENDIX 4:

ASSESSMENT OF SIGNIFICANCE (7-PART TEST), FLORA AND FAUNA

The following 7-part test has been undertaken to provide details on threatened species which may occur at the site.

S.5A (a)

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

In assessing the likelihood that a *viable local population* of a species will be placed at risk of extinction from this proposal the following factors have been considered:

- the proposal's likely impact upon the key habitat components essential to the species' lifecycle; and
- the size of the local population in comparison with that which is proposed to be removed/modified.

A local population is considered to be the population contained within interconnected suitable habitat within a 5 km radius of the study site.

Flora

One threatened plant species, the rough-shelled bush nut was recorded at the site. Another species, the white-flowered wax plant potentially occurs in the littoral rainforest.

The rough-shelled bush nut does not occur naturally south of the Clarence River and was recorded in an disused orchard. The white-flowered wax is a rainforest species which would not occur in the grassland at the site proposed for development. Thus, it is unlikely that any development proposal would *have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.*

Fauna either recorded at the site or those species which have essential habitat components at the site

A number of threatened species are considered likely to periodically occur at the site or are known from the Port Macquarie area. These species are included in the following assessment.

Birds

Barred cuckoo-shrike

The barred or yellow-eyed cuckoo shrike is a medium-sized (26-28 cm) gregarious, migratory songbird that forages for fruit in the rainforest canopy. It has a dark face, with black lores and a yellow eye. It is dark grey above, with darker wings. The breast and abdomen is white with black barring (Simpson and Day 1996).

Critical habitat for this species is rainforest with fruiting trees. However, it has been recorded in eucalypt forest including ecotones and regrowth where it feeds on fruit and insects (Blakers *et al.*, 1984). A major habitat component is the presence of fruiting trees, especially figs, *Ficus* sp.

Distribution

The barred cuckoo-shrike ranges along the eastern Australian coastline from Cape York to the Clarence River (RAOU Atlas). Morris *et. al.*, (1981) suggested that the barred cuckoo-shrike is scarce within NSW. Blakers *et al.* (1984) described it as living in pairs or flocks of up to 50 birds. Non-breeding occurrences have been reported from Woolgoolga Creek Flora Reserve, Repton, Nambucca Heads, Hungry Head and near Macksville (State Forests 1995).

Glossy black cockatoo

The glossy black cockatoo is a small blackish brown bird with a broad bulbous bill and a low round crest. The female is distinguished from the male by irregular yellowish patterns on the head, crest and/or neck. The female also has a red tail panel edged with yellow and is usually barred black.

The glossy black cockatoo lives in loose groups of two to 20 birds and appears to occupy areas permanently, although individuals and subgroups may move around within each area. It frequents open forests and woodlands extending into semi-arid areas.

This species feeds almost exclusively on the fruits of she-oaks. Swamp she-oak was recorded in the south-west corner of the site and along Duchess Creek.

Distribution

The glossy black cockatoo occurs in the eastern part of Australia and ranges from Rockhampton, Queensland to southern Victoria. It has also been recorded at islands off the South Australian coast (RAOU Atlas Map 265). This species has been recorded at Cudgen, Ellangowan, Evans Head, Iluka-Woombah, Yamba, Grafton (NPWS 1995), and at Pottsville (per. recs.). There was no evidence of the glossy black cockatoo feeding at the site on the swamp she-oak.

Masked owl

The masked owl closely resembles the more common barn owl, *Tyto alba.* It is readily distinguishable from the barn owl, however, by its distinctive screeching call. It is also larger and more robust than the barn owl with a rounder black-bordered facial disc. Its colour varies from white, similar to the

barn owl, to blackish above and buff-chestnut below (Pizzey and Knight 1997).

The masked owl frequents forest and woodland, but will also frequent treeless country where caves are available. Its home range is between 500-1000 ha and it is known to take more ground-dwelling prey than arboreal species (Schodde and Mason 1980 cited in State Forests 1996). Nesting sites include mixed-age or mid-successional stage dry sclerophyll forest (usually > 60 years old). The masked owl has been recorded at low densities throughout its range. However, it is most numerous in coastal and near-coastal regions (Debus and Rose 1994).

Distribution

The masked owl has a widespread but patchy distribution in drier forest types and is present in low densities in north-east NSW. Two sub-species occur over a range of more than one million square kilometres (Lindsey 1992 cited in State Forests 1996). The distributional range of the southern subspecies, *novaehollandiae,* is from Cooktown, around the southern coast of Australia to the Pilbara in Western Australia. This sub-species occurs mainly within 300 km of the coast, although there are records from the Nullabor Plain and up to 100 km inland from the coast along water courses (Garnett 1992; Lindsey 1992).

The masked owl frequents forests and woodlands extending from the coastal plains westward across the Great Dividing Range. It has been recorded within the Kempsey/Wauchope, Gloucester/Chichester and Wigham State Forest management areas (State Forests 1996).

Osprey

The osprey is predominantly confined to coastal estuaries, mangroves and the sea shore in northern NSW. Roosting and nesting sites are located close to estuaries on large trees that provide views over feeding sites.

Distribution

This species is Australia-wide in distribution, in suitable but limited coastal habitat. However, it has not been recorded breeding south of the Newcastle District and records south of this area are considered dispersing, post-breeding or juvenile birds. The osprey may fly over the site periodically and forage along Rainbow Beach and lake Cathie. The proposal is unlikely to impact on this species as no roosting or foraging habitat will be impacted.

Powerful owl

This species is a habitat generalist occupying a wide range of forest communities (Kavanagh 1990). Its diet is comprised primarily of arboreal marsupials, although other food items (e.g., ring-tail and brush-tail possums, fruit bats, young koalas and sulphur-crested cockatoos) have been recorded (Fleay 1944; Tilley 1982).

Distribution

The powerful owl frequents tall open forests ranging from the coast to the ranges of southern Queensland to western Victoria. It occurs in low densities in south-eastern Australia and is rare in Victoria.

Records of the powerful owl frequenting Sydney's bushland date from the late 1950s (Rose 1993). It has been recorded at Gloucester in 1959 and 1974, Dorrigo in 1975, Brisbane Water in 1976, Forster in 1977, Muswellbrook in 1978, Deua National Park in 1979, Washpool in 1980 and Nowra in 1980

(Rose 1993). It is likely to use forests and woodlands in the Port Macquarie environs but would not be impacted by this proposal which is confined to habitat not utilised by the powerful owl.

Rose-crowned fruit-dove

The rose-crowned fruit-dove is a small (22-24.5 cm) frugivorous bird that is largely confined to rainforest. Its distinctive colouration includes a rose crown, a blue head, a dark green back and abdomen and a yellow tail-tip.

This species is an obligate frugivore of the rainforest canopy. It is usually encountered in pairs or small groups, with larger congregations being generally restricted to profusely fruiting trees (State Forests 1996).

Distribution

The rose-crowned fruit-dove ranges from the Kimberly district in north-eastern Western Australia through Queensland and NSW, along the eastern coastline of Victoria and to Tasmania in the south (RAOU map 021). It frequents rainforests, monsoon and paperbark forests, eucalypt woodlands, vine groves, fruit orchids, camphor laurel and broad-leaved privet regrowth. It is moderately common in NSW (Morris *et al.*, 1981) and its population probably exceeds 7,000 individuals (Recher *et al.* 1995). Records south of Sydney are uncommon (Simpson and Day 1986). However, vagrants occur in the southern part of the State where they migrate between rainforest "stepping stones". "Stepping stone" forests are important for this and other fruit-pigeons (e.g., wompoo, topknot, and white-headed pigeons) (Date *et al.* 1991). The rose-crowned fruit-dove migrates to coastal and near-coastal areas during the winter months (pers. obs.) and may potentially occur at the site. However, the proposal will not impact on this species as the littoral rainforest will be preserved and enhanced.

Wompoo fruit-dove

This species is an obligate frugivore of the rainforest canopy. It is usually encountered in pairs or small groups, with larger congregations being generally restricted to profusely fruiting trees (State Forests 1996).

Distribution

The wompoo fruit-dove inhabits rainforests from the south coast of NSW along the eastern Australian coastline to Cape York (RAOU map 025). Individuals occur in the southern part of the State where they migrate between rainforest "stepping stones" (Date *et al.* 1991). It also migrates altitudinally, moving to coastal and near-coastal rainforests areas during the winter months (pers. obs.).

This species is relatively common in the CHUMA frequenting rainforest and moist sclerophyll forest. Typical breeding and non-breeding records are from Dorrigo National Park, Oakes State Forest, Pine Creek State Forest, Bellinger River State Forest and Moonee Nature Reserve (State Forests 1995). Vagrants may occur in moist forests. The proposal will not impact on this species as the littoral rainforest will be preserved and enhanced.

Mammals

Common bent-wing bat

The common or large bent-wing bat has an exceptionally long terminal segment of the third finger and its fur is chocolate brown above and paler below.

The common bent-wing bat is one of the world's most widely dispersed placental mammals. Its distribution extends outside of Australia to Papua New Guinea, south-east Asia, Africa and Eurasia (Klippel 1992). This species

is common throughout Australia with population estimates of individuals emerging from roosts at Wee Jasper caves at between 50-100,000 individuals (Dwyer 1996).

This species forages for flying invertebrate above and beneath the forest canopy. It utilises caves, old mines, or a variety of structures such as buildings and stormwater drains as diurnal roosts. It is typically found in well timbered areas where it forages above the tree canopy on small insects (Dwyer 1983a; 1995). This species will travel large distances between roost sites according to seasonal and local needs. Adult females congregate in large maternity colonies at specific sites of high temperature and humidity.

Distribution

The common bent-wing bat occurs along the Australian coast and ranges from north Western Australia, Northern Territory, Cape York to Adelaide (Klippel 1992). This species was recorded at Ellangowan and Moonee Beach (NPWS 1995) and in most State Forest surveys in the region and is widely but sparsely distributed (State Forests 1995). These include Buckra, Kangaroo River, Orara East, Irishman and Wild Cattle Creek (State Forests 1995). This species may periodically forage at the site but will be unaffected by the proposal which will retain the littoral rainforest and suitable foraging habitat.

Greater broad-nosed bat

The greater broad-nosed bat is a winged placental mammal with a broad squarish head and sparsely-haired muzzle with glandular swellings. This species has dark reddish-brown fur above and is slightly paler below (Cronin 1991).

The greater broad-nosed bat forages on slow-flying beetles and uses creeks or small rivers as corridors. It appears to prefer open areas at the edges of forests or tree-lined creeks and utilises tree hollows for diurnal roosting sites (Richards 1983). It has been recorded roosting in small dead stags (pers. obs.), tree hollows and in roof spaces in old buildings (Hoye and Richards 1995). This bat is a large species requiring a greater feeding range than other insectivorous species.

Distribution

The greater broad-nosed bat extends along the coast from Maryborough in Queensland to Orbost in Victoria (Klippel 1992). Its preferred habitat is along creek systems of the Border Ranges. However, it has been recorded in low numbers in near-coastal habitat. It is reasonably common in coastal northern NSW (Richards 1992) especially in the Richmond Range, Whian Whian State Forest and Mebbin State Forest (Martin Schulz cited in State Forests 1996). The greater broad-nosed bat has been recorded at Bundjalung National Park and Yamba (NPWS 1995) and suitable habitat occurs at the site.

Fishing bat (Large-footed myotis)

The fishing bat is a small coastal winged placental mammal with grey-brown to dark brown fur above and slightly paler fur below with frosted silver-grey fur on the chest (Cronin 1991).

The fishing bat roosts in caves usually located proximal to water and has been reported in colonies ranging from ten to hundreds of individuals. This species also roosts in tree-hollows and dense vegetation (see references cited in State Forests 1996). It has been recorded in mines, tunnels, under bridges, in buildings and in dense foliage. Habitats include rainforests, lakes and reservoirs (Richards 1983). It forages over the surface of water on aquatic

insects and small fish insects (e.g., water boatmen, grasshoppers, moths and mayflies) (Ferrier *et al.* undated; Robson 1984).

Distribution

The fishing bat has an extensive coastal distribution from south-eastern Australia around the east coast to north Western Australia. It has been recorded from the Brockley rainforest remnant near Lismore (Priestley 1992), Brunswick Heads (NPWS 1995), Byron Bay (pers. record), Lennox Head, Bundjalung, Iluka-Woombah and Yamba (NPWS 1995). This species has been recorded by the author at Lake Cathie and may forage over the site due to the presence of nearby water bodies. The proposal will not require the removal of known habitat for this species.

Little bent-wing bat

The little bent-wing bat is characterised by an exceptionally long terminal segment of the third finger. This placental flying mammal is greyish black to fawn-brown above and paler below.

The little bent-wing bat occurs in a wide range of forest types ranging from rainforest to warm temperate wet and dry sclerophyll forests. It forages on small insects below the tree canopy of well timbered habitat and relies on a limited number of caves for maternity and hibernation roosts (Dwyer 1983b). With the onset of spring, adult females move from widely scattered roosts to specific nursery caves. These sites are often shared with the common bent-wing bat. The little bent-wing bat relies on large numbers of common bent-wing bats to raise cave temperatures to that necessary to raise young (Dwyer 1983b; Baudinette *et al.* 1994).

Distribution

The little bent-wing bat frequents the coastal ranges of eastern Australia from the central coast of NSW to Cape York. This species utilises caves, old mines and a variety of structures such as buildings and stormwater drains as diurnal roosts. It is considered abundant nationally (Dwyer 1995) but in NSW it is restricted to the north of the State and is present in much lower numbers.

The little bent-wing bat is widely distributed and was recorded in most State Forest management areas in northern NSW (State Forests 1996) and was recorded at the site during the fauna survey. No roosting or foraging areas will be impacted by the proposal.

Common blossom bat

The common blossom bat is a small winged placental mammal that feeds on nectar. It has a long thin brush-like tongue and a slim pointed muzzle. Its long soft reddish-brown fur extends to the ankle. It is paler below and flecked with white (Cronin 1991).

The common blossom bat forages extensively in coastal heaths and coast banksia woodland and usually roosts in proximity to these feeding sites. In NSW feeding sites, it is considered a strict nectivore, whereas in north-east Queensland it is a facultative frugivore and to a lesser extent a folivore (Law and Spencer 1995).

In suitable environmental conditions, this species can be quite common reaching a density of between 1 and 17.5 bats/ha. The species' density is commonly associated with the density of banksia inflorescence (Law 1994).

Distribution

The common blossom bat has been recorded east of the ranges from Cape York in Queensland to the mid-north coast of NSW to approximately Taree where littoral rainforest and heath occur in close proximity. Rainforests, unlike more open habitats, are important for roosting purposes enabling bats to maintain a stable body temperature (Law 1993). This species was recorded at the site and is likely to roost seasonally in the littoral rainforest understorey. No roosting or foraging areas will be impacted by the proposal.

Grey-headed flying- fox

The grey-headed flying-fox feeds on the blossom of eucalypts, paperbarks, turpentines and native and introduced fruits.

Distribution

This species is distributed along the eastern Australian coastline from Gladstone in Queensland to south Gippsland and Melbourne in Victoria. It rarely travels more than 200 km inland. This species is commonly observed throughout the Shire, particularly at sunset. The grey-headed flying-fox was recorded at the site foraging on flowering broad-leaved paperbark.

The flora and fauna survey identified and mapped areas of conservation significance which are currently not afforded environmental protection. This assessment concluded that development outside of the proposed conservation areas is unlikely to *have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.*

S.5A (b)

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

No endangered populations, listed under Part 2 of Schedule 1 of the TSC Act, occur within the vicinity of the site. Thus, the action proposed will not cause *a viable local population of the species to be placed at risk of extinction*.

S.5A (c)

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

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

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

Littoral rainforest occurs at the site and will be retained, substantially buffered with plantings of local species and managed with respect to weeds, human access and drainage. The proposal will enhance and expand the area of the littoral rainforest and will not *have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction* nor will any proposed action *substantially and adversely*

modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

S.5A (d)

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

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

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

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

No threatened species habitat will be removed or modified as a result of this proposal.

S.5A (e)

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

The site does not contain any area which has been identified and declared as critical habitat under Part 3 of the TSC Act. Therefore, critical habitat will not be affected by the development of the site.

S.5A (f)

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

A number of recovery plans or threat abatement plans apply to some extent. These include plans for the European red fox and bitou bush. Conservation measures identified in this report are consistent with recovery planning. These include weed control and buffer planting and the construction of a boardwalk through degraded coastal dunes.

S.5A (g)

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

Threatening processes gazetted pursuant to the TSC Act are as follows:

- Alteration of habitat following subsidence due to longwall mining;
- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands (as described in the final determination of the Scientific Committee to list the threatening process);
- Anthropogenic climate change;
- Bushrock removal;
- Clearing of native vegetation. Clearing is defined as the destruction of a sufficient proportion of one or more strata (layers) within a stand or stands of native vegetation so as to result in the loss, or long-term modification, of the structure, composition and ecological function of a stand or stands;
- Competition and grazing by the feral European Rabbit, *Oryctolagus cuniculus;*
- Competition from feral honey bees, *Apis mellifera*;

- Death or injury to marine species following capture in shark control programs on ocean beaches;
- Entanglement in or ingestion of anthropogenic debris in marine and estuarine environments;
- Herbivory and environmental degradation caused by feral deer;
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition. High frequency fire is defined as two or more successive fires close enough together in time to interfere with or limit the ability of plants or animals to recruit new individuals into a population, or for plants to build up a seed-bank of sufficient size to maintain the population through the next fire;
- Importation of Red Imported Fire Ants, *Solenopsis invicta*;
- Infection by *Psittacine Circoviral* (beak and feather) disease affecting endangered psittacine species and populations;
- Infection of frogs by amphibian chytrid causing the disease, chytridiomycosis;
- Infection of native plants by the fungus, *Phytophthora cinnamomi;*
- Introduction of the Large Earth Bumblebee, *Bombus terrestris*;
- Invasion and establishment of exotic vines and scramblers
- Loss or degradation (or both) of sites used for hill-topping by butterflies. Hill-topping in butterflies is a complex behaviour that often facilitates mating between sexes. Many butterfly species appear to congregate on hill-tops or ridges that are usually higher than the surrounding landscape. These sites may range in area from a few square metres to several hectares;
- Invasion, establishment and spread of Lantana;
- Invasion of native plant communities by bitou bush, *Chrysanthemoides monilifera.* The ability of bitou bush to become the overwhelming dominant in invaded ecological communities threatens all plant communities within its distribution;
- Invasion of native plant communities by exotic perennial grasses;

- Predation by the mosquito fish, *Gambusia holbrooki;*
- Predation by the European red fox, *Vulpes vulpes*;
- Predation by the feral cat, *Felix cattus.* Predation by the feral cat has been implicated in the extinction and decline of many species of birds on islands around Australia and in the early extinction of up to seven species of small mammals on the Australian mainland;
- Predation by the ship rat, *Rattus rattus,* on Lord Howe Island; and
- Removal of dead wood and dead trees.

The proposal will not result in an increase in any of the above-listed threatening processes. Moreover, bushland management works will target bitou bush and lantana removal and thus minimise the impact that these two listed species have on the littoral rainforest.

APPENDIX 5:

ASSESSMENT OF SIGNIFICANCE (7-PART TEST), FISH AND INVERTEBRATES

S. 7A *Fisheries Management Act 1994* and s.5A (EPA Act): Fish and invertebrate assessment

The FM Act lists threatened species, marine vegetation and threatening processes. These are as follows:

Critically endangered species

Nereia lophocladia	Marine brown alga
Carcharias taurus	Grey nurse shark
Craterocephalus fluviatilis	Murray hardyhead
Galaxias rostratus	Flathead galaxias

Endangered species:

Archaeophya adamsi	Adam's emerald dragonfly
Austrocordulia leonardi	Sydney hawk dragonfly
Maccullochella ikei Rowland	Eastern freshwater cod
Maccullochella macquariensis	Trout cod
Macquaria australasica	Macquarie perch
Mogurnda adspersa	Purple spotted gudgeon
Nannoperca australis	southern pygmy perch
Nannoperca oxleyana	Oxleyan pygmy perch
Notopala sublineata	River snail
Thunnus maccoyii	Southern bluefin tuna

Endangered populations:

- *Ambassis agassizii,* olive perchlet, in western NSW; and
- *Gadopsis marmoratus,* river blackfish, Snowy River population

Endangered ecological communities:

- The aquatic ecological community in the natural drainage system of the lower Murray River catchment;
- The aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River; and
- The aquatic ecological community in the natural drainage system of the lowland catchment of the Lachlan River.

Vulnerable fish species:

Bidyanus bidyanus	Silver perch
Branchinella buchananensis	Buchanans fairy shrimp
Carcharodon carcharias	Great white shark
Epinephelus daemelii	Black cod

Key threatening processes:

- Degradation of native riparian vegetation along New South Wales water courses;
- Hook and line fishing in areas important for the survival of threatened fish species;
- Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams;
- Introduction of fish to waters within a river catchment outside their natural range;
- Introduction of non-indigenous fish and marine vegetation to the coastal waters of New South Wales;
- Removal of large woody debris from New South Wales rivers and streams; and
- The current shark meshing program in New South Wales waters.

S.5A (a)

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

The following factors have been considered in assessing the likelihood of whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction:

- the proposal's likely impact upon the key habitat components essential to the species' lifecycle; and
- the size of the local population in comparison with that which is proposed to be removed/modified.

Fish either recorded at the site or those species which have essential habitat components at the site

No threatened freshwater fish species (within the definition in the FM Act) is likely to occur at or in the vicinity of the site based on their known habitat distribution. Thus, the proposal will not impact on the habitat of any of threatened species to the extent that it will *have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction* review of the habitat.

S.5A (b)

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

No endangered fish or invertebrate populations occur within the vicinity of the site. Thus, the action proposed will not cause *a viable local population of the species to be placed at risk of extinction.*

S.5A (c)

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

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

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

No Critically Endangered or Endangered Ecological Communities listed under the FM Act occur at or in the vicinity of the site. Accordingly, the action proposed will not have an adverse effect on the extent of the ecological community such that its local occurrence is likely *to be placed at risk of extinction* nor will the proposed action *substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*.

S.5A (d)

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

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

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

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

The proposal will not result in the removal or modification of threatened species habitat or EECs, nor will it result in habitat fragmentation. Thus, the proposal will have no impact on the *long-term survival of the species, population or ecological community in the locality.*

S.5A (e)

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

The site does not contain any area which has been declared as critical habitat under Part 3 of the TSC Act. Therefore, critical habitat will not be affected.

S.5A (f)

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

No recovery plans or threat abatement plans apply.

S.5A (g)

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

Threatening processes are listed above. The proposal will not require the removal of woody debris or lead to an increase in any threatening processes.

APPENDIX 6:

ASSESSMENT OF SIGNIFICANCE (*ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT, 1999*)

Environment Protection and Biodiversity Conservation Act, 1999 assessment

The results of a search of the EPBC Act Protected Matters Tool for a distance of 5 km around the site listed *inter alia* the osprey and grey-headed flying-fox as vulnerable species which the flora and fauna survey either recorded or considered likely to occur.

The osprey is likely to forage for fish within Lake Cathie and along Rainbow Beach. It is tolerant of human activity and will nest in remnant trees on cleared land (Clancy 1989). However, the removal of trees along shorelines, loss of roosting and nesting sites, siltation and nutrification of water bodies from urban development may all potentially impact on this species. The proposal will not result in any potential impact on osprey habitat.

The grey-headed flying-fox is wide-ranging and forages on the blossoms of eucalypts, paperbark, turpentine and native and introduced fruits. It is distributed along the eastern Australian coastline from Gladstone in Queensland to south Gippsland and Melbourne in Victoria. It rarely travels more than 200 km inland. The proposal includes considerable planting within the littoral rainforest buffer and along Duchess Creek. These plantings will contribute to grey-headed flying-fox foraging resources.

In conclusion, the proposal is unlikely to impact on the osprey and grey-headed flying-fox and therefore does not need to be referred to the Minister for the Environment, Heritage and the Arts.

Littoral Rainforest and Coastal Vine Thickets of Eastern Australia is a critically endangered ecological community listed under the EPBC Act. Thus, any new or intensified activities that may have a significant impact upon one

or more patches of the listed ecological community would need to be referred to the Minister for the Environment, Heritage and the Arts for assessment. Typical activities which fall within these criteria include logging, clearing of understorey or ground layer, permanent changes in hydrology, introduction of invasive exotic species or fragmentation through construction of permanent access tracks.

The proposal will not require any clearing or impact on the littoral rainforest. Moreover, ameliorative measures which are discussed in this report include the construction of a boardwalk over a degraded access track through the littoral rainforest , weed control, buffer plantings and the control of stormwater runoff. Thus, the proposal will not impact the littoral rainforest and does not need to be referred to the Commonwealth Minister for the Environment, Heritage and the Arts.