

Living on the Edge



The Port Stephens Foreshore Reference Document Attachment 1 to Port Stephens Foreshore Management Plan

AUGUST 2009

FINAL

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STUDIES

- 1 Ecological Habitats**
- 2 Aboriginal Cultural Heritage**
- 3 European Heritage**
- 4 Foreshore Stability**

1.0 Introduction

The Port Stephens Foreshore Management Plan consists of:

- The Port Stephens Foreshore Management Plan;
- The Port Stephens Foreshore Reference Document (the current document);
- The Port Stephens Asset Inventory; and
- The Port Stephens GIS Layers.

1.1 Reference Document Contents

This Reference Document contains the detailed results of specialist studies undertaken to support and inform the Port Stephens Foreshore Management Plan and provide detailed background information to the Plan.

The studies are:

1. Ecological Habitats;
2. Aboriginal Cultural Heritage;
3. European Heritage; and
4. Foreshore Stability.

STUDY 1

Ecological Habitats

Port Stephens Council

Port Stephens Foreshore Plan of Management – Ecology Reference Document

August 2009

Port Stephens Foreshore Plan of Management – Ecology Reference Document

Prepared by
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1.0 Introduction

The Port Stephens estuary, located on the lower north coast of New South Wales, consists of more than 250 kilometres of foreshore which comprises a range of landscapes including sandy embayments, rocky headlands, and estuarine creeks lined with mangroves and saltmarsh. The significant ecological components of the Port Stephens Foreshore are identified in this Reference Document, which accompanies the Port Stephens Foreshore Plan of Management.

This Reference Document also identifies the major threats to the ecological values of the foreshore, and provides an outline of the current management actions that are in place to address these threats. Management actions have been recommended for those threats that are not currently addressed.

2.0 Literature Review

A wide range of resources have been drawn upon for the preparation of the Ecological Reference Document for the Port Stephens Foreshore Plan of Management. Threatened flora and fauna species records for the study area were obtained from a search of the Department of Environment and Conservation (DEC) Atlas of NSW Wildlife. Several regional vegetation studies were utilised for the preparation of the vegetation communities maps (**Figures 2.1(a)** and **2.1(b)**), including the *Tomaree National Park Vegetation Survey* (Bell 1997); *Great Lakes Council Vegetation Strategy – Eastern Portion* (Great Lakes Council 2003) and the *Lower Hunter and Central Coast Regional Biodiversity Conservation Strategy Technical Report: Digital Aerial Photo Interpretation and Updated Extant Vegetation Community Map* (House 2002). Information on the distribution of aquatic habitat throughout the Port Stephens Foreshore area was obtained from NSW Fisheries.

Other documents reviewed for the preparation of this report include:

- Mambo Wetland Plan of Management (Port Stephens 2006);
- Port Stephens Wetland Identification and Prioritisation Study (Eco Logical Australia 2005);
- Port Stephens Wetland Management Report (Eco Logical 2005);
- Foreshores Generic Plan of Management (Port Stephens Council 2001);
- Key Habitats and Corridors for Forest Fauna: A Landscape Framework for Conservation In North-east NSW, NSW NPWS Occasional Paper 32 (Scotts 2003);
- NSW Biodiversity Strategy (NSW NPWS 1999);
- Lower Hunter Regional Strategy (NSW Department of Planning 2006); and
- Port Stephens Estuary Oyster Lease Rehabilitation Project, Review of Environmental Factors (Umwelt for NSW Fisheries 2001).

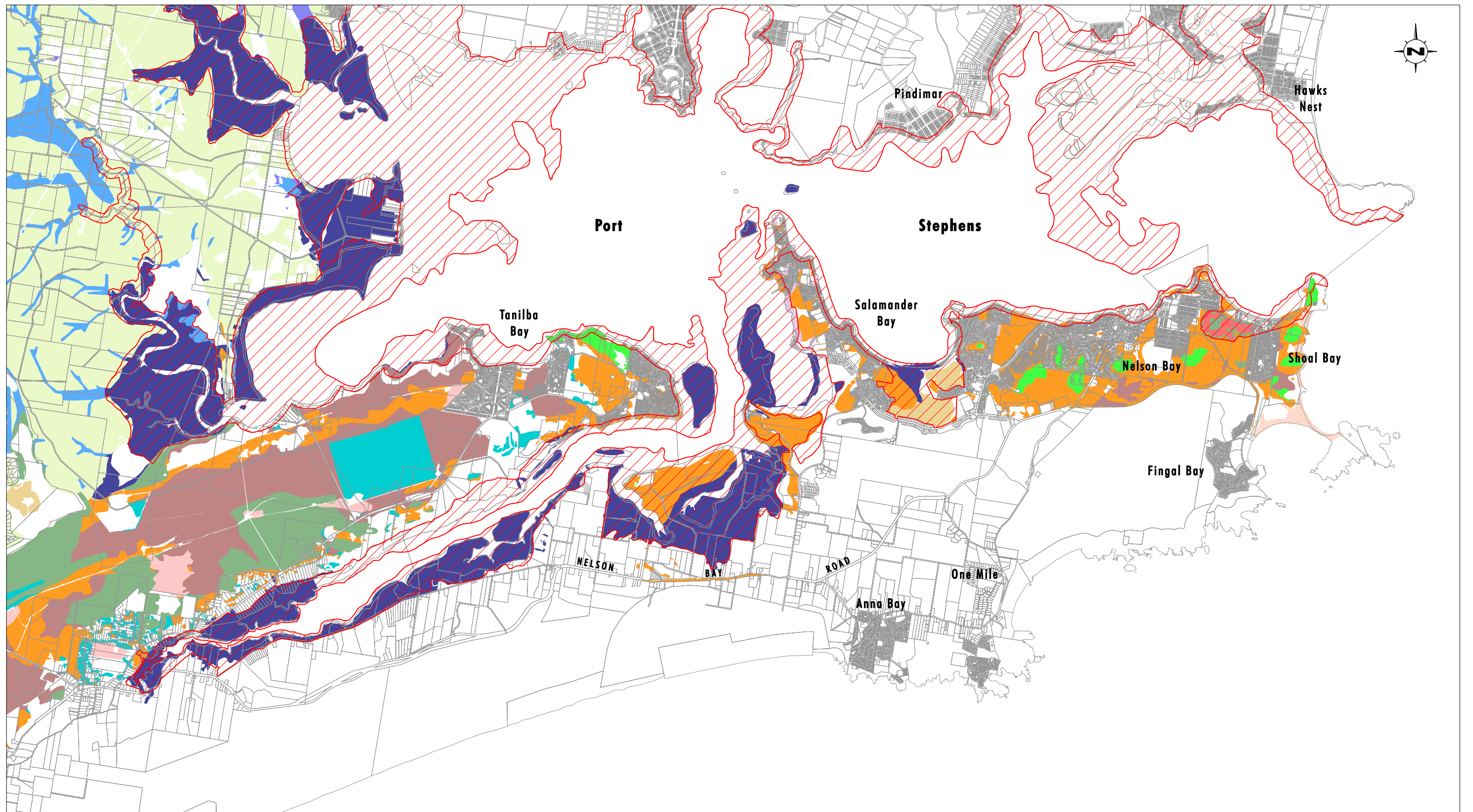
A full reference list of all literature reviewed for the preparation of this document is provided in **Section 15.0**.

2.1 Relevant Legislation

The ecological values of the foreshore environment are protected under a suite of legislation, government strategies, and formal agreements at a local, state, national and international level. Some of the main legislation and policies protecting NSW biodiversity are listed below.

International Conventions and Agreements

- United Nations Convention on Biological Diversity.
- Ramsar Convention on Wetlands of International Importance as Waterfowl Habitat.
- Japan-Australia Migratory Bird Agreement (JAMBA).
- China-Australia Migratory Bird Agreement (CAMBA).



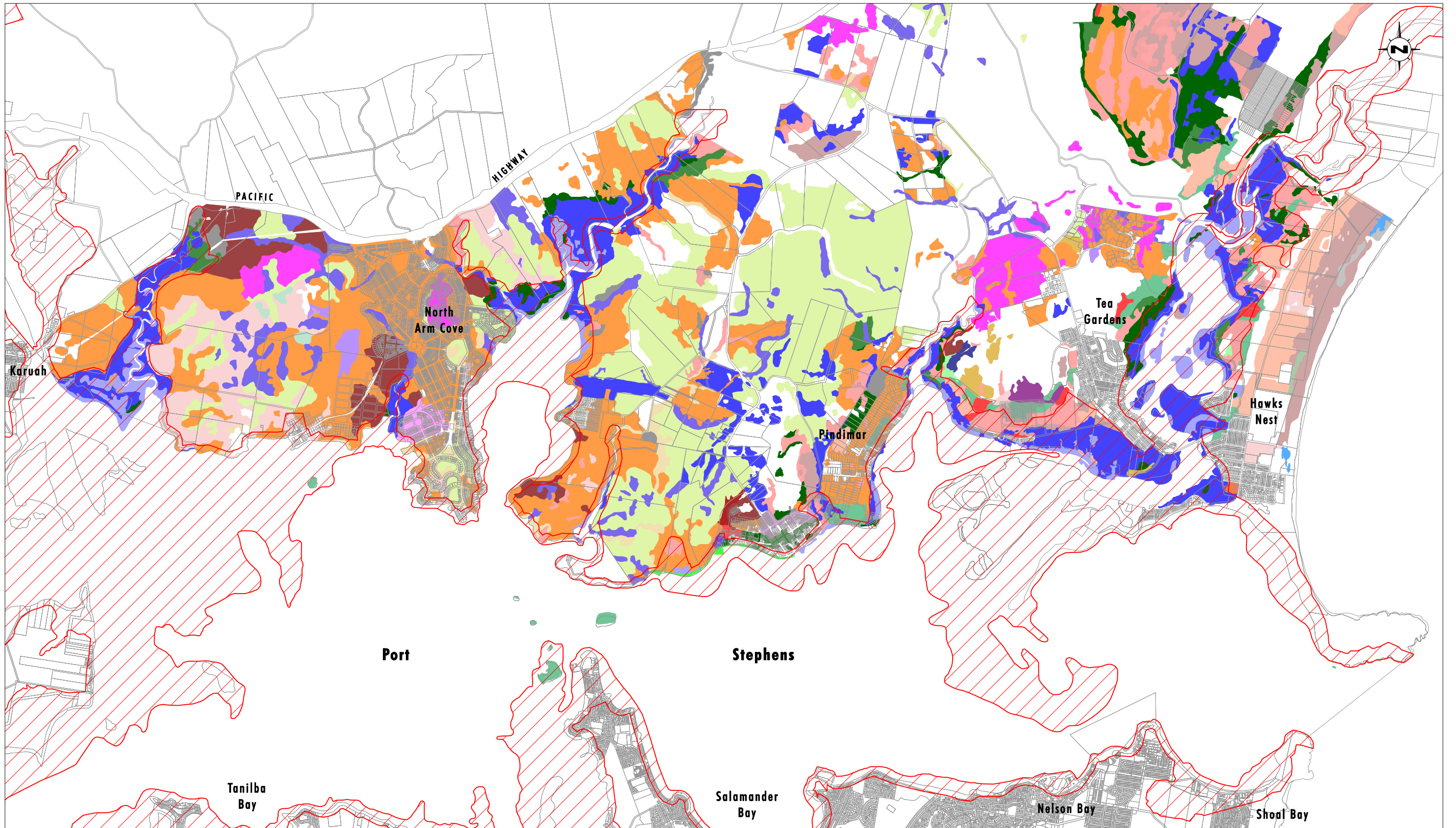
Source: Port Stephens Council (2006)
 Note: Seaward study area boundary defined by -2 metre (AHD) contour.

Legend

- | | | |
|---|---|-----------------------------------|
| Study Area | Coastal Sand Scrub | Littoral Rainforest |
| Alluvial Tall Moist Forest | Coastal Sand Wallum Woodland - Heath | Mangrove - Estuarine Complex |
| Beach Sands | Coastal Sheltered Apple - Peppermint Forest | Nerong Smooth Barked Apple Forest |
| Beach Spinifex | Coastal Wet Sand Cyperoid Heath | Riparian Melaleuca Swamp Woodland |
| Coastal Clay Heath | Freshwater Wetland Complex | Tomago Sand Swamp Woodland |
| Coastal Foothills Spotted Gum Ironbark Forest | Heath | |
| Coastal Plains Smooth-barked Apple Woodland | Hunter Valley Moist Forest | |
| Coastal Sand Apple Blackbutt Forest | Lepironia Swamp | |

0 1.0 2.0 4.0km
 1:80 000

FIGURE 2.1(a)
Vegetation Communities of the
Port Stephens Foreshore
(Port Stephens LGA)



Source: Great Lakes Council (2006) Note: Seaward study area boundary defined by -2 metre (AHD) contour.

0 1.0 2.0 3.0 km
1:60 000

Legend	
[Red Hatched Box]	Study Area
[Grey Box]	Banksia
[Green Box]	Blackbutt-Bloodwood Apple
[Blue Box]	Cleared Land
[Light Green Box]	Disturbed Heath
[Pink Box]	Dry Blackbutt
[Purple Box]	Fig Giant Stinger
[Light Green Box]	Flooded Gum
[Orange Box]	Forest Red Gum
[Blue Box]	Grey Gum Grey Ironbark White Mahogany
[Brown Box]	Heath
[Light Orange Box]	Heath Paperbark
[Light Green Box]	Ironbark
[Purple Box]	Ironbark Smoothbarked Apple Sydney Peppermint
[Blue Box]	Mangrove
[Light Green Box]	Moist Blackbutt
[Pink Box]	Paperbark
[Grey Box]	Paperbark Smoothbarked Apple Sydney Peppermint
[Orange Box]	Paperbark Blackbutt
[Blue Box]	Paperbark Flooded Gum
[Green Box]	Paperbark Swamp Oak
[Pink Box]	Pine
[Purple Box]	Red Bloodwood Forest
[Light Green Box]	Sand
[Orange Box]	Scribbly Gum
[Blue Box]	Scrub
[Brown Box]	Smoothbarked Apple
[Orange Box]	Smoothbarked Apple Sydney Peppermint Stringybark
[Light Green Box]	Spotted Gum
[Purple Box]	Spotted Gum Ironbark Grey Gum
[Blue Box]	Swamp
[Green Box]	Swamp Mahogany
[Red Box]	Swamp Mahogany Paperbark
[Green Box]	Swamp Oak
[Red Box]	Sydney Blue Gum
[Purple Box]	Tallwood Sydney Blue Gum
[Blue Box]	White Mahogany Red Mahogany Grey Ironbark Grey Gum

FIGURE 2.1(b)

Vegetation Communities of the Port Stephens Foreshore (Great Lakes LGA)

- Rio Declaration on Environment and Development.
- Agenda 21.

National Strategies and Legislation

- *Environment Protection and Biodiversity Conservation Act (1999) (EPBC Act).*
- National Local Government Biodiversity Strategy.
- Intergovernmental Agreement on the Environment (IGAE).
- National Biodiversity Strategy (1992).
- National Weeds Strategy (1997).
- National Principles and Guidelines for Rangeland Management (1999).
- National Framework for the Management and Monitoring of Australia's Native Vegetation (1999).

NSW Strategies and Legislation

- *Threatened Species Conservation Act (1995) (TSC Act).*
- *Fisheries Management Act (1993).*
- *Native Vegetation Conservation Act (1997).*
- *National Parks and Wildlife Act (1974).*
- *Environmental Planning and Assessment Act (1979).*
- *Local Government Act (1993).*
- *SEPP 14 Coastal Wetlands.*
- *SEPP 19 Bushland in Urban Areas.*
- *SEPP 26 Littoral Rainforests.*
- *SEPP 44 Koala Habitat Protection.*
- *SEPP 46 Protection and Management of Native Vegetation.*
- *SEPP 71 Coastal Protection.*
- Policy for Sustainable Agriculture in NSW (1998).
- NSW Native Vegetation Conservation Strategy (Draft).
- Biodiversity Strategy (1999).

3.0 Field Survey Methodology

Field surveys were conducted in areas that were poorly covered by existing studies, where high conservation value vegetation was likely to be present, threatened species habitat was present or where the conservation value of the area remains uncertain.

Fourteen management zones were surveyed around the foreshore. A boat was used to survey some of these management zones due to inaccessibility by foot. At each site the following was addressed:

- vegetation community;
- dominant plant species in each strata;
- structural attributes;
- dominant weed species, and those of highest threat, including noxious weeds and *Weeds of National Significance*;
- tree hollows, type and density;
- rocky outcrops, litter and fallen timber (habitat for reptiles and amphibians);
- wetland, riverine and wet soak areas;
- intertidal and subtidal rocky reef, vegetated and unvegetated sand and mudflat areas;
- impacts from feral animals, dieback, mistletoe, fire and other threats such as altered hydrology, erosion and land use change; and
- comprehensive information on site location, physiography, aspect, slope and depth.

Traverses in and around each site was made to ensure that the description of the site was representative in the local context. Traverses also aimed to ground-truth vegetation boundaries that have been mapped and fauna habitat was also assessed.

All plants and animals recorded were identified and named in accordance with the nomenclature adopted by the National Herbarium of New South Wales for flora and the Australian Museum for fauna.

A map of the foreshore vegetation, including sub-tidal seagrass habitats threatened flora and fauna species and EECs have been produced for the foreshore. Other important habitat features such as Koala habitat, SEPP 14 wetlands and SEPP 26 littoral rainforest and shorebird roosting habitat have also been mapped.

4.0 Vegetation of the Port Stephens Foreshore

Regional vegetation studies encompassing the Port Stephens LGA include the *Tomaree National Park Vegetation Survey* (Bell 1997); *Great Lakes Council Vegetation Strategy – Eastern Portion* (Great Lakes Council 2003) and the *Lower Hunter and Central Coast Regional Biodiversity Conservation Strategy Extant Vegetation Community Map* (House 2002). These regional vegetation surveys, supplemented with field surveys, have been utilised for the preparation of a map of the 36 vegetation communities occurring within the Port Stephens Foreshore area (**Figures 2.1(a)** and **2.1(b)**). Each of these 36 communities is listed below, while the vegetation communities occurring within each of the management zones are listed in **Section 5.0**.

**Denotes endangered ecological communities.*

- Coastal Wet Sand Cyperoid Heath (Mu 42)*;
- Coastal Sand Apple-Blackbutt Forest (Mu 33);
- Coastal Plains Smooth-Barked Apple Woodland (Mu 30);
- Littoral Rainforest (Mu 4)*;
- Swamp Mahogany-Paperbark Forest (Mu 37)*;
- Coastal Wet Sand Cyperoid Heath (Mu 44);
- Freshwater Wetland Complex (Mu 46)*;
- Mangrove-Estuarine Complex (Mu 47);
- Lepironia Swamp (Mu 45);
- Nerong Smooth-Barked Apple Forest (Mu 32);
- Coastal Clay Heath (Mu 48);
- Swamp Oak – Rushland Forest (Mu 40)*;
- Coastal Sand Scrub (Mu 50);
- Alluvial Tall Moist Forest (Mu 5);
- Seaham Spotted Gum – Ironbark Forest (Mu 16);
- Heath (Mu 36a);
- Exposed Coastal Scrub (Bell Mu 10);
- Mangrove (GI Mu 33);
- Smooth-Barked Apple – Sydney Peppermint – Stringybark (GI Mu 106);
- Ironbark (GI Mu 84);
- Dry Blackbutt (GI Mu 37);

- Heath (GI Mu 223);
- Swamp Oak (GI Mu 32);
- Swamp (GI Mu 231);
- Paperbark/Swamp Oak (GI Mu 31/32);
- Ironbark – Smooth-Barked Apple – Stringybark (GI Mu 84/106);
- Forest Red Gum (GI Mu 92);
- White Mahogany – Red Mahogany – Grey Ironbark – Grey Gum (GI Mu 60);
- Heath Paperbark (GI Mu 31/223);
- Paperbark (GI Mu 31);
- Blackbutt – Bloodwood/Apple (GI Mu 41);
- Swamp Mahogany/Paperbark (GI Mu 30-31);
- Scribbly Gum (GI Mu 117);
- Swamp Mahogany (GI Mu 30);
- Saltmarsh (Mu 46a)*; and
- Seagrass.

Of the 37 vegetation communities occurring within the Port Stephens Foreshore area, seven (denoted with an asterisk) correspond with an endangered ecological community, as listed on the *Threatened Species Conservation Act 1995*. These EEC's and related communities are described in detail in **Section 9.0**. These descriptions have drawn on information from the NSW Scientific Committee Final Determinations for each of the EEC's, supplemented with information from the vegetation mapping prepared for the Lower Hunter and Central Coast Regional Environmental Management Strategy (House 2002).

5.0 Biodiversity Values of Management Zones

For ease of discussion and development of management issues, the foreshore of Port Stephens has been divided into 14 smaller management units (**Figure 5.1**). A brief description of the main features and key ecological values of each of these management zones is provided below. The information has been sourced from a range of documents, including those listed in **Section 2.0**, supplemented with results obtained during the field surveys undertaken in January 2006 2005. The code in brackets after the vegetation community name refers to the author of the vegetation survey document the community has been described within (GL being Great Lakes Council), followed by the Map Unit (MU) number for that community.

5.1 Management Zone A1

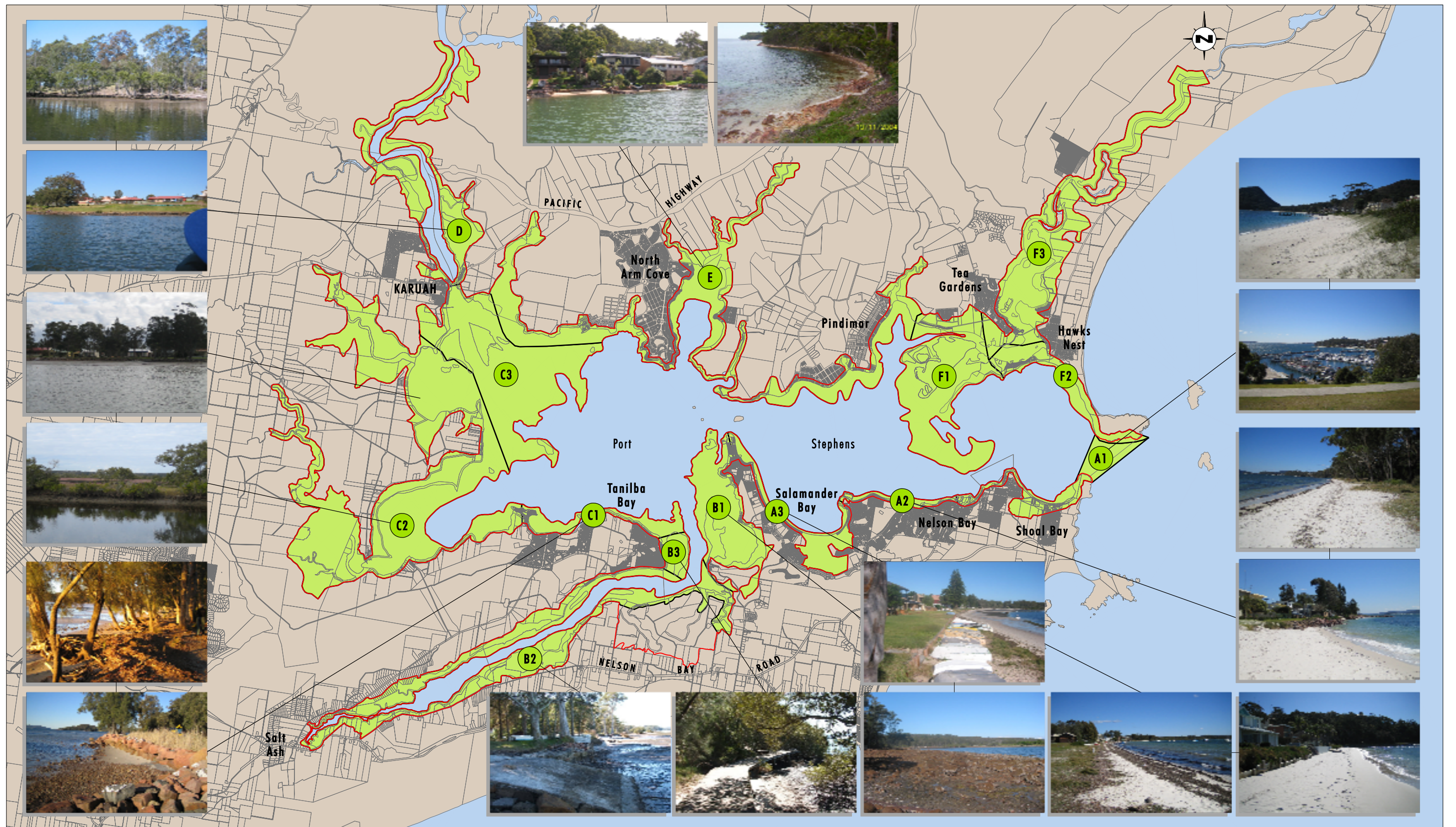
Management Zone A1 is approximately 334 hectares in size, covering the area of foreshore from Tomaree Headland, west to Nelson Bay (**Figure 5.1**). The majority of the foreshore vegetation within this zone has been cleared for development, which, in some areas, has occurred very close to the foreshore. Despite extensive coastal development, areas of remnant vegetation do remain along the foreshore, the majority of which occurs in public land. The most significant vegetation remnants occurring occur along the Fly Point foreshore, Anzac Park and Tomaree National Park. Approximately one third (134 hectares) of this management zone is public land.

The wetland area behind the retirement village at Shoal Bay is classified as a SEPP 14 wetland (**Figure 5.2**), covering an area of 43.12 hectares. There is a large area of seagrass off the foreshore of Shoal Bay, and also a small strip along the coast south of Fly Point.

The following eight vegetation communities have been recorded within Management Zone A1.

- Coastal Plains Smooth-barked Apple Woodland (House MU 30);
- Coastal Wet Sand Cyperoid Heath (House MU 44);
- Lepironia Swamp (HOUSE MU 45);
- Exposed Coastal Scrub (Bell 1997, MU 10);
- Swamp Mahogany – Paperbark Forest (HOUSE MU 37);
- Littoral Rainforest (HOUSE MU 4);
- Nerong Smooth-barked Apple (HOUSE MU 32); and
- Coastal Clay Heath (HOUSE MU 48).

Remnant stands of the Endangered Ecological Community, Swamp Sclerophyll Forest on Coastal Floodplains, have been identified along the foreshore of Fly Point Park and on the eastern section of Shoal Bay (**Figure 5.3**). A small patch of the Littoral Rainforest EEC occurs just outside of this management zone, on Tomaree Headland. It is considered that the vegetation community occurring within the Shoal Bay wetland may also comprise an EEC, however, further studies would need to be undertaken to confirm the presence or absence of this community.

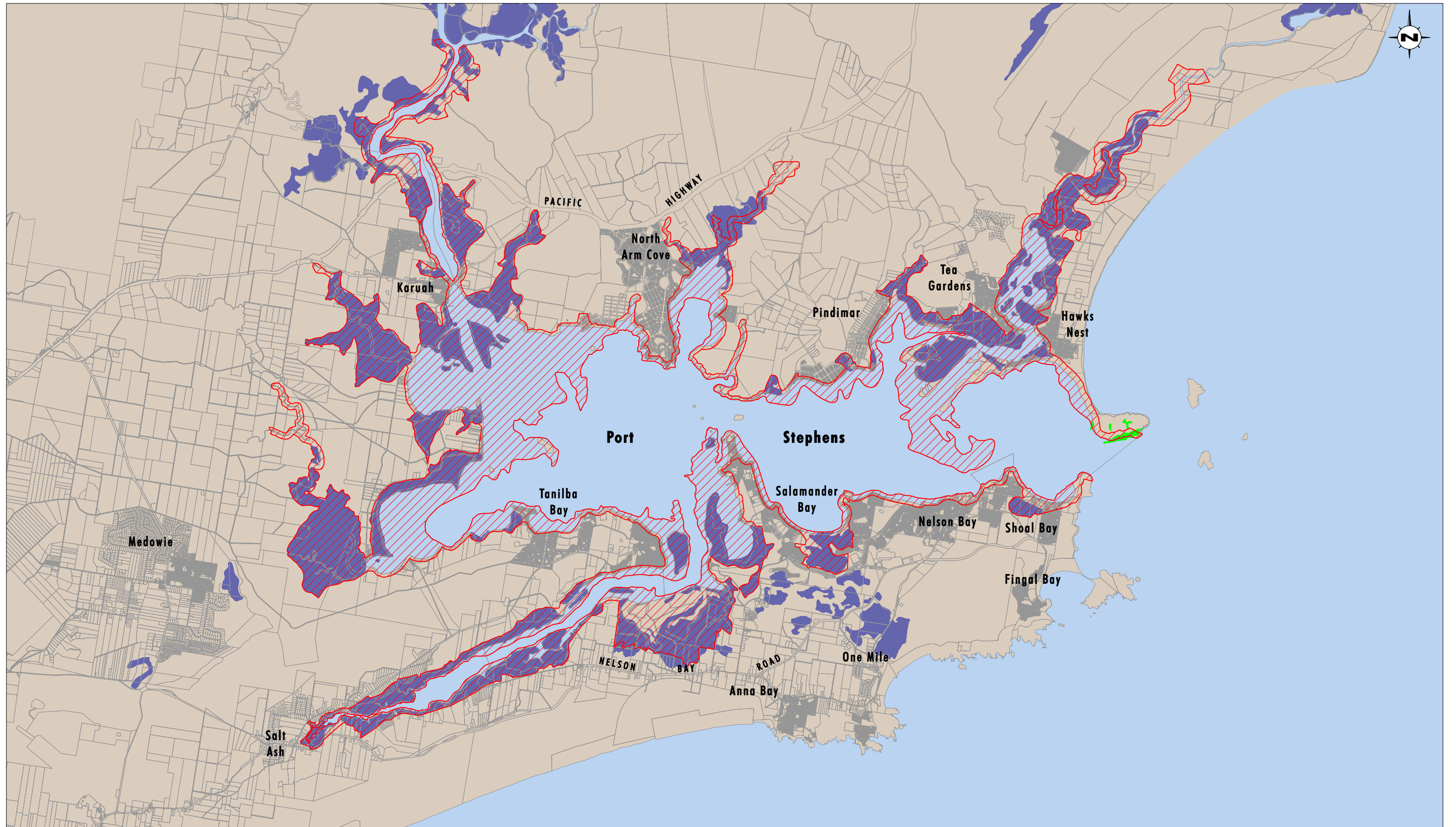


Source: LPI NSW (2000), Great Lakes Council, Port Stephens Council
 Note: Seaward study area boundary defined by -2 metre (AHD) contour.

0 2 4 6km
 1:120 000

Legend
 Study Area
A Management Zone

FIGURE 5.1
Foreshore Management Zones

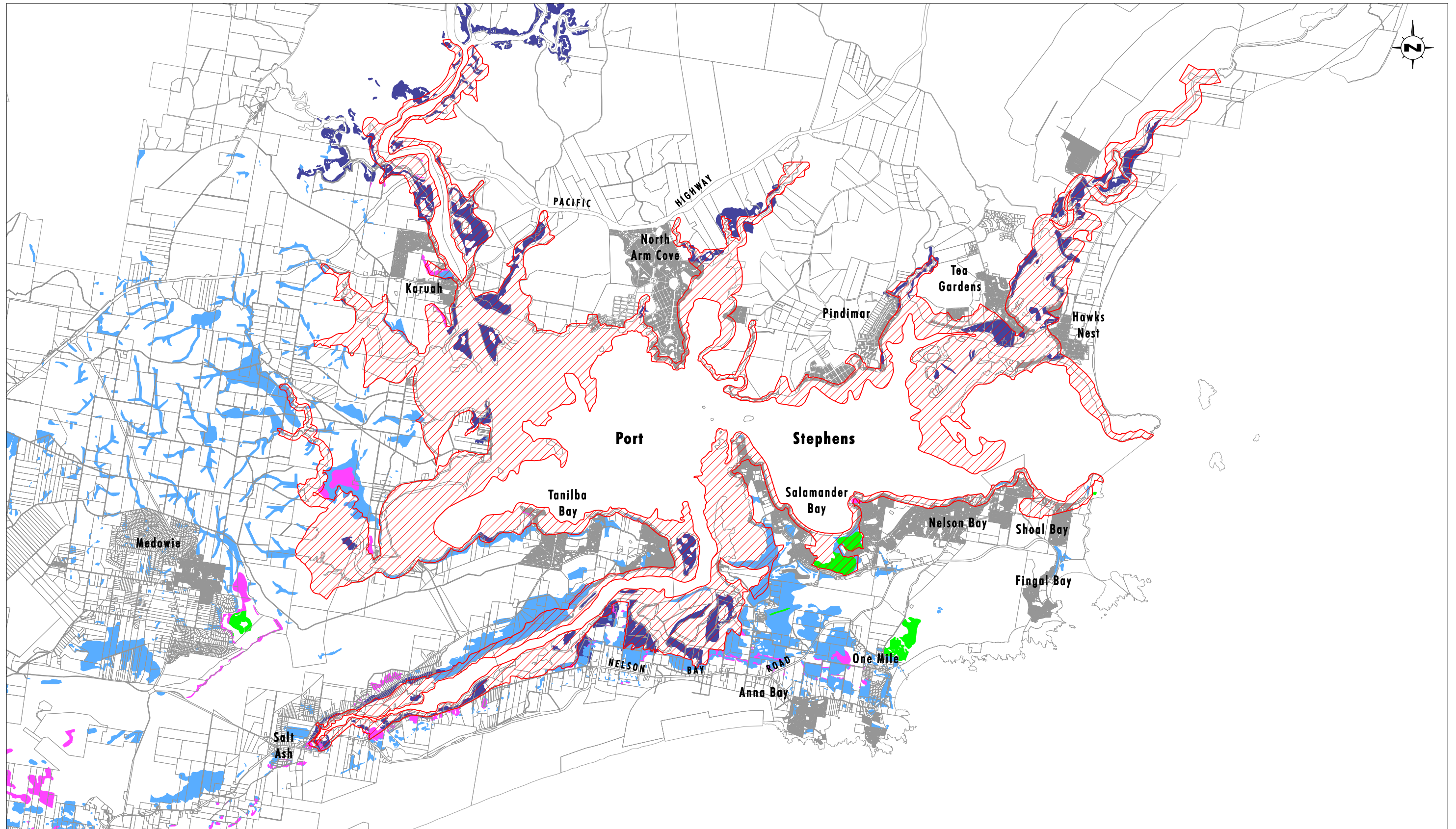


Source: LPI NSW (2000), Great Lakes Council, Port Stephens Council

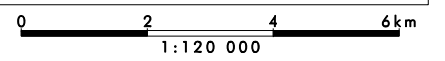
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1:120 000

- Legend**
- Study Area
 - SEPP 14
 - GLC SEPP 26

FIGURE 5.2
SEPP 14 Wetlands and SEPP 26 Littoral Rainforest



Source: LPI NSW (2000), Great Lakes Council, Port Stephens Council
 Note: Seaward study area boundary defined by -2 metre (AHD) contour.



- Legend**
- Study Area
 - Freshwater Wetland Communities
 - Saltmarsh Communities
 - Swamp Oak Floodplain Forest
 - Swamp Sclerophyll

FIGURE 5.3
Endangered Ecological Communities

Threatened flora species recorded within this management zone are shown on **Figure 5.4** and include Grove's paperbark (*Melaleuca groveana*), sand double-tail (*Diuris arenaria*), sand spurge (*Chamaesyce psamogeton*) and rough double-tail (*Diuris praecox*). Threatened fauna species recorded include the koala (*Phascolarctos cinereus*), sooty oystercatcher (*Haematopus fuliginosus*), dugong (*Dugong dugon*) and the green turtle (*Chelonia mydas*) (**Figure 5.5**). An area of 36 hectares of preferred koala habitat has been identified within this zone, occurring in the Shoal Bay SEPP 14 wetland, along Tomaree Headland and also in Fly Point Park. In addition, 21 hectares of supplementary koala habitat occur along Shoal Bay, in Anzac Park and at Nelson Head (**Figure 5.6**). Previous records of koalas are concentrated within Tomaree National Park, with only scattered records being from the foreshore zone.

No areas of important shorebird roosting habitat have been identified within this management zone.

5.2 Management Zone A2

Management Zone A2 covers approximately 83 hectares, extending from Nelson Bay Marina west to Corlette Point (**Figure 5.1**). Although the foreshore of Management Zone A2 has experienced a lot of pressure from residential development, several areas of foreshore vegetation have been retained, the majority of which occurs on public land. The most significant areas of remnant vegetation occur within Corlette Point Reserve, along the rocky coast of West Point and also within Bagnalls Beach Reserve (which adjoins Lorikeet Reserve). Approximately one quarter (24 hectares) of this management zone comprises public land.

A linear strip of seagrass habitat running parallel to the foreshore extends along the length of this management zone. No other aquatic habitat or SEPP 14 wetland areas have been identified.

The following three vegetation communities have been recorded within Management Zone A2.

- Swamp Mahogany – Paperbark Forest (HOUSE MU 37);
- Swamp Oak – Rushland Forest (HOUSE MU 40); and
- Coastal Sand Scrub (HOUSE MU 50).

There is a narrow strip of the Swamp Sclerophyll Forest on Coastal Floodplains EEC along the foreshore of West Point. A stand of the Swamp Oak Floodplain Forest EEC occurs at Corlette Point (**Figure 5.3**).

No threatened flora species have been recorded within this zone. Threatened fauna species recorded are shown on **Figure 5.5** and include the koala (*Phascolarctos cinereus*) and the green turtle (*Chelonia mydas*). A linear, 5.7 hectare remnant of preferred koala habitat has been identified along West Point and a larger remnant occurs in Corlette Point Reserve. The vegetation along Bagnalls Beach has been identified as supplementary koala habitat (**Figure 5.6**), of which approximately 6 hectares lies within the boundaries of the foreshore management zone.

No areas of important shorebird roosting habitat have been identified within this management zone.



Source: LPI NSW (2000), NPSW Atlas of NSW Wildlife
 Note: Seaward study area boundary defined by -2 metre (AHD) contour.

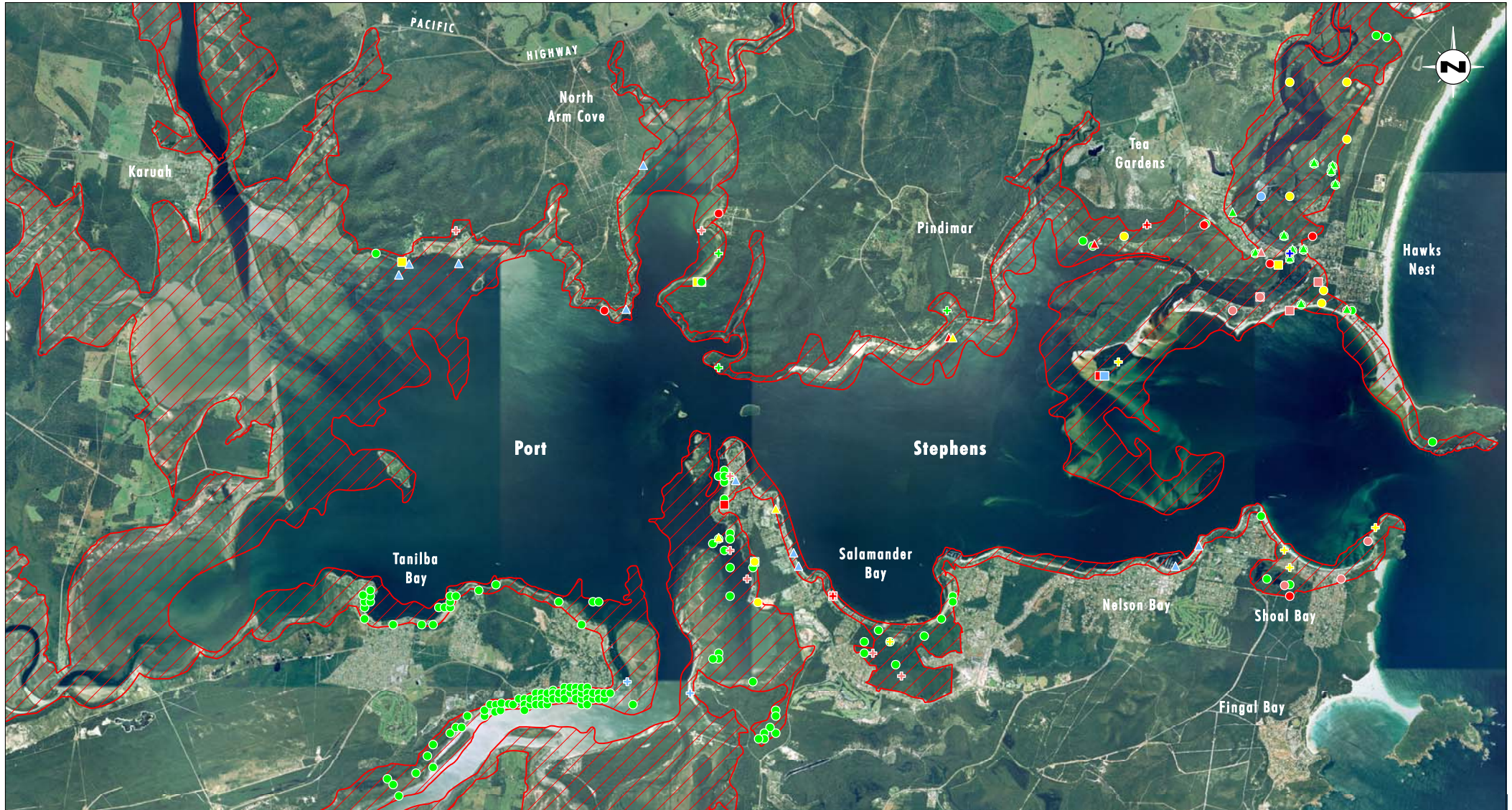
0 1.0 2.0 4km
 1:95 000

Legend

- Study Area
- Asperula asthenes*
- Chamaesyce psammogeton*
- Tetraloche juncea*
- Eucalyptus parramattensis subsp. decedens*
- Diuris arenaria*
- Melaleuca groveana*

FIGURE 5.4

Threatened Flora Species Records



Source: LPI NSW (2000), NPSW Atlas of NSW Wildlife

Note: Seaward study area boundary defined by -2 metre (AHD) contour.

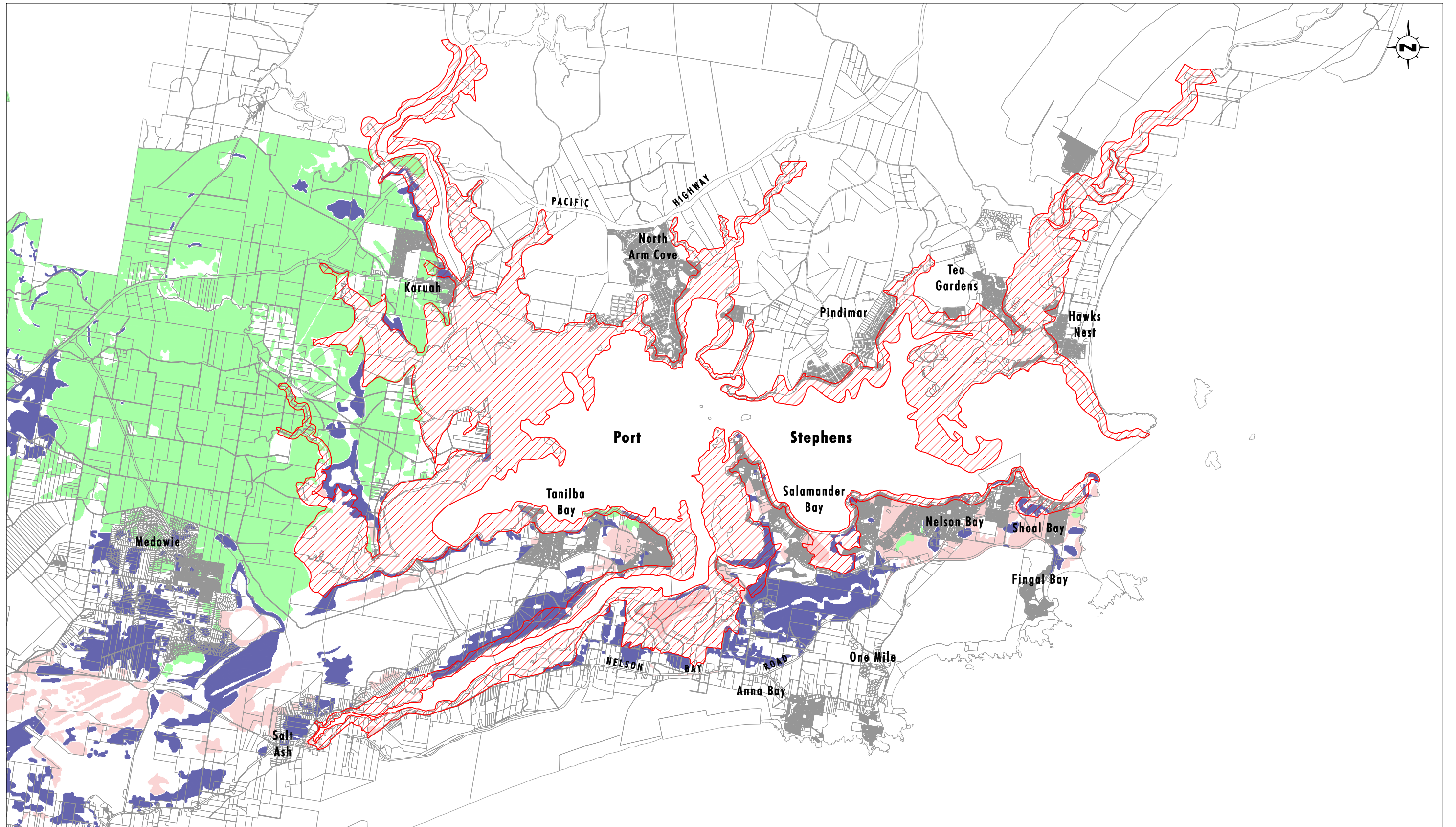
0 1.0 2.0 4 km
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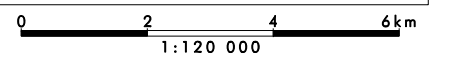
- | | | | |
|---------------------|-----------------------|-------------------------|---|
| Study Area | Sooty Oystercatcher | Brush-tailed Phascogale | Green Turtle |
| Little Bentwing-bat | Southern Giant-Petrel | Bush Stone-curlew | Grey-headed Flying-fox |
| Little Tern | Squirrel Glider | Dugong | Wallum Froglet |
| Osprey | Swift Parrot | Eastern Freetail-bat | Koala Population Hawks Nest and Tea Gardens |
| Pied Oystercatcher | Koala | Glossy Black-Cockatoo | |
| Powerful Owl | Black-necked Stork | Goulds Petrel | |

FIGURE 5.5

Threatened Fauna Species Records



Source: LPI NSW (2000), Port Stephens Council (2002)
 Note: 1. Seaward study area boundary defined by -2 metre (AHD) contour.
 2. There is currently no Koala mapping for Great Lakes LGA.



- Legend**
- Study Area
 - Marginal
 - Preferred
 - Supplementary

FIGURE 5.6
Koala Habitat Areas

5.3 Management Zone A3

Management Zone A3 covers extends along the foreshore between Corlette Point and Soldiers Point (**Figure 5.1**), covering a total area of approximately 301 hectares. Very little foreshore vegetation remains within this zone due to urban development extending to the coastline; however that which does remain occurs on public land. The remaining vegetation is restricted to the foreshore areas of Mambo Wetland Reserve and also Corlette Point Reserve. Over half of this management zone (186 hectares) comprises public land.

An area of 130 hectares within Mambo Wetland Reserve is mapped as a SEPP 14 wetland (**Figure 5.2**). There is a narrow, linear area of seagrass along the entire foreshore of this management zone. Within Mambo Wetland, a small patch of mangrove habitat has been mapped, in addition to a small area of saltmarsh/mangrove habitat.

The following vegetation communities have been recorded within Management Zone A3.

- Coastal Sand Scrub (HOUSE MU 50);
- Mangrove – Estuarine Complex (HOUSE MU 47);
- Swamp Mahogany – Paperbark Forest (HOUSE MU 37);
- Coastal Clay Heath (HOUSE MU 48);
- Coastal Sand Apple – Blackbutt Forest (HOUSE MU 33); and
- Freshwater Wetland Complex (MU 46).

A large area of the Freshwater Wetlands on Coastal Floodplains EEC has been identified in Mambo Wetland Reserve, in addition to a small patch of Swamp Sclerophyll Forest on Coastal Floodplains EEC (**Figure 5.3**). There are a further two remnants of the Swamp Sclerophyll Forest on Coastal Floodplains EEC occurring along the foreshore of Soldiers Point.

One threatened flora species has been recorded within this management zone, Parramatta red gum (*Eucalyptus parramattensis* subsp. *decadens*). Only two threatened fauna species have been recorded within this management zone, the koala (*Phascolarctos cinereus*), little bentwing-bat (*Miniopterus australis*), wompoo fruit dove (*Ptilinopus magnificus*), brush-tailed phascogale (*Phascogale tapoatafa*) grey-headed flying-fox (*Pteropus poliocephalus*) and the green turtle (*Chelonia mydas*). The locations of these threatened flora and fauna species are shown on **Figures 5.4** and **5.5** respectively. Small patches of preferred koala habitat, totalling 25 hectares, have been identified in Mambo Wetland Reserve, and towards Soldier's Point (**Figure 5.6**). Mambo Wetland Reserve also supports 36 hectares of supplementary koala habitat.

No areas of important shorebird roosting habitat have been identified within this management zone.

5.4 Management Zone B1

Management Zone B1, covering 679 hectares, includes the foreshore areas of Cromartys Bay, including Soldiers Point, Cromartys Bay and Taylors Beach (**Figure 5.1**). A large proportion of this foreshore within this zone is vegetated, having minimal foreshore development. Remnant vegetation within this zone which occurs on public land includes that occurring in Stony Ridge Reserve and Tilligerry Nature Reserve. The majority of the

vegetation around Cromartys Bay foreshore is on private land. This management zone predominantly consists of private land, with only 72 hectares of public land occurring.

A total area of 219.2 hectares of SEPP 14 wetland occurs in this management zone, located on Dowardee Island, and also around the foreshore of Cromartys Bay, including mud point (**Figure 5.2**). Linear areas of seagrass habitat have been identified around the foreshore of Soldier's Point and Taylors Beach. These seagrass meadows include extensive *Posidonia australis* beds, with *Zostera* sp. also being present in shallower waters landward of the *Posidonia* beds. Due to the intensive use of this area for recreational boating, there are isolated areas where seagrass has been damaged due to boat launching and mooring activities. Mangrove and saltmarsh/mangrove habitats have been identified around the foreshore of Cromartys Bay.

The following four vegetation communities have been recorded within Management Zone B1.

- Mangrove-Estuarine Complex (HOUSE MU 47);
- Coastal Clay Heath (HOUSE MU 48);
- Coastal Sand Apple-Blackbutt Forest (HOUSE MU33); and
- Swamp Mahogany – Paperbark Forest (HOUSE MU 37).

A strip of Swamp Sclerophyll Forest on Coastal Floodplains EEC occurs along the eastern foreshore of Cromartys Bay.

One threatened flora species, sand double-tail (*Diuris arenaria*), has been recorded just outside the foreshore boundary within this management zone (**Figure 5.4**). Threatened fauna species recorded include koala (*Phascolarctos cinereus*), bush-stone curlew (*Burhinus grallarius*), grey-headed flying fox (*Pteropus poliocephalus*), green turtle (*Chelonia mydas*), squirrel glider (*Petaurus norfolcensis*), pied oystercatcher (*Haematopus longirostris*) and brush-tailed phascogale (*Phascogale tapoatafa*) (**Figure 5.5**). An area of 85 hectares of preferred koala habitat has been identified around the foreshore of Cromartys Bay on the Salamander Bay side. A small (8 hectare) area of supplementary koala habitat occurs around Cromartys Bay (**Figure 5.6**).

The entire foreshore of Cromartys Bay has been mapped as important shorebird roosting habitat (**Figure 5.7**).

5.5 Management Zone B2

With a total area of approximately 1224 hectares, Management Zone B2 comprises both the northern and the southern foreshore of Tilligerry Creek (**Figure 5.1**). A large proportion of the foreshore within this zone is well vegetated, however, residential development extends into the foreshore area in some locations. The majority of the remnant vegetation in this zone occurs within public land, however there are several remnant areas occurring within private land.

The majority of management zone B2 is SEPP 14 wetland (791 hectares), which occurs along the foreshore of Tilligerry and Wallis Creeks (**Figure 5.2**). Narrow strips of seagrass occur along some sections of the Tilligerry Creek foreshore. Large areas of mangrove habitat occur throughout this zone, with scattered patches of saltmarsh also present.

The following vegetation communities have been recorded within Management Zone B2.



Source: LPI NSW (2000), Great Lakes Council, Port Stephens Council
 Note: Seaward study area boundary defined by -2 metre (AHD) contour.

0 2.0 4.0 6km
 1:120 000

Legend

- Study Area
- Shorebird Roosting Habitat

FIGURE 5.7

Important Shorebird Roosting Habitat

- Coastal Sand Apple-Blackbutt Forest (HOUSE MU 33);
- Swamp Mahogany – Paperbark Forest (HOUSE MU 37);
- Mangrove – Estuarine Complex (HOUSE MU 47);
- Swamp Oak – Rushland Forest (HOUSE MU 40); and
- Alluvial Tall Moist Forest (HOUSE MU 5).

Scattered remnants of Swamp Oak Floodplain Forest and Coastal Saltmarsh EEC occur throughout this zone (**Figure 5.3**). Larger remnants of the Swamp Sclerophyll Forest on Coastal Floodplains EEC occur on the northern foreshore of Tilligerry Creek.

No threatened flora species have been recorded within this management zone. A large concentration of koala records occurs along Tilligerry Creek, near Lemon Tree Passage (**Figure 5.5**). Other threatened species recorded include the bush stone-curlew (*Phascogale tapoatafa*), and the swift parrot (*Lathamus discolor*). A large remnant (189 hectares) of preferred koala habitat occurs on the northern foreshore of Tilligerry Creek, while scattered remnants occur on the southern foreshore (**Figure 5.6**). In addition to preferred koala habitat, an area of 36 hectares of supplementary koala habitat occurs along the southern foreshore of Tilligerry Creek.

No areas of important shorebird roosting habitat have been identified within this management zone.

5.6 Management Zone B3

Management Zone B3 encompasses Bulls Island, and also the eastern foreshore of Lemon Tree Passage (**Figure 5.1**), covering approximately 114 hectares. The vegetation of Bulls Island remains relatively undisturbed, whilst the foreshore of Lemon Tree Passage has largely been modified for residential development. The majority of remnant vegetation in this management zone occurs on public land, with only scattered remnants within private land.

An area of 59.7 hectares of SEPP 14 wetland has been identified within this management zone. Narrow strips of seagrass occur around the foreshores of Bulls Island and Lemon Tree Passage, the dominant species being *Zostera* sp. The majority of the vegetation occurring on Bulls Island is identified as saltmarsh habitat, while there are also scattered patches of mangrove habitat.

One vegetation community occurs within this management zone, being the Mangrove-Estuarine Complex (HOUSE MU 47). The whole of Bulls Island is mapped as the Coastal Saltmarsh EEC (**Figure 2.1**).

No threatened flora species have been recorded within this management zone, while the powerful owl (*Ninox strenua*) is the only threatened fauna species previously recorded. A small, 3 hectare area of supplementary koala habitat is present along the foreshore of Lemon Tree Passage (**Figure 5.6**).

The whole of Bulls Island has been identified as important roosting habitat for shorebirds (**Figure 5.7**).

5.7 Management Zone C1

Management Zone C1 extends from Lemon Tree Passage, covering Tanilba Bay and ending at Bato Bato Point (**Figure 5.1**), encompassing an area of approximately 224 hectares. Remnant vegetation within this zone includes that along the foreshore of Mallabula, and also Tilligerry Habitat situated along the eastern foreshore of Tanilba Bay. The majority of this management zone consists of private land, with only 30 hectares of public land occurring. Despite this, the majority of remnant vegetation within this zone occurs within public land.

No SEPP 14 wetland areas have been identified within this management zone. Scattered linear areas of seagrass habitat occur off the coast of Tanilba Bay. No areas of saltmarsh or mangrove have been identified within this management zone.

Vegetation communities occurring within this management zone include the Nerong Smooth-barked Apple Forest (HOUSE MU 32) and Swamp Mahogany – Paperbark Forest (HOUSE MU 37). A small, linear remnant of Swamp Sclerophyll Forest on Coastal Floodplains EEC is mapped to the east of Mallabula Point, and a smaller remnant occurs further west towards Sunrise Point (**Figure 5.3**).

No threatened flora species have been recorded within this management zone. Threatened species recorded include the koala (*Phascolarctos cinereus*), green turtle (*Chelonia mydas*) and the osprey (*Pandion haliaetus*) (**Figure 5.5**). Narrow, linear remnants of preferred koala habitat, covering 15 hectares, have been identified to the east of Mallabula Point, and also at Wundabalaynbah Point. In addition to the preferred koala habitat, approximately 13 hectares of marginal koala habitat is mapped between Mallabula Point and Rookes Point (**Figure 5.6**).

No areas of important shorebird roosting habitat have been identified within this management zone.

5.8 Management Zone C2

Management Zone C2, comprising 2817 hectares of foreshore, spans from Bato Bato Point to Karuah, encompassing Big Swan Bay, Twelve Mile Creek, Swan Bay and Little Swan Bay (**Figure 5.1**). There is very little development around this section of the foreshore, with only isolated settlements at Oyster Cove, Swan Bay, at the southern end of Moffats Road and at Lillies Point. A large proportion of the foreshore in this management zone lies within Worimi Nature Reserve, and a small part lies within Karuah Nature Reserve. There is still, however, a significant area of private land, with only 658 hectares of this management zone comprising public land. Approximately one third of the remnant vegetation within this management zone occurs on private land, the remainder being public land.

The NPWS Key Habitats and Corridors Project (NPWS 2006), identifies a regional corridor within this management zone. This corridor provides a link between Twelve Mile Creek and Reedy Creek.

Over 50% of this management zone comprises SEPP 14 wetland, covering an area of approximately 1495.5 hectares (**Figure 5.2**). Linear areas of seagrass habitats occur along the Big Swan Bay foreshore and over a small area of the south eastern point of Swan Island. Saltmarsh/mangrove habitats occur along Reedy Creek and 12 Mile Creek.

The following vegetation communities have been recorded within Management Zone B2.

- Swamp Mahogany – Paperbark Forest (HOUSE MU 37);

- Mangrove – Estuarine Complex (HOUSE MU 47);
- Swamp Oak – Rushland Forest (HOUSE MU 40);
- Heath (HOUSE MU 36a);
- Riparian Melaleuca Swamp Woodland (HOUSE MU 42); and
- Coastal Plains Smooth-barked Apple Woodland (HOUSE MU 30).

Two remnants of the Coastal Saltmarsh EEC occur within this management zone (**Figure 5.3**). Several remnants of the Swamp Sclerophyll Forest on Coastal Floodplains EEC are also present. No threatened flora or fauna species have been recorded within this management zone. However, approximately 137 hectares along the upper reaches of 12 Mile Creek have been identified as marginal koala habitat, while remnants of preferred koala habitat, encompassing 66 hectares, occur on the lower reaches of Twelve Mile Creek, and between Tanilba Point and Oyster Cove (**Figure 5.6**). A small area (2 hectares) of supplementary koala habitat also occurs within this zone.

No areas of important shorebird roosting habitat have been identified within this management zone.

5.9 Management Zone C3

Management Zone C3 encompasses the foreshores of Karuah, Swan Island and Wurrung Island (**Figure 5.1**), covering an area of approximately 1383 hectares. The foreshore of Karuah has been modified by development, however the majority of foreshore within this zone supports native vegetation of relatively good condition. A very small proportion of this management zone comprises public land (144 hectares), the remainder being privately owned. However, the majority of remnant vegetation does occur on public land, with the more disturbed remnants occurring on private land.

Wurrung Island, Swan Island and the Karuah foreshore have been identified as SEPP 14 wetland, in total covering an area of 259.1 hectares (**Figure 5.2**). Linear areas of Seagrass habitat occurs around Wurrung Island, and on the eastern foreshore of Swan Island and Karuah. Saltmarsh/mangrove habitat occurs on Wurrung and Swan Islands and also along the Karuah foreshore.

The following vegetation communities have been recorded within Management Zone C3.

- Mangrove (GL MU 33);
- Smooth-barked Apple – Sydney Peppermint – Stringybark (GL Mu 106);
- Ironbark (GL MU 84);
- Seaham Spotted Gum – Ironbark Forest (HOUSE MU 16); and
- Hunter Valley Dry Rainforest (HOUSE MU 3).

The Coastal Saltmarsh EEC occurs on both Wurrung Island and Swan Island and the eastern foreshore of Karuah (**Figure 5.3**). A linear remnant of the Swamp Oak Floodplain Forest EEC occurs just south of Karuah.

No threatened flora species have been recorded within this management zone. The green turtle (*Chelonia mydas*) is the only threatened fauna species recorded within this zone (**Figure 5.5**). No areas of Koala Habitat have been mapped within this management zone.

No areas of important shorebird roosting habitat have been identified within this management zone.

5.10 Management Zone D

Management Zone D is approximately 871 hectares in size and comprises the foreshore of the Karuah River (**Figure 5.1**). The foreshore vegetation has been substantially cleared along the Karuah River for agricultural activities, and the river banks continue to be degraded through cattle grazing. The majority of this management zone consists of privately owned land, with only 150 hectares of public land occurring. Approximately half of the remnant vegetation in this management zone occurs on public land, the remaining half being on private land.

The following vegetation communities have been recorded within Management Zone D.

- Dry Blackbutt (GL MU 37);
- Ironbark (GL MU 84);
- Mangrove (GL MU 33);
- Heath (GL MU 223);
- Swamp Oak (GL MU 32);
- Swamp (GL MU 231);
- Smooth-barked Apple – Sydney Peppermint – Stringybark (GL Mu 106);
- Paperbark/Swamp Oak (GL MU 31/32);
- Ironbark – Smooth-barked Apple – Stringybark (GL MU 84/106);
- Forest Red Gum (GL Mu 92);
- Ironbark (GL Mu 84); and
- White Mahogany/Red Mahogany/ Grey Ironbark/ Grey Gum (GL MU 60).

The majority of the Karuah River foreshore is mapped as SEPP 14 wetland (497.1 hectares) (**Figure 5.2**) and the vegetation is considered to correspond to the Coastal Saltmarsh EEC (**Figure 5.3**). Both the Swamp Oak Floodplain Forest EEC and the Swamp Sclerophyll Forest on Coastal Floodplains EEC occur near the Karuah township. Saltmarsh and mangrove habitats occur along the length of the Karuah River. No seagrass has been mapped within this zone.

One threatened flora species, black-eyed Susan (*Tetratheca juncea*) has been previously recorded within this management zone (**Figure 5.4**). No threatened fauna species have been recorded within this management zone. A 25 hectare remnant of preferred koala habitat occurs on Horse Island (**Figure 5.6**). A further 56 hectares of marginal koala habitat occurs along the Karuah River.

No areas of important shorebird roosting habitat have been identified within this management zone.

5.11 Management Zone E

Management Zone E extends from Number One Cove to Pindimar Bay on the northern foreshore of Port Stephens. It encapsulates Bundabah Creek, Fame Cove and Kore Kore Creek (**Figure 5.1**). A large proportion of this 1650 hectare zone remains undeveloped, except foreshore areas around North Arm Cove, Pindimar and South Pindimar, where vegetation has been cleared right to the foreshore and is maintained as mown grass. The majority of this management zone consists of privately owned land, with only 50 hectares of public land occurring. There is very little remnant vegetation occurring in public land, with the large proportion being private land.

The NPWS Key Habitats and Corridors Project (Scotts 2003) identifies a regional corridor in this management zone, linking the foreshore habitats of Fame Cove with Nerong to the north.

The following vegetation communities have been recorded within Management Zone E.

- Heath Paperbark (GL MU 31/223);
- Mangrove (GL MU 33);
- Paperbark (GL MU 31);
- Smooth-barked Apple – Sydney Peppermint – Stringybark (GL MU 106);
- Swamp (GL MU 231); and
- White Mahogany/Red Mahogany/Grey Ironbark/Grey Gum (GL MU 60).

An area of 462.8 hectares of SEPP 14 wetland occurs within this management zone (**Figure 5.2**). Linear remnants of the Coastal Saltmarsh EEC occur along Yalimbah Creek, Bundabah Creek and the Myall River (**Figure 5.3**). Seagrass habitat is scattered along the majority of the foreshore of this zone, shallowest areas being dominated by *Zostera* sp., with *Posidonia* sp. occurring in slightly deeper waters. Saltmarsh and saltmarsh/mangrove habitats occur along Bundabah Creek and in a small linear area along the Myall River.

The threatened flora species black-eyed Susan (*Tetratheca juncea*) has been recorded just outside of the boundary of the foreshore management zone (**Figure 5.4**). Threatened species recorded include the koala (*Phascolarctos cinereus*), eastern bentwing-bat (*Miniopterus schreibersii oceanensis*), little bentwing-bat (*Miniopterus australis*), swift parrot (*Lathamus discolor*), grey-headed flying-fox (*Pteropus poliocephalus*), glossy black-cockatoo (*Calyptorhynchus lathamii*), wallum froglet (*Crinia tinula*), osprey (*Pandion haliaetus*), green turtle (*Chelonia mydas*), brush-tailed phascogale (*Phascogale tapoatafa*) and the black-necked stork (*Ephippiorhynchus asiaticus*) (**Figure 5.5**).

No areas of important shorebird roosting habitat have been identified within this management zone.

5.12 Management Zone F1

Management Zone F1 starts just to the east of Wobbeong Bay, extending east to Tea Gardens, encompassing Corrie Island, Cut Feet Island and Winda Woppa Headland (**Figure 5.1**). The foreshore areas of this 1024 hectare zone remain largely undeveloped, aside from a small section around the settlement of Limestone. The majority of this management zone consists of privately owned land, with only 206 hectares of public land occurring. The foreshore of Tea Gardens is predominantly private land, however the remainder of remnant vegetation in this management zone is largely public land.

The following vegetation communities have been recorded within Management Zone F1.

- Paperbark (GL MU 31);
- Blackbutt – Bloodwood/Apple (GL MU 41);
- Swamp Mahogany/Paperbark (GL MU 30/31);
- Mangrove (GL MU 33);
- Heath (GL MU 223); and
- Swamp Oak (GL MU 32).

The Coastal Saltmarsh EEC occurs on the foreshore of Limestone and in scattered patches on Corrie Island (**Figure 5.3**). Sites of SEPP 14 wetland occur on Corrie Island and also the foreshores around Limestone, covering an area of 323.9 hectares (**Figure 5.2**). Seagrass habitat occurs around the western coast of Corrie Island, and off the coast of the mainland. The majority of Corrie Island comprises Mangrove habitat, with scattered remnants of saltmarsh. The foreshore of Limestone is also saltmarsh.

No threatened flora species have been recorded within this management zone. However, several threatened fauna species have been recorded, including the koala (*Phascolarctos cinereus*), eastern freetail-bat (*Mormopterus norfolkensis*), little tern (*Sterna albifrons*), dugong (*Dugong dugon*), pied oystercatcher (*Haematopus longirostris*), wallum froglet (*Crinia tinula*) and the squirrel glider (*Petaurus norfolcensis*) (**Figure 5.5**).

Corrie Island and Winda Woppa have been identified as important roosting locations for migratory shorebirds (**Figure 5.7**).

5.13 Management Zone F2

A total of 320 hectares of foreshore are included within Management Zone F2, encompassing Jimmy's Beach, a small section of Tea Gardens and the southern foreshore of Myall Lakes National Park, extending to Yacaaba Head (**Figure 5.1**). A large proportion of the foreshore of this zone is sandy beach, with the only vegetated areas occurring within Myall Lakes National Park. Only a small area near Jimmy's Beach has been disturbed for residential development. Approximately one half of the land within this management zone consists of public land (127 hectares), with the remainder being privately owned. The majority of remnant vegetation within this management zone occurs within public land, with very little occurring on private land.

The NPWS Key Habitats and Corridors Project (Scotts 2003) identifies a regional corridor in this management zone, connecting Yacaaba Head with Hawks Nest and the northern areas of Myall Lakes National Park.

The following vegetation communities have been recorded within Management Zone F2

- Swamp Oak (GL MU 32); and
- Swamp (GL MU 231).

A 30.4 hectare area of Coastal Saltmarsh EEC occurs around Jimmy's Beach (**Figure 5.3**), and this area is also identified as SEPP 14 Wetland (**Figure 5.2**). An area of SEPP 26 Littoral Rainforest occurs to the south of Myall Lakes National Park (**Figures 5.2 and 5.3**). Seagrass habitat occurs off the southern foreshores of Tea Gardens and Winda Woppa, functioning to stabilise shifting sands and reduce scouring of Jimmy's Beach during storm events. Mangrove and Saltmarsh habitats have been identified near Jimmy's Beach.

No threatened flora species have been recorded within this management zone. Several threatened fauna species have been recorded, including the koala (*Phascolarctos cinereus*), little bent-wing bat (*Miniopterus australis*), pied oystercatcher (*Haematopus longirostris*), squirrel glider (*Petaurus norfolcensis*) and the sooty oystercatcher (*Haematopus fuliginosus*) (**Figure 5.5**). No data for koala habitat is available for this management zone.

No areas of important shorebird roosting habitat have been identified within this management zone.

5.14 Management Zone F3

Management Zone F3 encompasses the foreshores of the Myall River, extending inland from the Port approximately 10 kilometres (**Figure 5.1**). The only foreshore development within this 1213 hectare zone occurs around Tea Gardens and Hawks Nest, while the remainder is predominantly vegetated. The majority of this management zone consists of privately owned land, with only 300 hectares of public land occurring. Approximately half of the remnant vegetation along the Myall River lies on public land, however, there is a significant proportion which occurs on private land.

The NPWS Key Habitats and Corridors Project (Scotts, 2003) identifies a regional corridor in this management zone, connecting Yacaaba Head with Hawks Nest and the northern areas of Myall Lakes National Park.

The following vegetation communities have been recorded within Management Zone F3.

- Swamp (GL MU 231);
- Paperbark (GL MU 31);
- Scribbly Gum (GL MU 117);
- Heath (GL MU 223);
- Paperbark/Swamp Oak (GL MU31/32);
- Swamp Oak (GL MU 32);
- Swamp Mahogany (GL MU 30); and

- Dry Blackbutt (GL MU37).

Remnants of the Coastal Saltmarsh EEC occur at Tea Gardens, and also scattered along the Myall River (**Figure 5.3**). Several areas of Seagrass habitat, Mangrove and Saltmarsh occur along the length of the Myall River. The seagrass areas are dominated by *Zostera* sp., with *Halophila* sp. occurring with *Zostera* sp. in some locations. A significant area of SEPP 14 wetland has been identified on the foreshores of Tea Gardens and the Myall River, covering approximately 678.0 hectares (**Figure 5.2**).

No threatened flora species have been recorded within this management zone. Threatened fauna species that have been recorded within this management zone include the southern giant petrel (*Macronectes giganteus*), squirrel glider (*Petaurus norfolcensis*), koala (*Phascolarctos cinereus*), swift parrot (*Lathamus discolor*), osprey (*Pandion haliaetus*) and the black-necked stork (*Ephippiorhynchus asiaticus*) (**Figure 5.5**). No data for koala habitat is available for this management zone.

No areas of important shorebird roosting habitat have been identified within this management zone.

6.0 Terrestrial Habitat Features

The vegetation of the southern foreshore largely comprises only the canopy stratum, with the understorey maintained as mown grass in most foreshore reserves. The canopy trees provide important habitat for a range of common fauna species, including the brush-tailed possum (*Trichosurus vulpecula*), ring-tailed possum (*Pseudocheirus peregrinus*), microchiropteran bats and many species of birds. They also support a number of threatened species such as the osprey (*Haliaeetus leucogaster*), koala (*Phascolarctos cinereus*), powerful owl (*Ninox strenua*), swift parrot (*Lathamus discolor*) and regent honeyeater (*Xanthomyza phrygia*). Both the swift parrot and the regent honeyeater are migratory species, occurring in the area only in winter, when they forage on winter flowering trees. There are several important winter flowering species occurring within the foreshore vegetation communities, for example swamp mahogany (*Eucalyptus robusta*).

A number of important feed trees for koalas occur within the foreshore vegetation, and many areas of preferred koala habitat occur throughout the Port Stephens foreshore. The vegetation of the foreshore area is, however, fragmented by busy roads in many locations, and therefore there is a high number of koala (and other fauna) killed by vehicle collisions as a consequence of movement into more significant habitat areas landward of the foreshore.

Areas such as the Karuah River, Mambo Wetland and Corlette Point Reserve, support vegetation in which an understorey stratum is present. This understorey vegetation provides a diversity of habitats for reptiles, amphibians and ground-dwelling birds and mammals. However, there are many vegetation remnants within the Foreshore Management Area which lack shrub and ground layer vegetation, and therefore have limited habitat value for small, ground dwelling fauna. Many species rely on foraging resources such as insects and seeds and roots of small plants, and require the protection of prickly shrubs to shield them against predators. Shelter is particularly important in urban environments, where dogs and cats occur. Vegetation remnants that do protect understorey vegetation are considered to be highly significant for the conservation of those fauna species dependant on understorey habitats.

7.0 Aquatic Habitat Features

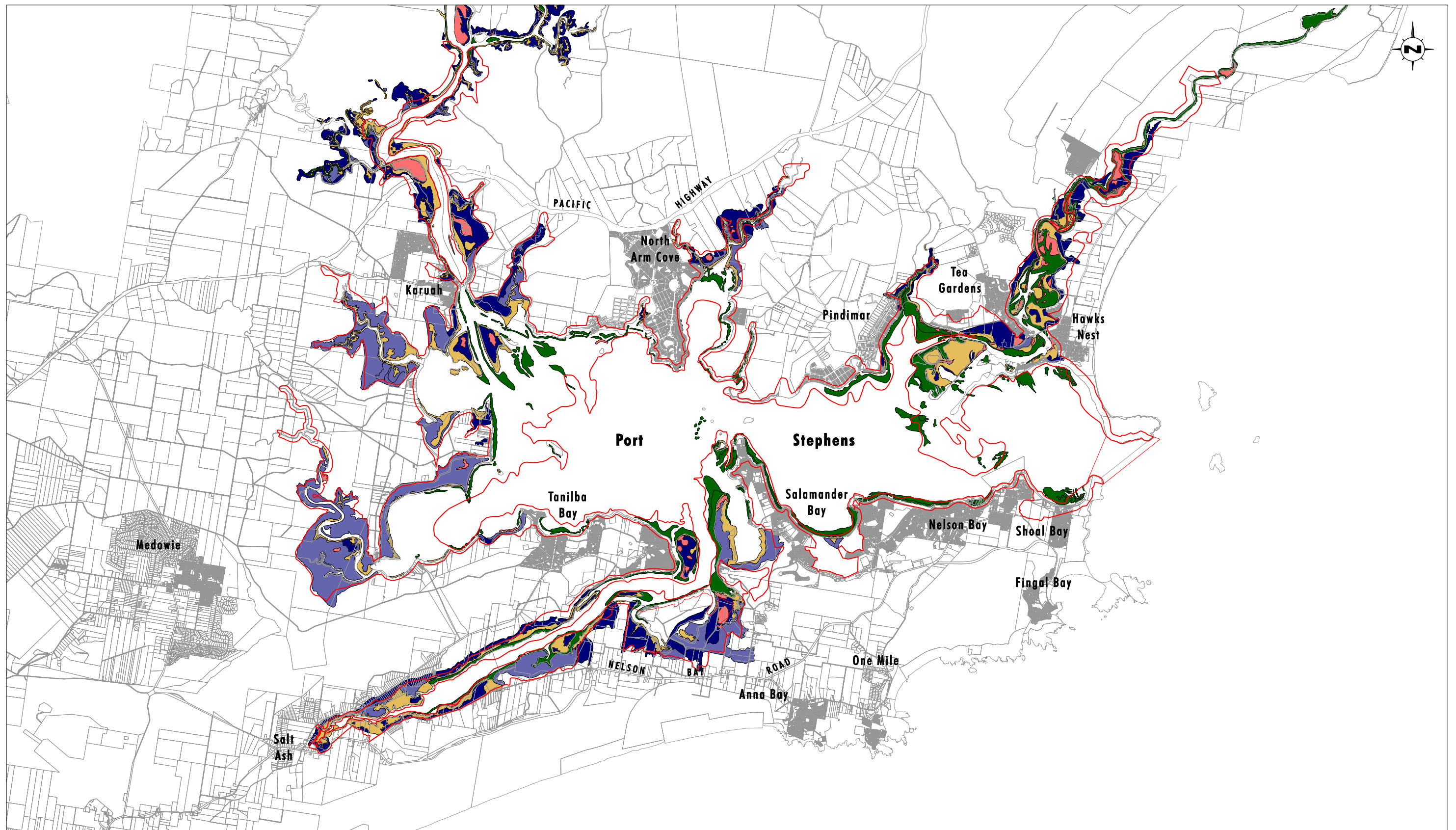
The Port Stephens Foreshore protects highly significant aquatic habitat features, the protection of which is not only important for biodiversity and ecosystem function, but also for recreational and commercial fishing, recreational and aesthetic values of the foreshore and consequently the economic value of tourism in Port Stephens.

One of the major aquatic habitat features of Port Stephens is the extensive seagrass beds, which occur along most foreshores of the Port (**Figure 7.1**). These seagrass beds provide important breeding habitat for many species of fish, as well as providing feeding grounds for fish species which feed on the seagrass itself or the epiphytes and algae which are associated with it. There are also a number of aquatic bird species which feed within seagrass beds.

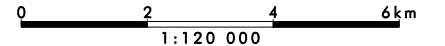
An assessment of the seagrass habitats within the Port Stephens Estuary was undertaken in 1998 (The Ecology Lab, 1998) for the Port Stephens and Myall Lakes Estuary Process Study. The seagrass beds within each of the areas assessed for that study were given a habitat rating between one and five, with one being relatively low, and five being excellent. The majority of sites were given a habitat rating of four, however the seagrass occurring around Corlette was given a rating of two to three as it appears to be affected by the input of sediment from stormwater drains and small creeks in the catchment feeding into the bay. These surveys also revealed that some seagrass vegetation was densely covered with epiphytes, possibly an indication of increased nutrient load due to anthropogenic changes in the catchment (The Ecology Lab, 1998). High epiphytic growth can have adverse impacts on the health of seagrass, as it can result in decreased photosynthetic capability.

The seagrass beds may also be utilised as feeding grounds for the threatened dugong (*Dugong dugon*) and green turtle (*Chelonia mydas*). There has been some destruction of seagrass throughout the Port since human settlement, as it is damaged by boating activities, changes to water quality and other activities affecting the waterways. Despite this, seagrass habitats throughout the Port are largely in good condition. No records of Green Turtles nesting within the Port Stephens foreshore area have been found, however there is potential for this species to nest along the sandy beaches. Should green turtles be found nesting, the protection of that location would have very high conservation significance.

Mangrove and saltmarsh habitats also provide important breeding grounds for fish species and other marine organisms such as crustaceans and molluscs. A comparison between aquatic habitat mapping undertaken by NSW Fisheries in 1985, and revised mapping in 2004, shows that there has been very little change in the distribution of mangrove and saltmarsh habitats. The biggest change has occurred throughout the foreshore of Twelve Mile Creek which was mapped in 1985 as mangroves, however 2004 has seen this area change to saltmarsh/mangroves. Similarly, comparisons between the distribution of seagrass habitats within Port Stephens have been undertaken, showing that there has been very little decline in seagrass beds, with most locations demonstrating an increase. This is discussed further in **Section 9.4.5**.



Source: LPI NSW (2000), Great Lakes Council, Port Stephens Council
 Note: Seaward study area boundary defined by -2 metre (AHD) contour.



- Legend**
- Study Area
 - Mangrove
 - Mangrove/Saltmarsh Communities
 - Saltmarsh Communities
 - Seagrass
 - Other

FIGURE 7.1
Aquatic Habitat

8.0 Corridors

The area included under this Plan of Management encompasses a very narrow strip of the foreshore, which in itself does not provide any substantial corridor connections. However, the foreshore vegetation often adjoins larger, landward remnants which do contribute to the linkage of important habitats throughout the LGA.

Due to development occurring throughout the length of the southern foreshore, there is no continuous link of foreshore vegetation, rather a series of linear remnants which, in most instances, are dissected from landward remnants by busy roads such as Foreshore Drive, Victoria Parade, Shoal Bay Road and Soldiers Point Road. These roads would only be barriers to the less mobile species that travel between remnants on the ground such as koalas (*Phascolarctos cinereus*), brush-tailed possum (*Trichosurus vulpecula*), ring-tailed possum (*Pseudocheirus peregrinus*), reptiles and amphibian species including the threatened wallum froglet (*Crinia tinula*).

There is good connectivity between habitats of the northern foreshore, as the vegetation is more continuous, having few barriers to movement. There are some concentrations of development which may influence the movement of species, however, the majority of development within the northern foreshore occur on larger-style lots which retain a significant proportion of canopy vegetation, and therefore linkages between remnant bushland is somewhat maintained. However, there is often an absence in the understorey vegetation on private land, the lack of which creates barriers for less mobile species such as those listed above.

Future strategic land use planning for the foreshore should take into consideration connectivity between foreshore habitats and landward habitats, such that future developments do not lead to their further fragmentation. The movement of species between habitats from the coast and inland is important for the flow of genetic information between populations and to maintain species diversity between habitats. Any isolated populations will experience a reduction in genetic diversity, which could eventually lead to local extinction of species.

8.1 NPWS Key Habitats and Corridors Project

The Key Habitats and Corridors Project (NPWS 2006) is an integration of available information on forest fauna, which has been used to identify and map important areas for conservation. One of the aims of the project is to provide spatially complete, integrated and practical conservation planning framework. The maps prepared as a result of the project are available as an interactive resource on the internet.

The NPWS Key Habitats and Corridors Project (Scotts 2003) identifies areas of key habitat within management zones C1, C2, E, F1, F2 and F3. Under the project, Key Habitats are areas of predicted high conservation value for forest fauna, and include many large areas of vegetated lands and important vegetation remnants. There are extensive areas of key habitats identified throughout the Port Stephens and Great Lakes LGAs, however, in many instances the mapped key habitats do not extend right to the foreshore zone.

There are numerous corridors identified which link foreshore key habitats with those further inland. A major foreshore corridor occurs around Big Swan Bay, connecting habitats from Tanilba Bay, round to Little Swan Bay, encompassing Moffat's Swamp Nature Reserve and Worimi Nature Reserve. Other important regional corridors linking foreshore habitats include:

- **Twelve Mile Creek Corridor:** linking the foreshore habitats of Fame Cove with Nerong to the north, encompassing parts of Myall Lakes National Park.
- **Myall – Hawks Nest Corridor:** connecting Yacaaba Head (in Myall Lakes National Park) with Hawks Nest and northern areas of Myall Lakes National Park.
- **Worimi-Walaroo Corridor:** provides a link between Twelve Mile Creek and Reedy Creek.

9.0 Significant Biodiversity Values

9.1 Directory of Important Wetlands

In recognition of the significant wetland habitats it supports, the Port Stephens Estuary has been listed on the Directory of Important Wetlands. It is recognised that Port Stephens supports 21% of NSW's mangroves, 13% of saltmarsh and 5% of seagrasses (West et al 1985 – see directory listing). The largest area of mangroves and the second largest area of seagrass in NSW occur in Port Stephens (Australian Heritage Commission 1998).

The following sections provide detail on some of the significant ecological features of the Port Stephens foreshore, which have contributed to it being listed on the Directory of Important Wetlands.

9.2 Threatened Flora

A search of the Department of Environment and Conservation (DEC) Atlas of NSW Wildlife was undertaken in order to identify threatened flora species that have previously been recorded within the Port Stephens Foreshore area. **Table 9.1** lists the five threatened flora species that were found to occur within the study area, the locations of which are shown on **Figure 5.4**.

Table 9.1 – Threatened flora species recorded within the Port Stephens Foreshore area (records from the DEC Atlas of NSW Wildlife)

Scientific Name	Common Name	Status
<i>Tetratheca juncea</i>	black-eyed Susan	V (TSCA) V (EPBC)
<i>Diuris arenaria</i>	sand doubletail	E (TSCA)
<i>Chamaesyce psammogeton</i>	sand spurge	E (TSCA)
<i>Melaleuca groveana</i>	Grove's Paperbark	V (TSCA)
<i>Eucalyptus parramattensis</i> subsp. <i>decadens</i>	Parramatta red gum	V (TSCA) V (EPBC)

TSC Act = *Threatened Species Conservation Act 1995*

EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999*

V = vulnerable

E = endangered

There are several records of black-eyed Susan (*Tetratheca juncea*) which occur just outside the boundary of the Port Stephens Foreshore area, in Zone E (**Figure 5.4**). This species is typically associated with open forest and woodland vegetation, in communities such as the Coastal Plains Smooth-barked Apple Woodland and Coastal Sand Apple – Blackbutt Forest. As such, there are few records of this species within the foreshore zone itself, with the majority of records being in the woodland vegetation occurring landward of the foreshore zone. As such, management of the foreshore zone should not place high priority on the conservation of *Tetratheca juncea*, although the protection of this species should be considered in any planning considerations in locations where it has been recorded.

Sand double-tail (*Diuris arenaria*) has been recorded within Management Zone A1, and also just outside of B1 (**Figure 5.4**). The distribution of this species is restricted to Port Stephens, where it favours Coastal Heath vegetation and also dry grassy eucalypt forest on sandy flats

(DEC 2006). Given the highly restricted distribution of *Diuris arenaria*, the foreshore areas in which this species has been recorded are considered to have high conservation significance, and should be appropriately managed to protect this species.

Within the Port Stephens Foreshore area, there is one record of the sand spurge (*Chamaesyce psammogeton*), located in Nelson Bay, in Management Zone A1 (**Figure 5.4**). The distribution of this species extends from south of Jervis Bay, north to Queensland, where it occurs on foredunes and exposed headlands, often with spinifex (DEC 2006). Widespread loss of suitable habitat for this species has resulted from coastal development, human trampling of dune systems, invasion of weeds such as bitou bush (*Chrysanthemoides monilifera*) and four-wheel drive vehicles. Remaining habitat for this species is considered to have of high conservation significance, and as such locations in which this species has been recorded should be managed appropriately to protect this species.

Grove's Paperbark (*Melaleuca groveana*) has been recorded within Mambo Wetland, in management zone A3 (**Figure 5.4**). Further records occur inland of the foreshore zone around Shoal Bay and Nelson Bay. Grove's paperbark has a scattered distribution in coastal habitats from Port Stephens north to south-east Queensland, occurring in heath and shrubland, often in exposed sites, at high elevations, on rocky outcrops and cliffs (DEC 2006). The Port Stephens LGA forms the southern limit of distribution for Grove's paperbark, and therefore it is important that remaining populations of this species are adequately conserved.

Records of the Parramatta red gum (*Eucalyptus parramattensis* subsp. *decadens*) are located along the Myall River in management zone F3 (**Figure 5.4**). There are two separate populations of *Eucalyptus parramattensis* subsp. *decadens*, one of which occurs in the Port Stephens LGA, and is referred to as the Tomago Sandbeds meta-population. The Tomago Sandbeds meta-population is bounded by Salt Ash and Tanilba Bay in the north and Williamstown and Tomago in the south (DEC 2006). Parramatta Red Gum usually grows on deep, low-nutrient sands, which are often subject to periodic inundation or where water tables are relatively high (DEC 2006). The species occurs in dry sclerophyll woodland with a dry heath understorey and it also occurs as an emergent in dry or wet heathland (DEC 2006).

9.3 Threatened Fauna

A search of the Department of Environment and Conservation (DEC) Atlas of NSW Wildlife was undertaken in order to identify threatened fauna species that have previously been recorded within the Port Stephens Foreshore area. **Table 9.2** lists the 26 threatened fauna species that were found to occur within the study area, the locations of which are shown on **Figure 5.5**. An additional five species have been added to the list, which are shorebird species that have been identified within Port Stephens (Stuart 2004) but do not appear on the DEC Atlas of NSW Wildlife.

Table 9.2 – Threatened fauna species recorded within the Port Stephens Foreshore area (records from the DEC Atlas of NSW Wildlife)

Scientific Names	Common Name	Status
<i>Dugong dugon</i>	dugong	E (TSCA)
<i>Chelonia mydas</i>	green turtle	V (TSCA) V (EPBC)
<i>Phascolarctos cinereus</i>	koala	V (TSCA) Endangered Population – Hawks Nest and Tea Gardens
<i>Phascogale tapoatafa tapoatafa</i>	brush-tailed phascogale (southern subsp.)	V (TSCA)
<i>Miniopterus australis</i>	little bentwing-bat	V (TSCA)
<i>Mormopterus norfolkensis</i>	eastern freetail-bat	V (TSCA)
<i>Petaurus norfolcensis</i>	squirrel glider	V (TSCA)
<i>Miniopterus schreibersii oceanensis</i>	eastern bentwing-bat	V (TSCA)
<i>Pteropus poliocephalus</i>	grey-headed flying-fox	V (TSCA) V (EPBC)
<i>Potorous tridactylus</i>	long-nosed potoroo	V (TSCA) V (EPBC)
<i>Dasyurus maculatus maculatus</i>	spotted-tailed quoll	E (EPBC) V (TSCA)
<i>Chalinolobus dwyeri</i>	large-eared pied bat	V (TSCA) V (EPBC)
<i>Ptilinopus magnificus</i>	wompoo fruit-dove	V (TSCA)
<i>Burhinus grallarius</i>	bush stone-curlew	E (TSCA)
<i>Lathamus discolor</i>	swift parrot	E (TSCA) E (EPBC)
<i>Pandion haliaetus</i>	osprey	V (TSCA)
<i>Ninox strenua</i>	powerful owl	V (TSCA)
<i>Calyptorhynchus lathami</i>	glossy black-cockatoo	V (TSCA)
<i>Ephippiorhynchus asiaticus</i>	black-necked stork	E (TSCA)
<i>Haematopus fuliginosus</i>	sooty oystercatcher	V (TSCA)
<i>Haematopus longirostris</i>	pied oystercatcher	V (TSCA)
<i>Macronectes giganteus</i>	southern giant-petrel	E (TSCA) E (EPBC)
<i>Pterodroma leucoptera leucoptera</i>	Gould's petrel	E (TSCA) E (EPBC)
<i>Tyto novaehollandiae</i>	masked owl	V (TSCA)
<i>Sterna albifrons</i>	little tern	E (TSCA)
<i>Dromaius novaehollandiae</i>	emu	endangered population in the NSW North Coast Bioregion and Port Stephens Local Government Area

Table 9.2 – Threatened fauna species recorded within the Port Stephens Foreshore area (records from the DEC Atlas of NSW Wildlife) (cont)

Scientific Names	Common Name	Status
<i>Limosa limosa</i>	black-tailed godwit	V (TSCA) recorded by Stuart (2004).
<i>Xenus cinereus</i>	terek sandpiper	V (TSCA) recorded by Stuart (2004).
<i>Calidris alba</i>	sanderling	V (TSCA) recorded by Stuart (2004).
<i>Charadius leschenaultii</i>	greater sand plover	V (TSCA) recorded by Stuart (2004).
<i>Charadius mongolus</i>	lesser sand plover	V (TSCA) recorded by Stuart (2004).

TSCA = *Threatened Species Conservation Act 1995*

EPBC = *Environment Protection and Biodiversity Conservation Act 1999*

V = vulnerable

E = endangered

9.4 Endangered Ecological Communities

Reflective of the fact that foreshore environments have been extensively cleared, or otherwise been highly modified through previous land use practices, many of the vegetation communities within of the Port Stephens Foreshore are listed as endangered ecological communities under the *Threatened Species Conservation Act 1995*.

There are five endangered ecological communities, listed under the *Threatened Species Conservation Act 1995* (TSC Act), which occur within the Port Stephens Foreshore area (**Figure 5.3**). Detailed surveys of the vegetation along the northern foreshore of the Port have not been undertaken to date, and therefore no EECs have mapped for those areas. It is considered that should detailed studies occur in the northern foreshore, further areas of EECs will be identified. The Seagrass community has also been described in this section, despite not being an EEC under the TSC Act. This community is afforded protection under the *Fisheries Management Act 1998*.

9.4.1 Swamp Sclerophyll Forest

Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-east Corner Bioregions is listed as an endangered ecological community under Part 3, Schedule 1 of the *Threatened Species Conservation Act 1995*.

Within the Port Stephens Foreshore area, the Swamp Sclerophyll Forest EEC occurs extensively throughout the southern foreshore zones of Port Stephens (**Figure 5.3**), covering an area of approximately 24 hectares. The swamp mahogany-paperbark forest (MU 37), one of the communities identified for the LHCCREMS vegetation study (House 2003), is considered to correspond to this EEC (NPWS 2004a).

The Swamp Sclerophyll Forest occurs within management zones A1, A2, A3, B1, B2, C1 and D. It is considered that the Swamp Mahogany/Paperbark (MU 31) community described in

the Great Lakes vegetation classifications possibly corresponds to the Swamp Sclerophyll Forest, and therefore the extent of this community is likely to be greater than that shown on **Figure 5.3**.

The Swamp Sclerophyll Forest EEC is not well represented within reserves in the Port Stephens Foreshore area. Very small remnants occur in Tomaree National Park, Tilligerry Nature Reserve and Worimi Nature Reserve.

The Swamp Sclerophyll Forest occurs on waterlogged or periodically inundated alluvial flats and drainage lines on coastal floodplains, typically below 20 metres elevation (NPWS 2004a). The structure of this community is highly variable, ranging from reedlands and sedgeland to open forest.

The floristic composition of the Swamp Sclerophyll EEC varies widely throughout its distributional range. Within Port Stephens, this community is characterised by a canopy of swamp mahogany (*Eucalyptus robusta*) with a sub-canopy of swamp oak (*Casuarina glauca*). There is a tall shrub-layer supporting sweet willow bottlebrush (*Callistemon salignus*), swamp paperbark (*Melaleuca ericifolia*), broad-leaved paperbark (*Melaleuca quinquinervia*), cheese tree (*Glochidion ferdinandi*) and occasionally lilly pilly (*Acmena smithii*). A range of sedges, grasses, ferns and other small herbs characterise the ground stratum.

9.4.2 Swamp Oak Floodplain Forest

Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South-east Corner Bioregions is listed as an endangered ecological community under Part 3, Schedule 1 of the *Threatened Species Conservation Act 1995*.

Several small remnants of the Swamp Oak Floodplain Forest EEC occur within the Port Stephens Foreshore area, (**Figure 5.3**) covering a total area of approximately 382 hectares. It has been identified within A2, B2, C2 and D management zones. The Swamp Oak Rushland Forest (MU 40), one of the communities identified for the LHCCREMS vegetation study (House 2003), is considered to correspond to this EEC (NPWS 2004b).

It is considered that the swamp oak (MU 32), Paperbark/Swamp Oak (MU 31/32) and Paperbark (MU31) communities described in the Great Lakes vegetation classifications possibly correspond to the Swamp Sclerophyll Forest, and therefore the extent of this community is likely to be greater than that shown on **Figure 5.3**.

The Swamp Oak Floodplain Forest EEC is poorly represented in reserves within the Port Stephens foreshore area, with only very small remnants occurring in sections of Worimi Nature Reserve.

The Swamp Oak Floodplain Forest EEC occurs in environments of saline or sub-saline environments which are waterlogged or periodically inundated, rarely above 10 metres elevation (NPWS 2004b). The community structure ranges from open forest to low woodland, scrubs or reedlands with scattered trees (NPWS 2004b).

The floristic composition of this community varies widely throughout the study area, however a dense to sparse canopy stratum dominated by swamp oak (*Casuarina glauca*) is always present. A distinguishing feature of this community is the relatively low abundance of Eucalyptus species in the canopy. A low tree layer characterised by species such as broad-leaved paperbark (*Melaleuca quinquinervia*), prickly-leaved paperbark (*Melaleuca styphelioides*) and swamp paperbark (*Melaleuca ericifolia*) is often present. The composition of the ground layer stratum is highly variable, being dependant upon the salinity level of the groundwater (NPWS 2004b). Ground layer species commonly encountered within this

community include slender knotweed (*Persicaria decipiens*), tussock sedge (*Carex appressa*), common reed (*Phragmites australis*), (*Gahnia clarkei*) and (*Cynodon dactylon*).

9.4.3 Littoral Rainforest

Littoral Rainforest in the NSW North Coast, Sydney Basin and South-east Corner Bioregions is listed as an endangered ecological community under Part 3, Schedule 1 of the *Threatened Species Conservation Act 1995*.

Littoral rainforest is not a widespread community within the Port Stephens foreshore area. There is one small remnant (11.6 hectares) occurring in Tomaree National Park, just on the inland edge of management zone A1 (**Figure 5.3**). This community is not considered to be adequately represented in reserves within the Port Stephens foreshore area.

Littoral rainforest is typically a closed forest, with several structural layers characterised by species with mesic or coriaceous leaves (NPWS 2004c). Littoral rainforest comprises a low-closed canopy stratum which may include species such as tuckeroo (*Cupaniopsis anacardioides*), cheese tree (*Glochidion ferdinandi*), lilly pilly (*Acmena smithii*) and cabbage tree palm (*Livistona australis*). The threatened species magenta lilly pilly (*Syzygium paniculatum*) may sometimes be present. Although this community predominantly supports rainforest species, emergent sclerophyll species such as smooth – barked apple (*Angophora costata*), coast banksia (*Banksia integrifolia*) and forest red gum (*Eucalyptus tereticornis*) may be present. The sub-canopy stratum may comprise rusty fig (*Ficus rubiginosa*), sandpaper fig (*Ficus coronata*), grey myrtle (*Backhousia myrtifolia*) and guioa (*Guioa semiglauca*). The tall shrub layer may feature species such as coffee bush (*Breynia oblongifolia*), hairy clerodendrum (*Clerodendrum tomentosum*) and muttonwood (*Rapanea variabilis*). The ground layer stratum comprises primarily consists of a diversity of ferns and vines. Some characteristic species include rasp fern (*Doodia aspera*), common maidenhair fern (*Adiantum aethiopicum*), water vine (*Cissus Antarctica*) and wonga wonga vine (*Pandorea pandorana*).

9.4.4 Freshwater Wetlands on Coastal Floodplains

Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-east Corner Bioregions is listed as an endangered ecological community under Part 3, Schedule 1 of the *Threatened Species Conservation Act 1995*.

An 81.4 hectare remnant of the Freshwater Wetland EEC occurs in management zone A3, within the Mambo Wetland Reserve (**Figure 5.3**). This community is not considered to be adequately represented within conservation reserves within the Port Stephens foreshore area.

The Freshwater Wetland Complex (MU 46), one of the communities identified for the LHCCREMS vegetation study (House 2003), is considered to correspond to this EEC (NPWS 2005).

The Freshwater Wetland EEC occurs in low-lying areas with periodic or semi-permanent inundation with fresh water, although there may be minor saline influence in some areas (NPWS 2005). Structurally, this community can range from sedgeland and reedlands to herbfields, with very few woody species being present (NPWS 2005). The floristic composition of this varies greatly in accordance with duration and frequency of inundation, depth of inundation and the degree of saline influence (NPWS 2005). Dependant on these conditions, there is often a complete dominance of one or two species.

In most circumstances, this community lacks a canopy stratum, however the occasional emergent such as prickly-leaved paperbark (*Melaleuca styphelioides*), swamp oak

(*Casuarina glauca*) or forest red gum (*Eucalyptus tereticornis*) may occur, particularly on swamp margins with improved drainage (House 2003). Characteristic of this community is the dense understorey of sedges, rushes and aquatic plants. Species that may occur include tall spike-rush (*Eleocharis sphacelata*), red-fruit saw-sedge (*Gahnia sieberana*), swamp water fern (*Blechnum indicum*), rapier sedge (*Lepidosperma flexuosum*), curly wigs (*Caustis flexuosa*), water couch (*Paspalum distichum*), jointed twig rush (*Baumea articulata*), *Juncus usitatus*, broadleaf cumbungi (*Typha orientalis*), slender knotweed (*Persicaria decipiens*) and ferny azolla (*Azolla pinnata*).

9.4.5 Coastal Saltmarsh

Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South-east Corner Bioregions is listed as an endangered ecological community under Part 3, Schedule 1 of the *Threatened Species Conservation Act 1995*. A recent study of wetlands in the Port Stephens Council area (Eco Logical 2005) identified Saltmarsh communities as high priority for protection and management.

Mapping of the distribution of the Coastal Saltmarsh EEC within the Port Stephens Foreshore area has been prepared by data provided by the NSW fisheries (NSW Fisheries/Department of Primary Industry 2004; West et al 1985). The Coastal Saltmarsh EEC occurs widely throughout the Port Stephens foreshore area, occurring in the majority of the 14 management zones (**Figure 5.3**) and covering an area of approximately 959 hectares. Mapping showing the area of saltmarsh within Port Stephens in 1985 was compared with the more recent mapping of this community (2004), revealing there has been no significant change in the area of saltmarsh within the Foreshore Management Area between 1985 and 2004. A large proportion of Coastal Saltmarsh occurs within rural zoning (Eco Logical 2005b).

Healthy stands of the Coastal Saltmarsh EEC were observed along the foreshores of the Myall River. This EEC is not considered to be well protected in conservation reserves within the Port Stephens Foreshore area, however small remnants do occur in both Worimi and Karuah Nature Reserves.

Under the vegetation classification mapping undertaken from LHCCREMS (House 2003), the Saltmarsh community (MU 47a) is a variation of the Mangrove-Estuarine Complex (MU 47) which is mapped widely throughout the Port Stephens Foreshore area (**Figure 5.3**). This Saltmarsh community is considered to correspond to the Coastal Saltmarsh EEC.

The Coastal Saltmarsh EEC occurs in the intertidal zone on the shores of estuaries and lagoons (NPWS 2004d), usually landward of mangrove communities. This community is structurally simple, being characterised by salt tolerant, low growing ground covers and sedges, including a variety of non-vascular organisms such as algae. The most dominant vascular species occurring within Coastal Saltmarsh within Port Stephens is samphire (*Sarcocornia quinqueflora* subsp. *quinqueflora*). Other species that may occur in this community include marine couch (*Sporobolus virginicus*), twig rush (*Baumea juncea*), streaked arrow grass (*Triglochin striatum*), knobby club-rush (*Isolepis nodosa*), creeping brookweed (*Samolus repens*) and sea rush (*Juncus kraussii*). As this community often occurs adjacent to mangrove habitats, seedlings of grey mangrove (*Avicennia marina*) may be scattered throughout (NPWS 2004d).

Coastal Saltmarsh offers important habitat values for a range of fauna species, habitats which few other vegetation communities provide (NPWS 2004d). The saltmarsh provides suitable environments for terrestrial and aquatic invertebrates such as crabs, molluscs, spiders and insects. A diversity of fish species may occupy saltmarsh areas and many species rely on these for breeding. In some areas, the saltmarsh is important high tide

roosts for migratory wading birds, many of which are listed as threatened under both state and national legislation.

Due to alterations in hydrological cycles as a result of human disturbances, there has been a landward encroachment of mangrove communities, which are invading areas once occupied by saltmarsh (Burns and Davey 2003). This is evident in some areas, however there are certain locations, for example Twelve Mile Creek, at which the area of saltmarsh has increased, and mangroves decreased.

9.4.6 Seagrass

Port Stephens supports extensive areas of seagrass beds, which, in most locations, appear to be thriving (**Figure 7.1**). The three dominant seagrass species within Port Stephens are eelgrass (*Zostera capricornii*), paddleweed (*Halophila ovalis*) and strapweed (*Posidonia australis*). Eelgrass is the dominant species in the shallower areas, with small amounts of paddleweed interspersed throughout. Strapweed occurs in deeper waters, primarily in the lower port, however can also occur in the mid zone (The Ecology Lab, 1998).

An assessment of the seagrass habitats within the Port Stephens Estuary was undertaken in 1998 (The Ecology Lab, 1998). The seagrass beds within each of the areas assessed for that study were given a habitat rating between one and five, with one being relatively low, and five being excellent. The majority of sites were given a habitat rating of four, however the seagrass occurring around Corlette was given a rating of two to three as it appears to be affected by the input of sediment from stormwater drains and small creeks in the catchment feeding into the bay.

In order to determine the changes over time in the distribution of seagrass beds, mapping of seagrass habitats prepared in 1985 have been compared with mapping prepared in 2004. Within the entire Foreshore Management Area, there has been a reduction of only 30 hectares of Seagrass habitat over this 19 year period. There has been a decline of approximately 73 hectares of seagrass within Management Zone E, however all other management zones experienced a slight increase in the area of Seagrass habitat, or otherwise remained the same. The most significant increase in Seagrass habitat occurred in management zone C1, having no areas of Seagrass in 1985, increasing to 43 hectares in 2004.

The Ecology Lab (1998) compared seagrass distribution in 1998 with mapping prepared by West, 1985. Similarly, this comparison revealed that seagrass beds had increased in most areas, with only a few areas experiencing a decrease. This includes a reduction in: eelgrass (*Zostera capricornii*) around the Karuah River and Salamander Bay; strapweed (*Posidonia australis*) around Shoal Bay and paddleweed (*Halophila ovalis*) along the foreshore of Tahlee and in North Arm Cove (The Ecology Lab 1998).

9.5 Endangered Populations

An isolated population of emu occurring within the NSW North Coast Bioregion and the Port Stephens Local Government Area (LGA) is listed as endangered population under part 2, Schedule 1 of the *Threatened Species Conservation Act 1995*. It is not clear as to when the emu was last recorded within the Port Stephens LGA, however records from the DEC Wildlife Atlas Database indicate this was around 1992. There have been nine records in the Port Stephens LGA between 1977 and 1992. This includes records at Tilligerry Creek, Lemon Tree Passage, Corlette and the Karuah River. Due to the lack of recent records, it is considered very unlikely that a population of emus remains within the Port Stephens LGA. The population previously occurring is considered to have become extinct as a result of threatening processes such as loss and fragmentation of habitat due to clearing for

agricultural and urban development, inappropriate fire regimes, deliberate killing, predation of eggs and young by pigs, dogs and foxes, road kill and altered population dynamics (NPWS 2004e).

The population of koalas occurring in Hawks Nest and Tea Gardens is listed as an endangered population under part 2, Schedule 1 of the *Threatened Species Conservation Act 1995*. The endangered population occurs in the Great Lakes Local Government Area, in the immediate vicinity of Hawks Nest and Tea Gardens extending in the south-east to the Yacaaba Headland and in the south-west to the peninsula west of Winda Woppa (NSW Scientific Committee 1999). It is considered that the population is in immediate danger of extinction, with the koala numbers having declined from 21 individuals in 1989 to only 12 in 1998 (NSW Scientific Committee 1999). This rapid decline in the population is the result of habitat destruction and fragmentation due to urban development, and also from koalas being killed by vehicles and domestic animals.

9.6 SEPP 14 – Coastal Wetlands

Forty percent of the Port Stephens Foreshore management area is classified as SEPP 14 – Coastal Wetland. As shown on **Figure 5.2**, SEPP 14 wetland occurs throughout a large proportion of the study area, covering a total area of 4989.7 hectares. Each of the 14 Management Zones features SEPP 14 wetland, with the greatest area occurring in Management Zone F3, which supports 1213 hectares of SEPP 14 wetland.

SEPP 14 provides additional protection against development for lands covered under this policy. The clearing of land; construction of a levee and the draining or filling of land are all activities that cannot be undertaken on land designated as a SEPP 14 wetland unless consent from the local council is granted, along with the concurrence of the Director. SEPP 14 doesn't apply to NPWS reserves or land to which SEPP 26 occurs.

9.7 SEPP 26 – Littoral Rainforest

Some scattered remnants of Littoral Rainforest occur in management zone F2 on the Yacaaba headland of Myall Lakes National Park (**Figure 5.2**) and also some very small areas within management zone A1, which lies within Tomaree National Park. SEPP 26 requires that the likely effects of any proposed development be thoroughly considered in an environmental impact statement. The policy applies to 'core' areas of littoral rainforest as well as a 100 metre wide 'buffer' area surrounding these core areas, except for residential land and areas to which SEPP No. 14 - Coastal Wetlands applies (Department of Planning 2006).

9.8 SEPP 44 – Koala Habitat

A total of 447 hectares of preferred koala habitat occurs within the Port Stephens Foreshore Management area, in addition to 104 hectares of supplementary habitat, and 215 hectares of marginal habitat. Any development application prepared within the Port Stephens Local Government Area will automatically trigger assessment under SEPP 44. However, compliance with the CKPoM constitutes compliance under SEPP 44 in the Port Stephens LGA.

SEPP 44 encourages the conservation and management of natural vegetation areas that provide habitat for koalas to ensure permanent free-living populations will be maintained over their present range. The policy applies to 107 local government areas. Local councils cannot approve development in an area affected by the policy without an investigation of core koala

habitat. The policy provides the state-wide approach needed to enable appropriate development to continue, while ensuring there is ongoing protection of koalas and their habitat (Department of Planning 2006).

A list of known koala feed trees is provided in the SEPP 44 legislation, consideration of which must be given in any SEPP 44 assessment. These koala feed trees are listed below in **Table 9.3**.

Table 9.3– SEPP 44 Koala Feed Tree Species

Scientific Name	Common Name
<i>Eucalyptus tereticornis</i>	Forest Red Gum
<i>Eucalyptus microcorys</i>	Tallowwood
<i>Eucalyptus punctata</i>	Grey Gum
<i>Eucalyptus viminalis</i>	Ribbon or Manna Gum
<i>Eucalyptus camaldulensis</i>	River Red Gum
<i>Eucalyptus haemastoma</i>	Broad Leaved Scribbly Gum
<i>Eucalyptus signata</i>	Scribbly Gum
<i>Eucalyptus albens</i>	White Box
<i>Eucalyptus populnea</i>	Bimble Box or Poplar Box
<i>Eucalyptus robusta</i>	Swamp Mahogany

The vegetation of the Port Stephens Foreshore supports a number of these known feed trees for koalas, including swamp mahogany (*Eucalyptus robusta*), forest red gum (*Eucalyptus tereticornis*), scribbly gum (*Eucalyptus signata*) and grey gum (*Eucalyptus punctata*).

9.9 Important Shorebird Habitat

Shorebirds (also known as wading birds or waders), as defined by Stuart (2004), are 'birds that are ecologically dependant on the habitat at the shores of oceans, lakes and rivers'. In areas of tidal waters, shorebirds feed on the exposed sand/mud flats during low tide, while roosting on slightly higher ground during high tide (Stuart 2004). Emergent posts in foreshore areas, and infrastructure associated with Oyster leases are recognised as very important roosting sites locally for shorebirds (Stuart 2004).

Port Stephens is a highly significant area for shorebirds, providing large areas of important habitat for migratory and resident shorebirds, with 32 species being identified since the 1970's (Stuart 2004), (**Table 5.7**). Port Stephens is important all year round for larger shorebird species such as godwits, curlews and whimbrels, while a very large number of some smaller species of shorebirds occur in Port Stephens in winter. There are much fewer records for medium-sized shorebirds (Stuart 2004). Many of the shorebirds are migratory, returning annually to the northern hemisphere where they breed in the warmer climate.

Table 9.4 – Shorebirds recorded within Port Stephens (Stuart 2004)

Common Name	Scientific Name	Migratory/Resident	Status
black-tailed godwit	<i>Limosa limosa</i>	migratory	V (TSCA)
bar-tailed godwit	<i>Limosa lapponica</i>	migratory	
whimbrel	<i>Numenius phaeops</i>	migratory	
eastern curlew	<i>Numenius madagascariensis</i>	migratory	
marsh sandpiper	<i>Tringa stagnatilis</i>	migratory	
common greenshank	<i>Tringa nebularia</i>	migratory	
wood sandpiper	<i>Tringa glareola</i>	migratory	
terek sandpiper	<i>Xenus cinereus</i>	migratory	V (TSCA)
common sandpiper	<i>Actitis hypoleucos</i>	migratory	
grey-tailed tattler	<i>Heteroscelis brevipes</i>	migratory	
ruddy turnstone	<i>Arenaria interpres</i>	migratory	
red knot	<i>Calidris canutus</i>	migratory	
sanderling	<i>Calidris alba</i>	migratory	V(TSCA)
red-necked stint	<i>Calidris ruficollis</i>	migratory	
pectoral sandpiper	<i>Calidris melanotos</i>	migratory	
sharp-tailed sandpiper	<i>Calidris acuminata</i>	migratory	
curlew sandpiper	<i>Calidris ferruginea</i>	migratory	
pacific golden plover	<i>Pluvialis fulva</i>	migratory	
grey plover	<i>Pluvialis squatarola</i>	migratory	
double-banded plover	<i>Charadrius bicinctus</i>	migratory	
greater sand plover	<i>Charadrius leschenaultii</i>	migratory	V(TSCA)
lesser sand plover	<i>Charadrius mongolus</i>	migratory	V(TSCA)
bush stone-curlew	<i>Burhinus grallarius</i>	resident	E(TSCA)
pieb oystercatcher	<i>Haematopus longirostris</i>	resident	V(TSCA)
sooty oystercatcher	<i>Haematopus fuliginosus</i>	resident	V(TSCA)
black-winged stilt	<i>Himantopus himantopus</i>	resident	
banded stilt	<i>Cladorhynchus leucocephalus</i>	resident	
red-necked avocet	<i>Recurvirostra novaehollandiae</i>	resident	
red-capped plover	<i>Charadrius ruficapillus</i>	resident	
black-fronted dotterel	<i>Euseyonis melanops</i>	resident	
red-kneed dotterel	<i>Erythronyx cinctus</i>	resident	
masked lapwing	<i>Vanellus miles</i>	resident	

Significant shorebird roosting locations include Jimmys Beach, Winda Woppa Point, Corrie Island, Pindimar Bay (amongst ship wrecks), Oyster leases off Tahlee, Karuah River, Wurrung Island, north of Swan Bay, oyster leases off Swan Bay, west of Tanilba Bay, oyster leases off Oyster Cove, Oyster Cove, Cromartys Bay, Mud Point, east of Fenninghams Island, Mud Island Tilligerry Creek and north of Mud Island (Stuart 2004). Important shorebird locations are shown on **Table 9.4**. Saltmarsh communities are a very important habitat component for shorebirds, as they provide a broad range of essential foraging resources.

Worimi Nature Reserve, in particular, houses many migratory and non-migratory bird species. To date, the Hunter Bird Observers Club has recorded 34 species of shorebirds at Big Swan Bay (Stuart 2004). Swan Bay/Worimi Nature Reserve provides roosting habitat for 25-50% of the total estimated number of shorebirds in Port Stephens. Of the 34 species of waders located at Swan Bay and Worimi Nature Reserve, the bar-tailed godwit, eastern curlew, marsh sandpiper, common greenshank, wood sandpiper, common sandpiper, grey-tailed tattler, ruddy turnstone, red knot, red-necked stint, pectoral sandpiper sharp-tailed sandpiper, curlew sandpiper, Pacific golden plover and the grey plover are all protected under the Bonn Conservation, CAMBA (China and Australia Migratory Bird Agreement) and JAMBA (Japan and Australia Migratory Bird Agreement). Additionally, the black-tailed godwit, terek sandpiper, sanderling, pied oystercatcher, sooty oystercatcher and lesser sand plover are all listed as Vulnerable under the *Threatened Species Conservation Act 1995*. The bush-stone curlew is listed as Endangered under the *Threatened Species Conservation Act 1995*.

The *Biology and Management of Waders in NSW* (Smith 1991) identifies Port Stephens as a Priority 2 site for NSW, the reasoning for this is as follows:

'The most important NSW site for the whimbrels, and one of the two most important sites for the eastern curlew. Both these species and the pacific golden plover have been recorded in numbers over the 1% level. The estuary also supports a remnant population of bush stone-curlew. It is a large estuary which has only been partly covered in most surveys. Wader numbers may well be larger than indicated.' (Smith 1991)

Disturbance to resting shorebirds by human activities is recognised as a major issue in the conservation of shorebirds (DEH 2005a). The energy expenditure of the birds to fly away from the disturbance is considered to compromise their capacity to build enough energy reserves to undertake their migration. Recommendations for this threat are provided in **Section 13.1**.

Another threat to shorebird habitat is the invasion of mangroves into saltmarsh communities. This is discussed further in **Section 13.1**.

10.0 Key Threats to Foreshore Biodiversity

10.1 Land Clearing

Since settlement of Port Stephens, residential development has continually been encroaching on the foreshore environment, particularly around the southern foreshore. Land clearance and the filling of wetland habitats for the establishment of housing and associated infrastructure have seen the loss of a large proportion of the southern foreshore of Port Stephens, and is slowly encroaching on the northern foreshore areas. More recently, the rate of development of the foreshore has slowed, largely due to increased awareness of the environmental consequences of building close to the foreshore. However, there is concern for the areas of vegetation that remain, particularly on the northern foreshore of Port Stephens where there has been relatively little development to date.

The population of villages on the northern foreshore of Port Stephens, in the Great Lakes Council Area, is currently much lower than those on the southern foreshore. However, the signs for increasing pressure for urban development are clearly apparent in this area and can be expected to increase as travelling times to Sydney are reduced by improvements to the Pacific Highway (Umwelt 2003). Given that the majority of landholders on the northern foreshore are private, the protection of high conservation values will be dependant upon future management decisions of private land holders.

10.2 Introduced Species

The vegetation of the Port Stephens area has been invaded by a large number of introduced flora, both terrestrial and aquatic species. Bitou bush (*Chrysanthemoides monilifera* subsp. *rotundata*), and lantana (*Lantana camara*) are considered to be the most significant terrestrial weed species, occurring extensively throughout the foreshore area. A number of aquatic weed species have been identified within wetland areas, including long-leaf willow primrose (*Ludwigia longifolia*), alligator weed (*Alternanthera philoxeroides*) and water hyacinth (*Eichhornia crassipes*).

The highly invasive nature of most of these weed species has resulted in a simplification of the ecosystems in which they have colonised, with many native species being out-competed for space.

The assessment of each individual zone for weed management issues was outside the scope of this project. However, it is likely that one or several introduced flora species would occur in all areas of remnant vegetation within the foreshore zone. The management of weeds in Port Stephens is currently addressed through bush regeneration programs conducted by Port Stephens Council. Weed management within Port Stephens Council is addressed in further detail in **Section 11.2**.

10.3 Threats to Koala Habitat

Historically, a major impact on koala populations of the Port Stephens LGA has been the clearing of habitat. This is still occurring to some extent, however the rate has slowed dramatically, and there is legislation in place which controls development in areas containing koala habitat. What remains is a patchy distribution of habitat remnants throughout the LGA, occurring amongst residential development. In this urban environment amongst which many remaining koala populations occur, the key threats include predation by domestic dogs and cats, fatality through vehicle collision, invasion of habitat by weed species, bushfires and clearing of vegetation for bushfire protection measures.

10.4 Threats to EECs

The spread of urban development has greatly reduced the distribution of several communities within the Port Stephens foreshore area, consequently these communities have been listed as endangered ecological communities to protect them from further development pressures. **Section 9.4** describes the five EECs which occur within the Port Stephens Foreshore Management Area. The majority of remaining areas of these EECs are highly fragmented from past clearing activities, and are further threatened by continuing fragmentation and degradation, impacts associated with urban stormwater, rubbish dumping, invasion of introduced species, clearing of understorey vegetation for bushfire protection, altered fire regimes and flood mitigation and drainage works.

10.5 Tree Poisoning

The poisoning of trees in foreshore areas by residents to retain water views is becoming a major issue along the majority of the southern foreshore of Port Stephens, on both private and council owned land. This is causing loss of mature trees important for habitat and foreshore stabilisation, as well as affecting the scenic amenity of the foreshore. Due to the difficulty in obtaining evidence against offenders, few people have been fined.

11.0 Current Management Actions Protecting Foreshore Biodiversity

There are a number of management activities currently in place which assist in the protection of biodiversity values, including those of the Port Stephens Foreshore area. These management activities include those that have been put in place by Port Stephens Council and also those put in place by the DEC. These management actions address many of the key threats identified in **Section 10.0**. The continued implementation of existing management actions will play a significant role in the conservation of the important foreshore environment. Some of the key management actions protecting foreshore biodiversity in Port Stephens are described in the following sections (**Sections 11.1 to 11.12**), however there are many others that have not been included here.

11.1 Tree Preservation Order

It is Council's undertaking to protect and preserve trees and bushland to retain habitats for native birds and animals, and to maintain the aesthetic value of our area.

Port Stephens Council has established a Tree Preservation Order, the intent of which is to retain trees and bushland to protect habitats and the aesthetic value of our area. The Tree Preservation Order prohibits the ringbarking, cutting down, topping, lopping, pruning, removing, injuring or wilful destruction of any tree or trees specified below except with the consent of Council. The order applies to all species of trees and shrubs on all land in the Port Stephens Council area (other than those referred to in the exemption) where:

- the girth of the tree or shrub exceeds 300 mm when measured 1 metre above the ground; and/or the height of the tree or shrub exceeds 3 metres;
- mangroves, NSW Christmas bush and cabbage tree palm regardless of height or girth; and
- all trees or groups of trees which have been listed in Council's Register of Significant Trees regardless of their height or girth.

11.2 Weed Management and Bush Regeneration

A number of introduced flora species have invaded the vegetation of the Port Stephens Foreshore area. Some of the more significant weeds include bitou bush (*Chrysanthemoides monilifera* subsp. *rotundata*), long-leaf willow primrose (*Ludwigia longifolia*), lantana (*Lantana camara*), gloriosa lilly (*Gloriosa superba*), asparagus fern (*Protoasparagus aethiopicus*) and myrtle-leaf milkwort (*Polygala myrtifolia*).

The Port Stephens Council bush regeneration program is addressing key areas of the foreshore requiring weed control works. Many of the reserves within the Port Stephens foreshore have specific Plans of Management which identify the major weed species and detail a proposed scope of works for the management of these. The scope of works outlined in the Port Stephens Council Bitou Bush Management Plan is being implemented on an ongoing basis throughout the Port Stephens LGA.

Biological control of long-leaf willow primrose (*Ludwigia longifolia*) has recently been trialled by Port Stephens Council, showing some success in the defoliation of young seedlings of the

weed. Further investigations into the potential use of this biological control in the management of *Ludwigia longifolia* will be undertaken.

The weed management program in Port Stephens is addressing many of the key issues, however, the extent of works undertaken is limited by the resources available. There is more scope for bush regeneration within Port Stephens, however, additional funding and resources would need to be acquired in order to expand the weed management program.

11.3 Port Stephens Comprehensive Koala Plan of Management

The Port Stephens Comprehensive Koala Plan of Management (CKPoM) provides a discussion of issues relating to the management of koalas and koala habitat in the Port Stephens LGA and recommended actions to address these issues. The Port Stephens CKPoM is consistent with the National Koala Strategy (ANZECC 1998) in that it seeks to conserve koalas in their existing habitat by identifying and protecting koala habitat and incorporating koala conservation into local government planning processes (Lunney et al 1998).

Any proposed developments within the Port Stephens LGA require assessment in accordance with the CKPoM. In the Port Stephens LGA, compliance with the CKPoM constitutes compliance under SEPP 44.

11.4 Fly Point – Halifax Aquatic Reserve

Fly Point Halifax Park Aquatic Reserve was declared in 1983 under the Fisheries Management Act 1994 and covers an area of about 70 hectares between Nelson Head and Fly Point. It extends 500 metres seaward of the mean high water mark. The marine environment is diverse and includes steep submarine cliffs, rocky reefs, and a sandy channel with extensive seagrass beds. According to DPI (Fisheries), marine fauna includes seahorses, pipefish, pygmy leatherjackets, small wrasses, tiny gurnards, flatheads, molluscs, urchins and nudibranchs. Sponges, soft corals, ascidians, hydroids and tunicates occur in deeper waters. Juvenile tropical fish inhabit the area during summer months.

11.5 Coastal Weeds Action Group

The NPWS is part of the Coastal Weeds Action Group along with Port Stephens Council, Department of Lands and local community groups. This group, with support from a Natural Heritage Trust grant, is working to implement a management strategy to encourage the coordinated control of bitou bush and other weeds in the Port Stephens area.

11.6 Wetland Identification and Prioritisation Study

The Port Stephens Wetland Identification and Prioritisation Study (Eco Logical, 2005) was undertaken to develop a classification and prioritisation system for wetlands within the Port Stephens LGA. This study resulted in the development of a GIS database and map of wetlands in the LGA, an Access database storing information about the wetlands in the LGA, a wetlands classification methodology and a prioritisation system (Eco Logical, 2005). The Study provided recommendations on the conservation priority of the different wetland classifications, using criteria which can broadly be defined as: statutory value, landscape conservation value, conservation value (flora and fauna), condition and threat assessment.

The Port Stephens Wetland Identification and Prioritisation Study should be considered for any development proposed to disturb any wetland areas within Port Stephens.

11.7 Council Reserve Plans of Management

A number of Plans of Management for individual reserves have been prepared, which include:

- Shoal Bay Foreshore Management Plan and Landscape Strategy;
- Soldiers Point Plan of Management;
- Mambo Wetland Plan of Management; and
- Tilligerry Creek Catchment Plan.

As detailed in **Section 8.12.3** of the Foreshore Management Plan, there are several reserves for which the preparation of detailed plans of management are recommended. The detail of what these plans should include is also provided in that section.

11.8 Significant Tree Register

Port Stephens Council maintains a Significant Tree Register (STR), which has been established to facilitate the protection of important trees which have values such as aesthetic, social, historic, ecological, landscape, recreational or cultural. Any person can make a nomination for a tree to be added to the STR, and trees occurring on private or public land can be nominated.

The identified criteria for listing a tree under the STR are:

- i) Historical value;
- ii) Contribution to landscape/townscape;
- iii) Commemorative tree;
- iv) Belonging to historic building/garden/park;
- v) Exceptionally old or fine specimen;
- vi) Curious growth habit or physical appearance;
- vii) Horticultural/scientific value;
- viii) Unusually large size;
- ix) Rare to the area;
- x) Outstanding aesthetic quality;
- xi) Valuable corridor or habitat; and
- xii) Indigenous cultural significance.

In recognition of the importance of the presence of mature trees within the foreshore environment, both for aesthetic and for ecological values, this Plan of Management strongly encourages the continued recruitment of trees to the STR. It is also recommended that initiatives are implemented to educate the community on what the STR is, how they can make nominations for listings on the register and the implications of having a significant tree listed on private land. This is an important way that the ecological and aesthetic values of the foreshore can be protected on private land.

11.9 Recovery Plans and Threat Abatement Plans

Under the TSC Act, the Department of Environment and Conservation (DEC) is required to prepare a recovery plan for all listed threatened species. Recovery Plans set out management actions, agreed upon by government departments and other organisations, the aim of which are to return the species, population or ecological community to a point where their survival is viable in nature. Recovery Plans relevant to this Plan of Management include the Recovery Plan for the Hawks Nest and Tea Gardens Endangered Koala Populations (NPWS 2003) and the Draft Recovery Plan for the Koala (*Phascolarctos cinereus*) (NPWS 2003).

The DEC is responsible for the preparation of Threat Abatement Plans for any key threatening process listed under the TSC Act. Threat Abatement Plans outline actions to manage key threatening processes and identify how the success of these actions will be assessed. Threat Abatement Plans relevant to this Plan of Management include the Draft Threat Abatement Plan for Invasion of Plant Communities by bitou bush/boneseed (DEC 2004) and the Threat Abatement Plan for the Plague Minnow (*Gambusia holbroki*) (NPWS 2003).

11.10 Mambo Wetland Plan of Management

The Mambo Wetland Plan of Management (Port Stephens Council 2006) refers to Mambo Wetland Reserve in Salamander Bay. The Plan of Management aims to develop a framework for the future management of the wetland to conserve its important natural values, whilst ensuring that the interests and safety of the community are protected. The Plan proposes 30 actions addressing a range of different management issues, the implementation of which is to be achieved jointly by Council staff, members of the community and other external stakeholders. Some of the issues covered in the proposed implementation plan include weed management, stormwater and hydrology issues, fauna management, public use and access issues, protection against development, foreshore erosion and fire management.

11.11 Seagrass Monitoring

Survey of seagrass beds in Port Stephens is currently being undertaken by a University of Newcastle student, through a partnership with Port Stephens Council and NSW Fisheries. This will result in the establishment of detailed, up-to-date baseline information on the distribution of seagrass beds in the Port which can be used for future monitoring and assessments in relation to seagrass beds.

12.0 Identified Management Actions for High Priority Conservation Areas

Twelve areas of high conservation significance have been identified within the Port Stephens Foreshore area. These areas are considered to be of high significance because they support large, intact areas of significant ecological features such as endangered ecological communities, habitat for threatened species, significant wetland areas (such as saltmarsh, seagrass, mangrove) or important roosting areas for shorebirds. Each of these high conservation significance areas are listed in **Table 12.1** below, which provides a summary of the significant features, and identifies the current land zoning of these areas.

Some of these high conservation areas are already protected in a National Park, Nature Reserve or other NPWS estate, however there are some areas which remain in private ownership. In light of this, the conservation of the ecological values of these areas will be dependant on future planning decisions in relation to that land. These high conservation areas should be given special consideration in planning policies and development applications. Existing legislation already protects many of the features of high conservation areas, for example SEPP 14 protects significant wetlands, the *Threatened Species Conservation Act 1995* requires consideration be given to threatened species, populations and ecological communities and their habitat during the Environmental Assessment (EA) process and SEPP 44 provides protection to koalas and their habitats.

Although many of the ecological values of these high priority conservation areas are afforded protection under current management actions, however, there are several areas in which specific management actions have been identified to further protect these values. Identified management actions for each of the high priority conservation areas are provided in **Table 12.1**.

Table 12.1 – Management Recommendations for High Priority Conservation Areas

No.	High Significance Area	Land Zoning	Key Features	Management Actions
1	Bagnalls Beach Reserve	6(a)	<ul style="list-style-type: none"> – Swamp oak floodplain forest EEC. – Preferred koala habitat. – Seagrass beds. – Significant linear strip of foreshore vegetation connecting Corlette Point Reserve to Fly Point Reserve. 	<ul style="list-style-type: none"> – Consider rezoning to 7(f1) Environmental Protection (Coastal Lands). – Preparation of a Plan of Management to co-ordinate the undertaking of bush regeneration and habitat enhancement activities specific to this reserve. – Undertake regeneration activities to increase habitat values. – Manage recreational uses to minimise disturbance to vegetation.

**Table 12.1 – Management Recommendations for High Priority
Conservation Areas (cont)**

No.	High Significance Area	Land Zoning	Key Features	Management Actions
2	Fly Point Reserve	6(a)	<ul style="list-style-type: none"> – Swamp Sclerophyll Forest EEC. – Preferred koala habitat. – Relatively large foreshore remnant in an otherwise developed area. 	<ul style="list-style-type: none"> – Consider rezoning to 7(f1) Environmental Protection (Coastal Lands). – Undertake regeneration activities to increase habitat values. – Consider the development of a Scope of Works to prioritise management actions. – Manage recreational uses to minimise disturbance to vegetation.
3	Mambo Wetlands Reserve	7(a)	<ul style="list-style-type: none"> – SEPP 14 wetland. – One of few remnants of freshwater wetland EEC in Port Stephens. – Swamp Sclerophyll Forest EEC. – Significant wetland area. – Seagrass beds. 	<ul style="list-style-type: none"> – Continue to implement and monitor management actions set out in the Mambo Wetland Plan of Management. – Manage recreational uses to minimise disturbance to vegetation.
4	Stoney Ridge Reserve	6(a)	<ul style="list-style-type: none"> – Preferred koala habitat areas. – Swamp Sclerophyll Forest EEC. – Relatively large reserve protecting a continuous remnant of foreshore vegetation. 	<ul style="list-style-type: none"> – Currently afforded protection under 7(a) Environmental Protection land zoning. Consider rezoning to 7(f1) Environmental Protection (Coastal Lands). – Preparation of a plan of management to co-ordinate the undertaking of bush regeneration and habitat enhancement activities.

Table 12.1 – Management Recommendations for High Priority Conservation Areas (cont)

No.	High Significance Area	Land Zoning	Key Features	Management Actions
5	The entire foreshore of Cromartys Bay	1(a)	<ul style="list-style-type: none"> – SEPP 14 wetland. – Preferred koala habitat. – Coastal saltmarsh EEC. – Swamp Sclerophyll Forest EEC. – Significant areas of important shorebird roosting habitat. – Significant wetland habitat. 	<ul style="list-style-type: none"> – Mud Point and southern margin of Cromartys Bay: acquisition and rezoning from 1(a) Agriculture to 7(f1) Environmental Protection (Coastal Lands). – Removal of any stock-grazing activities from foreshore area and from sensitive habitats such as saltmarsh. – Consider the development of a Scope of Works to prioritise management actions.
6	Foreshore of Mallabula including Mallabula Point		<ul style="list-style-type: none"> – Significant preferred koala habitat area. – Swamp Sclerophyll Forest EEC. – Important foreshore remnant in an area where much of the foreshore vegetation has been developed. 	<ul style="list-style-type: none"> – Manage recreational uses to minimise disturbance to vegetation. – Undertake regeneration activities where appropriate to increase habitat values.
7	Tilligerry Nature Reserve and Tilligerry Creek	6(a), some areas of 1(a)	<ul style="list-style-type: none"> – SEPP 14 wetland. – Preferred koala habitat. – Coastal Saltmarsh EEC. – Significant areas of important shorebird roosting habitat. 	<ul style="list-style-type: none"> – Rezone from 6(a) General Recreation to 7(f1) Environmental Protection (Coastal Lands).
8	The foreshore of Twelve Mile Creek	Mostly 5(a), with small areas of 7(a). In the upper, scattered 1(a)	<ul style="list-style-type: none"> – SEPP 14 wetland. – Preferred koala habitat. – Swamp Sclerophyll Forest EEC. – Coastal Saltmarsh EEC. – Areas of important shorebird roosting habitat. – Significant wetland habitat. 	<ul style="list-style-type: none"> – Implement management actions outlined in the Tilligerry Creek Catchment Management Plan.

Table 12.1 – Management Recommendations for High Priority Conservation Areas (cont)

No.	High Significance Area	Land Zoning	Key Features	Management Actions
9	The foreshore of Reedy Creek (Worimi Nature Reserve)	7(a) mostly, with 1(a) in upper parts.	<ul style="list-style-type: none"> – SEPP 14 wetland. – Significant areas of saltmarsh and mangroves. 	<ul style="list-style-type: none"> – Incorporation of the foreshores of Reedy Creek (currently crown land) into Worimi Nature Reserve.
10	The entire area of the northern foreshore from Karuah to Hawks Nest	Largely 7(a), with some 2(a), 7(b), 8(a)	<ul style="list-style-type: none"> – Significant, continuous foreshore vegetation. – Significant areas of seagrass beds around foreshore. – Areas of SEPP 14 wetland. – Areas of coastal saltmarsh EEC. – Several threatened species records. – Significant areas of important shorebird roosting habitat. – Important koala habitat areas. 	<ul style="list-style-type: none"> – Investigate areas with potential to acquire land for rezoning as 7(f1) Environmental Protection (Coastal Lands). – Encourage private land owners to enter into conservation agreements to protect foreshore vegetation. – Establish guidelines for foreshore buffer zones to protect against future developments.
11	Corrie Island Nature Reserve	7(a)	<ul style="list-style-type: none"> – SEPP14 wetland. – Coastal Saltmarsh EEC. – Mangrove and saltmarsh habitat. 	<ul style="list-style-type: none"> – Currently protected and managed under NPWS estate – no further protection considered necessary at this point in time.
12	Myall Lakes National Park	8(a)	<ul style="list-style-type: none"> – SEPP 14 wetland. – Extensive areas of saltmarsh/ mangrove habitat along the Myall River. – Important koala habitat areas. 	<ul style="list-style-type: none"> – Currently protected and managed under NPWS estate – no additional protection considered necessary at this point in time.

13.0 Whole of Foreshore Management Actions for Protection of Biodiversity

Section 12.0 identifies management actions for specific areas of the Port Stephens foreshore. This section identifies those management activities which relate to the whole of foreshore, rather than specific areas. These management actions have been established with the view to encourage the ecological sustainable use of the foreshore, promote recreational activities whilst minimising the impact on the foreshore by community use.

13.1 Protection of Shorebird Roosting Habitat

As discussed in **Section 9.9**, disturbance to resting shorebirds by human activities is recognised as a major issue in the conservation of shorebirds (DEH 2005a), as it increases their energy expenditure. Given that a large proportion of the foreshore of Port Stephens is utilised by humans for recreation or other purposes, it is difficult to manage human disturbance. Although developments that have already occurred cannot be reversed, the location of important shorebird roosting habitat should be considered for any future developments in the Port Stephens Foreshore.

In Port Stephens, infrastructure associated with the derelict oyster leases provide important high tide roosts for shorebirds. Due to their significance as habitat for shorebirds, old oyster leases and emergent posts should be retained until alternative roosting options are available.

A further threat to shorebird habitat is the invasion of mangroves into saltmarsh communities. This is occurring due to a number of factors such as changes to natural hydrology and also increases in sediment along the foreshore. It is important to recognise which areas around the Port are experiencing significant mangrove encroachment, and consequently undertake preventative and remediation measures where necessary. The removal of mangroves should only be undertaken after thorough analysis of the site, as it can cause foreshore erosion if not conducted properly. A program for removal of mangroves to protect the saltmarsh of Tilligerry Creek is set out in the Draft Tilligerry Creek Catchment Management Plan (Earth Tech 2006).

13.2 Tree Planting in Parks and Reserves

Many of the parks and reserves along the foreshores of Port Stephens currently support large, mature trees which provide both scenic and habitat values. In some areas there is no recruitment of younger trees occurring due to routine mowing of the understorey. Consequently, when the existing trees become old and dangerous and need to be removed, there will be no trees already established to take their place.

In order to plan for the future loss of scenic trees in foreshore parks and reserves, it is recommended that plantings of suitable canopy trees be undertaken in appropriate locations. The provision of trees for habitat should be a consideration in the selection and positioning of trees. Initiatives to encourage residents to plant local tree species on private land should also be considered.

13.3 Encourage Native Planting on Private Property

There are many areas of the Port Stephens foreshore which are privately owned, particularly along the northern foreshore. It is recommended that Council pursue initiatives to encourage

private land holders to establish native plant species, enhancing the habitat values of the foreshore.

In order to assist private land holders in choosing the right species, Council should develop a planting guide, detailing suitable species for planting in particular, environments, including foreshores. The planting guide should also provide information on local nurseries that supply locally native plant species.

13.4 Encourage Soft Engineering Solutions for Foreshore Erosion

Foreshore erosion in Port Stephens is often addressed using 'hard' engineering solutions such as sea walls, which provide no habitat value and often impact on nearshore seagrass beds. Where possible, these 'hard' engineering solutions should be replaced with 'soft' alternatives, such as the re-establishment of native vegetation which protects the foreshore against soil erosion. The establishment of foreshore vegetation in areas not currently affected by erosion can also assist to protect against future erosion.

13.5 Conservation Agreements

Conservation agreements allow for landholders to ensure the protection of important biodiversity features of their land, and to gain assistance with the management of these important features. There are a number of forms of conservation agreements, including Voluntary Conservation Agreements, Wildlife Refuges and Property Vegetation Plans. These three types are discussed in further detail in the following sections. It is strongly recommended that Council seek to encourage and provide incentive for landholders of significant parcels of land to enter into a Conservation Agreement, particularly along the northern foreshore, where the majority of land is privately owned. It has been recommended that Council seek to acquire land on the northern foreshore, and rezone that land for conservation purposes. Where this is not an option, a Conservation Agreement on the private land may be an alternative to provide protection of foreshore biodiversity values.

A property vegetation plan has been prepared for Mambo Wetland Reserve, the agreement being between the CMA and Port Stephens Council. The plan protects the biodiversity values of the reserve, and has enabled funding to be sought for weed management.

13.5.1 Voluntary Conservation Agreements

A Voluntary Conservation Agreement (VCA) is a joint agreement between landholders and the Minister for the Environment which provides permanent protection for special features of the land. The area under the agreement is registered on the title of the land ensuring that if the land is sold, the agreement and management requirements remain in place. Owners of freehold land, lessees of Crown land and local councils are eligible to enter into these agreements, and may be eligible for rate relief and tax deductions as an incentive for entering into the agreement. The agreement can apply to the whole of the land, or parts of the land that contain special features of significance.

Landholders of VCAs have access to assistance from the NPWS, who offer services such as property management planning advice, biodiversity surveying and assessment assistance, information and practical advice about conservation management strategies, links and contacts with like minded people, notes and news on particular management issues and ecology, signs, access to education programs and activities and assistance programs to support implementation of management plans. Financial assistance may also be provided to assist with the implementation of actions outlined in the management plan for the VCA.

Voluntary agreements result in significant conservation outcomes on private land where management is often difficult to regulate and conservation cannot usually be certain. This ensures that significant biodiversity features are conserved in the future, and that important management actions are being implemented to protect and enhance these features.

13.5.2 Wildlife Refuges

Wildlife refuge declarations enable landholders to nominate part or all of a property where the land has native wildlife values and will be managed for this purpose. With whole property management, landholders can continue to include agricultural and other land uses with the conservation of wildlife.

With assistance from the NPWS staff, a property report and management plan is prepared outlining a scheme of operations. These plans are tailored for each property, ensuring that other property management objectives can be achieved while improving and maintaining native wildlife protection and conservation. A wildlife refuge declaration is free and has flexibility, with options enabling landholders to change the Wildlife Refuge status as required.

13.5.3 Property Vegetation Plans

A property vegetation plan is a voluntary but legally binding agreement, under the *Native Vegetation Act 2003*, between the landholder and the local Catchment Management Authority. A property vegetation plan will clarify what can be done with native vegetation on a property and give certainty that the agreement will continue for the period of the plan. The clearing provisions of a property vegetation plan last for up to 15 years.

A property vegetation plan has the following benefits:

- provides long term security so that native vegetation on a property can be better managed for both financial and environmental outcomes;
- provides clearing provisions that last up to 15 years, reducing the need for repeated development applications;
- provides the basis for providing financial support to farmers to improve the condition of native vegetation on their property;
- provides consistency between agreed management actions on a property and priorities in the local Catchment Action Plan; and
- provides clarification for existing use.

14.0 Conclusion

As identified in this report, the Port Stephens foreshore supports significant biodiversity values, including threatened flora and fauna species, endangered ecological communities, SEPP 14 wetlands, important shorebird roosting habitat and important aquatic habitats such as seagrass, saltmarsh and mangroves. As a consequence of past land use practices, a large extent of the original foreshore vegetation and habitats have been cleared or modified. Consequently, much of the remaining foreshore biodiversity has high conservation significance, and must be appropriately managed such that it is protected in the long term.

There are currently a number of management actions in place which protect the foreshore biodiversity, some of which are described in **Section 11.0**. Although there are a number of management actions in place, it has been identified that there are several areas within the Port Stephens foreshore which require additional, more specific management actions. Recommended management actions for these areas have been detailed in **Section 12.0**. In addition, a number of management actions relevant to the whole foreshore have been identified, which are detailed in **Section 13.0**.

A co-ordinated approach involving the implementation of current and recommended management actions is required to ensure the protection of important biodiversity values of the Port Stephens Foreshore, while still functioning to provide recreational values. The management of the foreshore should be regularly reviewed in order to take into consideration new issues, and to incorporate new technologies and ideas in relation to the foreshore management for the protection of biodiversity.

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STUDY 2

Aboriginal Cultural Heritage

Port Stephens Council

Port Stephens Foreshore Plan of Management - Aboriginal Cultural Heritage

August 2009

Port Stephens Foreshore Plan of Management - Aboriginal Cultural Heritage

Prepared by
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1	Summary of Available Archaeological Reports
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1.0 Introduction

The Port Stephens foreshore falls within the boundaries of the Worimi Local Aboriginal Land Council (WLALC), the Worimi Traditional Aboriginal Elders and Owners Group (WTAE&OG), and the Karuah Local Aboriginal Land Council (KLALC). This report presents the known Aboriginal archaeological and cultural context of the shoreline.

Numerous indigenous heritage sites occur along the Port Stephens foreshore. The majority of previously recorded sites are middens/artefact scatters close to the estuary foreshore and the major creeks that flow into the estuary, including the Karuah River. Scarred trees and rock shelters with deposits and with art have also been recorded. These sites are highly significant to the local Aboriginal community. Additionally, there are many locations associated with cultural stories, and places/resources of historical interest to members of the local Aboriginal community.

The relationship between Aboriginal people and the economic and spiritual resources provided by the land is not restricted to the physical evidence of Aboriginal occupation. This report also evaluates the resources (stone, water, food and medicine, shelter) that the area provided for its Aboriginal inhabitants, as well as any ceremonial, spiritual and totemic associations that past and contemporary Aboriginal communities had or have to the land.

2.0 Project Objectives and Methodologies

The assessment of Aboriginal cultural heritage issues relevant to the management of the Port Stephens foreshore was undertaken in two stages. The first stage involved the identification of issues through:

- A search of the DEC Aboriginal Heritage Information Management System (AHIMS). This provided a list of all previously recorded Aboriginal objects and places in the foreshore area, as well as a reference to documents reporting the results of cultural heritage surveys undertaken in the area. A map (and GIS layer) of Aboriginal objects/places and previously surveyed areas was generated.
- Literature review of all available cultural heritage reports relevant to the foreshore area.
- A search of the National Native Title Tribunal Registers and a search to identify all Aboriginal Land Claims under the *Aboriginal Land Claims Act 1983*.
- Landscape analysis that identified major landscape types, major soil landscapes, geological boundaries, and the location of previously recorded sites, and the location of resources likely to have been utilised by traditional Aboriginal people.
- Consultation with the Aboriginal community to identify: cultural heritage issues relevant to each community, gaps in cultural heritage knowledge, cultural heritage information ownership and management issues, the objectives of each community with regard to claims under the *Aboriginal Land Rights Act 1983*, and appropriate field survey methodology.

The second stage involved data collection and analysis. The field survey involved targeted investigation of the foreshore to determine where Aboriginal heritage sites, resources and important places are located, the condition of these places, and the types of impacts/processes that are threatening them. The criteria for determining the location of targeted field survey included:

- site types that appear to have been heavily impacted by land use (the status of the numerous middens and artefact scatters located within residential and recreational areas within the foreshore zone needed to be clarified);
- sections of the foreshore underrepresented in terms of systematic survey coverage;
- areas which have the potential to be affected by development/recreational impacts;
- areas which are and have the potential to be impacted by natural processes such as erosion;
- areas managed for conservation that contain Aboriginal heritage sites; and
- areas identified by the Aboriginal community as requiring further investigation or more effective management.

3.0 Ethnographic Context

Information regarding Aboriginal population, occupation and lifestyle in the Port Stephens area is limited. The available ethnographic observations of Aboriginal people in the early contact period come from early European settlers, surveyors and explorers, and any bias inherent in their observations must be taken into account when reading and reviewing the available literature.

3.1 Tribal Affiliations

Sokoloff (1980:1) identifies the Port Stephens area as belonging to the Worimi tribe. Within this linguistic group there were at least four or five hordes (clan groups). According to Sokoloff the Worimi territory extends from the Hunter River in the south, Barrington Tops in the west, and to the Myall Lakes in the north (1980:3). Tindale's tribal boundary information situates the Worimi land as stretching from Forster in the north to Raymond Terrace in the South and west to Maitland and Martins Creek (Tindale, 1974 in Navin Officer, 1999:22). Sokoloff reports that the Worimi maintained social and ceremonial relations with neighbouring tribes (the Wannarua to the west, the Geawegal and Kamilaroi to the north-west, the Birpai to the north, the Pambalong, Awabakal and Garuagal to the south, and the Darkinjung to the south-west).

3.2 Population

There is little documented evidence of the Aboriginal population in the Port Stephens area, or throughout the Hunter Valley region more generally, prior to European settlement. One of the earliest official records of population numbers is the register taken at various stations during the annual distribution of blankets. This register, however, only provides a partial indication of population numbers as not all residents of the area would turn up and others would turn up at a couple of different stations and thereby be counted twice. In 1834, the

blanket distribution record of the Port Stephens area registered 538 men, women, and children; 206 in 1838; and 337 in 1839.

The following observations give some further indication of the indigenous population prior/just after contact:

Barralier (1802:81) in his investigations of the lower Hunter in 1801 writes that there were 'great numbers' of Aboriginals in that area, based on the many canoes he observed.

Ebsworth (1826:58) writes of an Aboriginal camp at Port Stephens, comprising 20 or 30 fires, each tended by a group of four or more people. He also writes:

'...the tribe of natives belonging to Port Stephens amount to nearly two hundred men, women and children.'

Dawson (1830:327) writes:

'The numbers of each tribe vary very much, being greater on the coast, where they sometimes amount to two or three hundred, and I have known them in other quarters not to exceed one hundred.'

The early missionary Threlkeld, 1837 (in Gunson 1974) observes that:

'The various tribes at Port Stephens and its vicinity contain about 500 blacks; Hunter's River and its dependencies having about 300, and other contiguous tribes consisting of about 200 more.'

Mr William Scott, who was born at Carrington in 1844, and whose father, John Scott, was employed by the Australian Agricultural Company on their Port Stephens Holdings, estimated the population of the local tribe, which he referred to as Gringai¹, to number about 100 during his youth. By 1872 this number had halved (Scott, 1929:13). The Aborigines Protection Board reported in 1890 that 48 Aborigines lived in the Port Stephens area (Navin Officer, 1999:23), which would corroborate Scott's account of a declining indigenous population.

3.3 Ceremonial Life

Scott's account of the local Aboriginal life extended to useful information in relation to certain sections of the male initiation ceremony that he was allowed to view, or that he viewed inadvertently by stumbling upon by accident. He relates that when the boys were deemed ready for initiation (sometime in adolescence) they would be segregated in preparation for the ceremonies. As a young boy himself, Scott was allowed to see one ceremony, known in the Port Stephens area as the 'poombit', but more generally as the 'bora'. He describes the Poombit ground as follows:

'On the flat there was an oval cleared space with a banked up margin, and in the centre of it a heaped-up conical shaped fire. The gins who played a part in the ceremony were made to lie down around the edge of the oval, although whether within or outside the defined ring I am not able to say with certainty.' (Scott, 1929:28-29)

At a later date Scott witnessed another part of the initiation ceremony, which was taking place about 'half a mile' from the area where he had witnessed the previous ceremony. The ceremony took place at the foot of a hill:

¹ Scott identifies the Aboriginal people of the Port Stephens /Carrington area as the Gringai tribe: *A sub-branch of numerous native people that once inhabited the lower portions of the Hunter and Karuah River valleys.* (Scott, 1929:1)

'From my point of observation I beheld a conical fire burning in the midst of a cleared space [a round oval some 30 or 40 square feet in area]...About this fire, and in a line radiating from the centre like spokes of a wheel, were a number of naked blacks, their heads bowed to earth. Their bodies were painted in grotesque patterns so that they resembled weird and wonderful skeletons. Within the cleared space, and on one side of it was a crude wooden effigy, coloured vividly with some red pigment, having a cross-piece for arms, and a striking head-dress of grass and bark similar to the pattern used by the blacks when stalking kangaroos.'

Scott returned the following day, under invitation, to watch the finish of the ceremony. He witnessed about 200 men rushing down the hillside from the top of the hill and making loud noises. Scott refers to the visiting Aborigines as 'up-country blacks' (1929:31) suggesting that the 'poombit' ground in this area was an important ceremonial place attended by more than one tribe (Umwelt, 2003:4.2).

Scott's reminiscences also provide a description of the practice of cicatrisation (scarring):

'I have been told that circumcision was practised among the coastal blacks in the early days, but during my time at Port Stephens this was never part of the ceremonies, nor was it ever the custom to knock out one of the front teeth of the initiates, although this was done in the early twenties when the A.A. Company first established itself on the shores of the harbour. Mutilation of the arms and chest was not practised at the 'poombit' ceremonies, although men and women usually had repellent cicatrices on arms and torso, caused by gashing with shells or knives. These disfigurements were regarded as personal adornment more than anything else and seemed to have no particularly significant in any other respect.'

Contrary to Scott's remark that the scars were only for adornment, cicatrisation is now widely known to have been associated with the rites of passage of a child to adulthood and to be part of the initiation process.

'Scars were made on the body for many reasons, but mainly during ceremonies to mark age, initiation, or to raise a person's status. Techniques varied from place to place, but scarification (or cicatrisation) usually involved cutting the skin with a sharp shell or rock, then rubbing irritating substances like ash into the cuts so that prominent keloid scars resulted (Horton, 1994:137)

Individuals received their first cicatrices at puberty or earlier, and scars were gradually added until they reached adulthood....Cuts were made with sharp stones or shells and more recently with glass flakes (Horton, 1994:195).'

Aboriginal oral history provides further information on the ceremonial life of the Aboriginal occupants of the area. Les Ridgeway, Elder, of the Worimi Traditional Aboriginal Elders and Owners Group recalls how the:

'...whole area around both North Arm Cove and Tahlee/Carrington has always been a very special place to us older Aborigines who ancestors were initiated in this area.

When Robert Dawson established the area as the first base for the A.A Company, who brought the first shipment of merinos to Australia, he found many of our Aborigines camped in the area. Both North Arm Cove and Tahlee were once rich in tree markings also canoe trees...'

Mr Ridgeway speaks of the North Arm Cove Stone Arrangements as 'a very spiritual place':

'This was not an initiation ground. It was one of a number of places that the young boys were taken during their initiation. The initiation ground was somewhere else. This place was a discipline place.....Part of what they did up here was the cuts on the chest, on the arms and on the back. Not all of the cuts would be done at the same time....Can you

imagine being cut across with shell knife. After the first cuts and the boys were made into men during the initiation process, they would come back many times to this place over their life to get more cuts.

I believe the spirit was telling me that this is a Men's Place and that women should not be here. (Les Ridgeway quoted in Umwelt, 2003:6.2-6.3).'

Steve Brereton a NSW NPWS Aboriginal Field Officer provides this further information about the stone structures and male initiation:

'I was told by the Elders that Aboriginal mothers would take the young boys, when they were about 12 or 13 years old, and put them down inside the stones walls, tell them to lay down and not move no matter what they hear, then completely covering them with leaves or bark. The women left the boys there until the men came (this would be days later), and took them away for ceremonies. This was a symbolic gesture where the mothers handed over the boys to the men, so that they could be made into men (Steve Brereton quoted by Ridgeway quoted in Umwelt, 2003:6.4).'

3.4 Relationships with Europeans

The first European settlement in the Port Stephens area occurred when the Australian Agricultural Company (AACo) selected a million acres that stretched from the northern shore of Port Stephens to the Manning River. The AACo established its headquarters at Carrington in 1826. The original intention was to use the land for sheep grazing, however, this was not a suitable activity for the type of land selected and a variety of other agricultural activities were attempted. During the period of its operation in the Port Stephens area, the AACo employed members of the local Aboriginal community as stock workers and couriers (Navin Officer, 1999:23). Hannah (2002) reports:

'The total number of Aborigines living adjacent to pastoral runs at Port Stephens was about 100. The highest level of Aboriginal participation in the corporation after 1833 was in the period from 1856 to 1857 when at least 11 workers were employed. The lowest level of involvement was in 1840 when only three Aborigines worked for the Company. The participation of Aborigines in the Company ranged from about one to 30 per cent of the indigenous populations near pastoral runs. Thus the majority of indigenous people on or adjacent to the estates did not depend significantly on the new employer. Also, Aboriginal people living adjacent to the estates, but independent of the Company, persistently fought against the incursion of Europeans onto their lands for the entire period of this study [1824 to 1857]. The impact of European colonisation on the ecological bases of the Aboriginal economies was insignificant in forcing Aboriginal people generally to seek employment with the Australian Agricultural Company in this period.'

Hannah's report then goes on to reveal that the chief agent of the AACo, Robert Dawson, treated the Aborigines well:

'Atchison stated that 'Dawson's humane and liberal attitude towards the Aboriginal inhabitants of Port Stephens was evident from the beginning 'and that he [Dawson] found the Worimi friendly to his approaches. However a policy of intimidation with firearms was implemented from the beginning at Port Stephens. Resistance to the demands made by the company was countered in a retributive way. Dawson employed Aborigines only on the condition that they disarm. The Company did not use sustained physical force against Aboriginal people. The Company tried to capitalise on Aboriginal fears and expectations about violence. Aboriginal people initially sought employment in the Australian Agricultural company because Dawson extended an offer to 'protect' them from hostile elements in colonial society.'

The ethnographic information provided by Navin Officer (1999) indicates that this policy of intimidation and deterioration of relationships occurred with the replacement of Dawson with Edward Parry. As a result, the 1830s saw an outbreak of violence, including acts of retaliation by both Aboriginals and the police, and the abduction of Aboriginal women. In about 1840, armed soldiers killed 11 Aboriginals during the process of recovering a white child, which the Aboriginals had abducted from Stroud (Rich, 1992:79 in Navin Officer, 1999:23).

Aboriginals also found employment outside the AACo in the area of farming, fencing, oystering, fishing, timber getting, and possibly at the Alicetown mill (Navin Officer, 1999:23-25). After the closure of the mill in 1891 it seems that an Aboriginal settlement/reserve of 40 acres was established on the western side of the Karuah River sometime between 1884 and 1894 (Kilkelly, 1966:50 in Navin Officer, 1999:24). The Aboriginal children at the settlement attended the school by crossing the river in a row boat supplied by the Aboriginals Protection Board (Navin Officer, 1999:23-24). Both black and white children at this time were educated together although it is reported by Annie McLennan, a teacher at the time, that this co-education was causing friction among the parents (KCC, 1984:13 in Navin Officer, 1999:24). In 1908, Aboriginal children were excluded from the school and they received no official education until 1916 when the Aboriginals Protection Board built a separate school at Karuah for Aboriginals only (KCC, 1984:31 in Navin Officer, 1999:25).

It appears that Christian missionary influence reached the Aboriginal reserve from about 1905, at which time it was reported that a significant number of Aboriginal people had converted to Christianity (Navin Officer, 1999:24).

4.0 Cultural Heritage Resources

4.1 Food Resources

Navin Officer (1999:23) relates that the Aboriginals around Carrington in the late 1840s were 'still living a largely traditional lifestyle'.

The Port Stephens environment would have provided indigenous inhabitants with a rich and varied source of marine, terrestrial and wetlands foods. Sokoloff reports that marine resources, such as fish and oysters, dominated the Worimi diet, and that terrestrial food resources were supplementary (Sokoloff, 1980:6). Food was exploited according to its abundance and seasonal availability. The marine resources decreased in accessibility and abundance over winter but other food sources such as kangaroos, goannas, snakes, birds, flying foxes and possums (which were a delicacy), along with plant foods, such as the stalks of the gigantic lily (*Doryanthes excelsa*), fern roots, a species of yam called a 'wombie', and a fruit called 'curramah' were also available (Sokoloff, 1980:6). The juice of the grass tree, (*Xanthorrhoea* spp.) and the bloom of the banksias were consumed for their sweetness (Sokoloff, 1980:6). Honey and insects also formed a part of the Worimi's diet.

William Scott's reminiscences of Aboriginal lifestyle and customs in the Port Stephens/Carrington area during the 1840s to 1873 indicate that wild game was abundant:

'... [the harbour] was teeming with game of all description ... It was really a land of plenty.'
(Scott, 1929: 20)

'The foreshores were covered with oysters, which formed a staple part of the diet. The bush abounded with game in the form of kangaroos, wallabies, possums, emus, flying foxes, wild duck, swans, parrots and pigeons. It required little effort to keep the communal larder filled to repletion.'
(Scott, 1929:17).

'The possum was also esteemed a great delicacy... Snakes were greatly esteemed their flesh when roasted, being beautifully white and apparently very tasty. As they were fairly plentiful in the bush they were often on the menu.' (Scott, 1929:21).

'The kangaroo was in the middle decade of last century, the favourite food of the blacks. The marsupials ran in large mobs, easily driven by the nimble natives to a point where waiting groups could spear them with ease.' (Scott, 1929:20).

'There was a marvellous variety of fish in the harbour in those days...porpoise, shark, turtle, schnapper, jew fish, mullet, bream, stingray, torpedo fish, eel, flathead, oysters, cray-fish, crab, shrimp.' (Scott, 1929:20).

'Birds were easily secured and were an abundant part of the daily meal...One of the most fancied foods was the flying-fox...[which] roasted properly in the aboriginal fashion, proved quite tasty.' (Scott, 1929:23).

Another early observer writes with regard to the kangaroo hunt:

'... I have seen them take their game in this manner in large quantities. They form themselves in a line, and move forward, shouting and driving the kangaroos before them: the two extremes of the line are gradually drawn in, until the kangaroos find themselves enclosed in a nook, with the bend of a river, or some other obstruction, in front of them. The natives then closing upon them, the slaughter commences, and the greater part, if not the whole of their game, is secured.' (Dawson, 1831:182)

Dawson also makes the following observation regarding the hunting of possums:

'...the hunter located the possum by the presence of claw marks on the trunks of trees. The hunter then climbed the tree by using his hatchet to cut notches in the tree as he went to act as toe holds. When he got in reach of the possum it was pulled from the tree and killed with a blow of the axe to its head.' (Dawson, 1831:238).

Backhouse (1843) and Dawson (1830) both describe the consumption of flying foxes at Raymond Terrace and Myall Lakes. Sokoloff writes:

'...flying foxes were caught by tugging down vines and branches or by being speared' (Sokoloff, 1980:9).

'Smaller animals, like the kangaroo-rat, which sought cover in hollow logs were forced out by butting a hole in the centre with the axe. Birds were killed with stones or spears and the throwing stick was also used to secure small game.' (Sokoloff, 1980:9).

Fish were readily and frequently caught with fishing lines and spears. Spear fishing was undertaken as far into the water as the spear could be used with best effect. The hunter would stand motionless in the water until he was surrounded by fish then he would strike (Enright, 1990:115).

According to Sokoloff it was the women's responsibility to ensure a steady supply of fish and selected women were dedicated to fishing:

'So important an office do they consider this near the coast, that the mother nominates one of her female children to it as soon as born, amputating the little finger of the right hand, as a token of such appointment.' (Dawson, 1831:314)

Scott's recollections recall amputation being effected by the fastening of a very tight ligature around the first joint of the selected girl's finger whilst she was still quite young:

'...and being left there for a considerable time the top portion mortified, and, in time, fell off. This was carefully secured, taken out into the bay, and, with great solemnity, committed to

the deep. The belief was that the fish would eat this part of the girl's finger, and would ever, thereafter, be attracted to the rest of the hand from which it had come.' (Scott, 1929:4).

It was also the responsibility of these nominated women to prepare the fishing lines:

'The bark would be stripped carefully from the tree and soaked in water until the outer portions could be readily scraped off with a shell...Some of the hooks were fashioned from bone.' (Scott, 1929:17).

The women undertook most of their fishing from canoes. Another less common method was for the husband and wife to fish at night using a lighted torch and a waddy (Sokoloff, 1980:9).

'...fish hooks...were made from oyster or pearl shell...the large ear shell, the mud oyster and perhaps pipi. The process of the manufacture of the hook entailed the weakening of the centre of the selected shell with heated sticks, punching a hole in the weakened section, filling [sic] the edges of the hole to the desired shape...The utensil used for filing [sic] down the hooks were pieces of fine sandstone, shale or quartzite.' (Sokoloff, 1980:23)

Fish hook files were most likely used along the shoreline where shells for fish hook manufacture were readily available and where Scott reports the Aboriginal people often camped (Scott, 1929:13).

Fish weirs were also used along the Hunter estuary. The fish traps and weirs 'were made of sprig material, rather than rock' (Dean-Jones, 1990:68).

4.2 Tools, Implements and Weapons

From all accounts it appeared that the Worimi manufactured and utilised a range of tools and implements for use in resource exploitation, defence, and transportation.

Stone Tomahawks:

Were tools that required a large cost in terms of time for their manufacture and maintenance. 'Years were often spent in polishing them and otherwise preparing them for use' (McKiernan, 1911:890). As such they were always carried by the men tucked into their belts (Scott, 1929:40-41) and were only discarded when broken beyond repair. They were used as both weapon and implement.

Boomerangs:

Were usually made out of a 'suitably curved branch of myrtle (*Trochocarpus laurina* or *Eugenia myrtifolia*)' (Sokoloff, 1980:20). They were shaped with stone implements and shell scrapers and hardened by fire.

Womerah:

'...was a well balanced flat or round piece of hardwood.' (Scott, 1929:37).

Watties (Waddies) and the nullah nullah:

Were manufactured from Ironbark or myrtle and ranged in length from just over half a metre to just over 1 metre, with a tapering end. Occasionally they were decorated with carvings or notches down their length (Sokoloff, 1980:21).

Clubs:

‘...were...roughly fashioned from any suitable piece of timber.’ (Scott, 1929:38).

Shields:

were manufactured from

‘...an oval piece of hardwood some two feet wide having a hand-grip on the back made from a length of vine affixed in holes made for that purpose.’ (Scott, 1929:38).

Spears:

The shaft of the spear was made of various hardwoods, shaped and thinned with shells.

‘The end piece, comprising the barb, or pointed tip, was affixed to the main shaft very skilfully, considering that the hole for its reception had to be bored with a piece of hardwood, twirled between the hands, the best substitute for an auger procurable. The top, fitted into this slot, would be made firm and slid with cords of animal sinew or fibre, and coated over with gum from the grass-tree.’ (Scott, 1929:35).

Canoes:

were constructed from a single sheet of bark from the stringy bark tree, *Eucalyptus obliqua*.

‘The stripping operation was carried out with an exact judgement, lines being cut cross-wise with a tomahawk around and across the tree so that the section removed would be the required size and shape.’ (Scott, 1929:38).

The bark was passed over a fire so that it turned up at its ends. The ends were then fastened with a vine. The canoe was made water tight with the application of clay (Sokoloff, 1980:31).

Cutting implements:

Shells seemed to be the most common implement used for cutting and scraping (Umwelt, 2003:4.5).

String

String or cord was made from the young bark of the kurrajongs tree (*Brachychiton populneus* and *B. acerioflum*). The string to be used for fishing line was made by women who had been specifically initiated (Sokoloff, 1980:23). Knotless net bags were also made from string.

Vessels

Containers for carrying food or for drinking were made out of tea-tree bark from *Melaleuca quinquenervia*. Leg bones of kangaroos were fashioned into combs. (Sokoloff, 1980:25).

Shelter

Dean-Jones provides the following observations of Aboriginal shelter as described by Dawson, 1831 and Caswell, 1841.

‘...huts, made with three sticks and Melaleuca bark.’ (Dean-Jones, 1990:64).

William Scott recalls:

‘There never was anything of permanency about a black fellow’s home.....A few sheets of bark, leaning on a pole against a tree, served him as shelter through days of sunshine or nights of storm and rain. Fires were always kept burning about the camp. In most seasons the blacks sleep between two small fires, getting warmth on both sides of their bodies so that they could slumber in a reasonable degree of comfort.’ (Scott, 1929:13).

5.0 Previous Archaeological Research

Numerous archaeological investigations have been undertaken in the Port Stephens area over the past two decades. These investigations have been undertaken mainly in response to the legislative requirement to undertake Environmental Impact Assessments (EIA) prior to proposed mining, industrial and residential developments. In the coastal and foreshore regions development has included sand mining and sand quarrying, construction of tourist facilities, main road realignments and housing subdivisions all requiring the submission of an EIA. Therefore it is not surprising that the distribution of known Aboriginal sites is biased in favour of these development locations and the conspicuous nature of middens (Resource Planning Pty Limited, 1991b:3-4).

Most surveys have been small isolated studies restricted to small study areas in association with specific developments. No overall systematic or detailed study of the area has been undertaken apart from that conducted by Dean-Jones (1990) and ERM (in progress) carried out in the Newcastle Bight. Hence the current archaeological record/model of Aboriginal occupation of the area is very broad.

A summary of the available archaeological reports relating to the project area is contained in **Appendix 1**.

Middens have been recorded in the deflation basin along the beach at Newcastle Bight, on Holocene transgressive dunes, on bedrock headlands, on the shoreline of Tilligerry Creek, and at several locations along the estuarine shoreline of Port Stephens. There is considerable variability in the nature of middens, with respect to both shell species content and stone artefact content, according to the resource and geomorphic contexts with which they are associated. Midden shell is rarely associated with Aboriginal sites on the Pleistocene barrier of Newcastle Bight unless the Pleistocene sand mass also forms the Holocene – recent estuarine shoreline’ (Resource Planning Pty Limited, 1991b:4). The majority of the subsurface archaeological investigation in the general Port Stephens area has been related to the Pleistocene transgressive dunes associated with fresh water swamps (e.g. Resource Planning Pty Limited, 1991a; Baker, 1994) and as far as known there has been no subsurface investigation of the Pleistocene beach ridges (Umwelt, 2002:6).

In previous archaeological surveys, Aboriginal sites comprising scatters of flaked stones have been recorded within many of the low dune landform, and midden sites have been found to occur along the estuarine shorelines of the peninsula (Koettig, 1987; Dean-Jones, 1990). Many of these dunes have been disturbed by past sand extraction and other development, exposing subsurface archaeological deposits (Umwelt, 2002:4). Dean-Jones’ 1990 study of Stockton Bight draws our attention to the discrepancy of the apparent distribution and the likely real distribution of sites that can be attributed to the ‘nature of active surface processes, and the behaviour of flaked stone within a mobile sandy substrate’. (Resource Planning Pty Limited, 1991b:4). Given such factors/processes there exists the high probability of subsurface archaeological material which would have no surface expression on undisturbed dune surfaces (Resource Planning Pty Limited, 1991b:4) and without subsurface investigations taking place many sites may not be located and the site distribution pattern will remain skewed.

5.1 Landscape Analysis

During the late Pleistocene, sea levels were 130 metres below those of today and the shoreline was approximately 30 kilometres seaward of its present location. During this period the Port Stephens embayment would have been a valley through which the Karuah River flowed incising its channel into the Pleistocene sands and transporting them seawards (Thom et al 1992:346). Throughout the terminal Pleistocene and early Holocene the Karuah River valley was again gradually inundated by rising seawater. By 6500BP the marine transgression was terminated with sea levels around one metre higher than that of the present. Sea levels regressed slightly again until by 3000BP the location of the estuarine shoreline of the Port Stephens area would have been similar to that of today.

The landscape of the southern peninsula of Port Stephens and Tilligerry Peninsula is of Pleistocene age and forms part of a transgressive dune field typical of the inner barrier of Newcastle Bight. This sandy barrier was deposited during the last interglacial period of high sea level, approximately 120,000 thousand years ago. Land surfaces older than 17,000 years are rare, however, as most have been reworked by terrestrial winds towards the end of the last Glacial (Dean-Jones 1990:118). During the Pleistocene the area would have been well inland but Aboriginal people would have had direct access to freshwater wetlands located in the depressions between transgressive dunes. While such wetlands would have offered rich plant and animal resources, the reworking of the area by terrestrial winds during the end of the last Glacial is likely to have resulted in an environment of limited and uncertain resources.

Previous studies have found (e.g. Dean-Jones 1990:119), that relatively few Aboriginal sites have been located on Pleistocene sand dunes and those which do occur are relatively sparse in content. Additionally, it has been noted that there is a distinct lack of shell in such sites. There are a number of possible explanations for these results. Firstly, Aboriginal occupation may have been concentrated on the plant resources of the wetlands, resulting in little or no archaeological evidence. Secondly, sites may be sub surface as a result of geomorphic processes. There are also a number of possible explanations for the lack of shell in sites on Pleistocene dunes. If the sites are Late Pleistocene or early Holocene, then estuarine resources may have been too far away or not plentiful enough to warrant exploitation from the Pleistocene dune campsites (Dean-Jones 1990:119). If occupation continued into the Late Holocene, the estuarine environment may still have been regarded as too remote compared to the immediately available plant and animal resources in the dune woodland and associated wetlands. Differential preservation of evidence may also explain the lack of shell, although this seems unlikely.

Tidal flats around Tilligerry Peninsula. Mobile sand (beach and dune) within embayments in Port Stephens. Holocene.

Dean-Jones (1990:128) has argued that Holocene estuarine foreshore environments, particularly those formed on rock platform or dune surfaces, have a high potential to contain Aboriginal archaeological deposits in the form of small middens and stone artefact scatters. During the last 6000 years as sea level stabilised, rich ecological systems were also stabilising. A mangrove environment and shellfish beds developed, providing a diverse and rich range of resources to Aboriginal people.

5.2 Type and Location of Previously Recorded Aboriginal Heritage Sites

Although the occupation of the Worimi incorporated a complex network of resource exploitation for everyday activities and ceremonial purposes, much of the evidence of their

material culture would not have been preserved for extended periods of time in the open. In the manufacture of their hunting implements for example, the Worimi predominantly made use of organic material, with the exception of fish hook files and stone tomahawks. They also made extensive use of plant fibres in weaving (ERM, 1998:4.2). Physical evidence of such material culture is unlikely to have survived over time. Thus the archaeological record is incomplete or at best indicative only of the early cultural practices of the indigenous inhabitants of the area and should be considered in conjunction with the available ethnographic record and Aboriginal stories.

5.2.1 Aboriginal Heritage Information Management System (DEC)

A search was conducted of the Department of Environment and Conservation's (DEC²) Aboriginal Heritage Information Management System (AHIMS) Register for sites known to be within 100 metres landward of the mean high tide mark and 20 metres seaward of the mean low tide mark. The search parameters included sites recorded on the Port Stephens 9332-IV-S and Karuah 9232-1-S 1:25,000 map sheets and bounded by the extent of the foreshore. Ninety one sites were registered on the AHIMS database. Another ten registered sites were found during the literature review which did not appear on the AHIMS register. It should be noted that DEC advise that the register of Aboriginal sites cannot be guaranteed to be free from error and currently has a program of site verification underway to address some of these inaccuracies. A further four sites were identified by AMBS in their 2001 archaeological survey which covered the Twelve Mile Creek area. These four sites include three open campsites and one isolated find. This makes a total of 105 sites within the Port Stephens foreshore area.

The predominant site type is midden (52), followed by scarred trees (17) (although many of these appear to be duplicate recordings), and isolated finds (15). Individual sites have not been mapped due to concerns expressed by the Aboriginal community regarding the public availability of such information. Instead, areas of Aboriginal cultural sensitivity have been mapped (see **Figure 5.1**). The mapping shows areas which contain sites, have the potential to contain sites, or are of significance to the Aboriginal community for mythological and/or contemporary reasons.

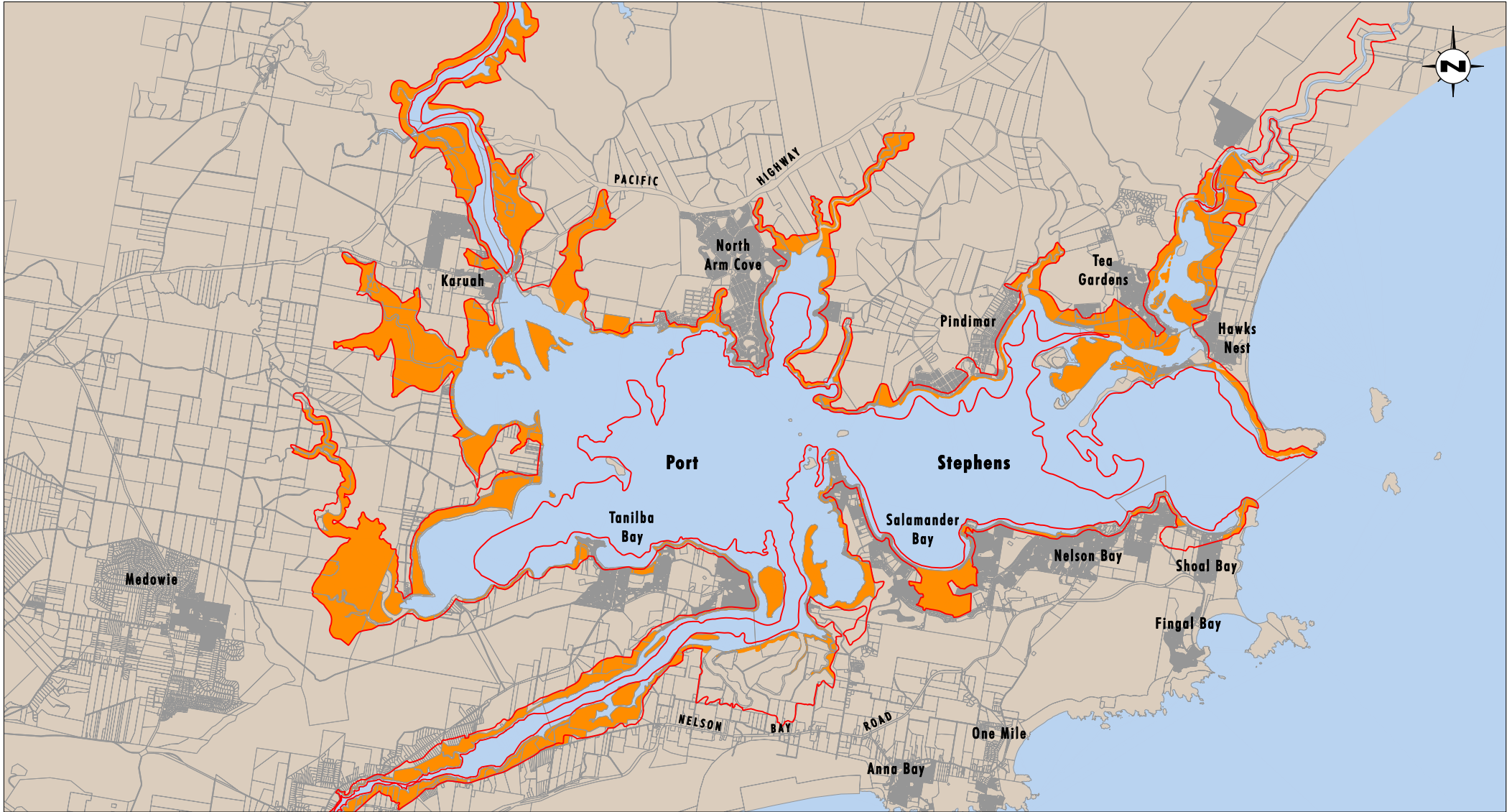
6.0 Survey Results

A targeted inspection of the southern foreshore of Port Stephens was undertaken on 15 and 21 July. On the first day, sites/places were investigated between Shoal Bay and Soldiers Point (see **Figure 6.1**). On the second day, the eastern end of the Tilligerry Peninsula was surveyed. Marys Bay (on the western margin of Soldiers Point) and Fly Point/Little Beach/Halifax Point were also visited.

6.1 Shoal Bay

The eastern end of Shoal Bay was targeted for inspection because the AHIMS Register showed that nine scarred trees had been recorded in a relatively small area. The trees are located within and adjacent to a popular recreation area (Fishermans Park). Such a large number of scarred trees in the same location is uncommon and the location is considered highly significant by the local Aboriginal community. The site cards also indicated that there may have been a number of double recordings of individual trees by various recorders. They also indicated that the trees were being affected by a number of natural processes. Site cards dating back to 1 August 2001 recommended that the NPWS (now DEC) should

² DEC now incorporates the National Parks and Wildlife Service



Source: LPI NSW (2000), Great Lakes Council (2006), Port Stephens Council (2006)

0 2 4 8 km
1:150 000

Legend

- Study Area
- Areas of Aboriginal Heritage Sensitivity

FIGURE 5.1

Areas of Aboriginal Heritage Sensitivity



Source: LPI NSW (2000) Port Stephens(2006) & Great Lakes Councils (2006)

0 2 4 6 km
1:110 000

Legend

- ▭ Study Area
- Foot Transect
- Boat Transect (targeted inspections)

FIGURE 6.1
Survey Transects

arrange a Voluntary Conservation Agreement with Port Stephens Council and the local Aboriginal community for this area.

Five trees were identified during the current study. These were in relatively good condition despite continuing gully erosion beneath one tree and white ant activity in others. Not all the trees recorded on existing site cards could be definitely matched with existing trees, nor could the site cards, some of which presumably refer to the same sites, be matched with each other. The tree within the reserve is in good condition despite being so visible and accessible.

The existence of the scarred trees is not widely known. The condition of the trees has not suffered as a result of human activity. However, natural processes have and continue to affect the trees. The tree that is being undermined by gully erosion will eventually fall down or will need to be cut down if it becomes a safety hazard. The Worimi LALC may want to remove the scarred tree and put it on display elsewhere at this time. Relevant experts should be contacted to provide advice about how best to halt the damage being done by termites and prolong the life of the scarred trees. Council workers should be aware of the trees within and on the boundary of the picnic area, and ensure that their maintenance activities do not impact the trees.

6.2 Little Beach (Little Nelson Bay)

Two scarred trees have been registered in the AHIMS database in the Little Beach foreshore area. These are in good condition despite being located within a popular recreational area. There are other trees in the area (more than 100 metres away from the shoreline) that have scars on their trunks. These should be inspected carefully and recorded and registered on the AHIMS database if the scars are judged to be cultural.

The Little Beach area is significant to the local Aboriginal community, not only because of the heritage sites but also because it was used as a camping area by Aboriginal people in the nineteenth and early twentieth centuries (Peter Morris, pers. comm. July 2005). People were moved to the Bagnalls Beach area by the army during World War II in order to make way for a training camp.

Council workers should be made aware of the existence of Aboriginal heritage sites in the Little Beach area, and their responsibility to ensure that such sites are not damaged or destroyed. If any works in the area involve sub surface disturbance, then the Aboriginal community should be consulted prior to work commencement.

6.3 Bagnalls Beach

Two scarred trees and a midden have been recorded in the Bagnalls Beach area. Within one of the scars there is a contemporary carving of an old Aboriginal man's face. Both trees are located on the boundary of popular picnic areas. Both are in good condition and do not appear to have been damaged by human activity. The previously recorded midden could not be located. This may have been due to poor ground surface visibility. The area in which it was recorded does not appear to have been disturbed in any way.

While the Aboriginal heritage sites in this area are in good condition, their context could be improved in the form of improved landscaping of the reserve.

6.4 Soldiers Point

Soldiers Point is a highly significant area to the local Aboriginal community because of physical evidence of traditional Aboriginal occupation, the existence of a ceremonial site and a number of Aboriginal burials. Many Aboriginal families lived on Soldiers Point permanently following European settlement, descendants of these families continue to live in the area today.

The only registered Aboriginal site on Soldiers Point is a midden that is located adjacent to the Soldiers Point Marina. This deposit has been substantially disturbed by the development of the area, in fact the most substantial section of the midden has been exposed in a road cutting leading to the marina. Fragmented shell material noted above this area has been protected by a covering of mulch.

Aboriginal burials are known to exist on the point now occupied by the Soldiers Point Caravan Park. Worimi LALC has advised that any development in this area must avoid subsurface disturbance.

Local knowledge also indicates that a ceremonial area is located on the point. Although there is no physical evidence of such a site, the area is considered to be of great importance. Again, the Worimi LALC has advised that any development in the area must avoid subsurface development.

Marys Bay, on the western side of Soldiers Point was a traditional camp site. The foreshore area is now densely vegetated and so any evidence of this occupation, if it exists, is not currently visible. However, Peter Morris (pers. comm. July 2005) recalls seeing midden material and stone artefacts in the area as a child. Fragmented midden material was noted during the current study in the front yards of foreshore residences. Additionally, the stone remains of what could possibly be a fish trap can be identified within the bay. It is also believed that Marys Bay is the site of a massacre of Aboriginal women and children by an early European settler.

The Aboriginal heritage sites on Soldiers Point have deliberately not been discussed in detail here. It has been a conscious decision by Worimi LALC to not register a number of these sites on the AHIMS database. The reasoning behind this decision is that the Land Council does not want the location of these sites to be publicly known due to the possibility of vandalism.

The significance of Soldiers Point to the local Aboriginal community means that it is essential that they are consulted about proposed development of the area and any works that may disturb the ground surface. They should be contacted during the planning stages of any proposed development/work so that appropriate methods and management can be implemented, and so that costly hold-ups during construction period can be avoided.

DEC, Port Stephens Council and the local Aboriginal community have produced the Soldiers Point Management Plans. It provides a strategy on how best to protect and conserve the heritage of Soldiers Point.

6.5 Management Zone B2/B3/C1

6.5.1 Tilligerry Peninsula

A shelter with deposit, rock art sites, numerous middens and an artefact scatter has been recorded around the margin of Tilligerry Peninsula. These were generally found to still be in

existence but have been and continue to be affected by natural processes such as bank erosion, as well as human activity such as works associated with erosion control.

The rockshelter and deposit at Mallabula Point was relocated during the current study. While the small rockshelter is still in existence, there is no deposit within it. It is considered unlikely that the shelter ever contained a substantial deposit due to the limited floor space and the fact that the floor has a substantial downward (outward) slope. The many other previously recorded middens around the peninsula were also noted during the current study. The majority of these appear to be well protected beneath grass cover, however, it is likely that a large proportion of midden material has been eroded and washed into the bay/creek or affected by previous landscaping.

Aboriginal heritage material appears to have been inadvertently disturbed by Council works in two locations. The first location is on the south eastern tip of the peninsula where a retaining wall has been constructed on a steep slope. Midden material was noted immediately adjacent to the wall and it is highly likely that such material was located in the area where the wall is now located. While cultural material was probably being affected by the erosion that the wall aims to halt, a formal archaeological assessment including consultation with the local Aboriginal community should have been undertaken prior to construction.

Further to the west, a ten metre wide area has been cleared adjacent to a small creek and a private residence. It appears that this area has been cleared as a bushfire precaution. A small amount of midden material has consequently been exposed.

An archaeological assessment, including consultation with the local Aboriginal community, should be undertaken prior to any works that involve disturbance to the ground surface in the foreshore area of Tilligerry Peninsula.

6.6 Management Zone D/E

6.6.1 Karuah River and Tahlee/Carrington

A survey of the banks of the Karuah River was undertaken on Thursday 18 August 2005.

The Department of Planning is currently undertaking the Aboriginal Cultural Landscape Planning Project as part of its Comprehensive Coastal Assessment. The project aims to record the Aboriginal community's value and association with the coastal zone, this includes Port Stephens. These cultural values will then be considered in the coastal planning and management decision making process. Maps of the areas and locations of significance in the coastal landscape will be produced, and the information collected will be redistributed to Aboriginal communities for their use during involvement in planning decisions. The project also involved an audit of known cultural heritage sites (focusing on NPWS's AHIMS database) within each coastal local government area. A report (with associated maps) that includes the Port Stephens area will eventually be available (the date of release was unable to be confirmed).

The survey found that there are numerous concentrations of shell on the banks/foreshore of the river. It is likely that some of these concentrations are associated with oyster farming activities, and in some places midden material and oyster farming material overlap.

Aboriginal cultural sites on the Karuah River foreshore are threatened by bank erosion caused by cattle trampling. Natural bank erosion caused by the proximity of the thalweg is a lesser threat. Cattle should be fenced off from the foreshore area wherever possible. This

would reduce the potential for damage to Aboriginal sites as well as the important ecological habitat.

A survey of selected areas of Tahlee, Carrington and North Arm Cove (see **Section 6.7**) was undertaken on Thursday 9 September 2005 by Katie Sachs, Colleen Perry, and David Feeney. A small section of the northern shoreline of North Arm Cove was also inspected on this day (see **Figure 6.1**).

The objective of the investigation in the Tahlee area was to relocate the midden sites previously recorded along the foreshore by Warren Bluff in 1990. Fifteen sites (thirteen middens, an artefact scatter and an isolated find) are registered on the AHIMS site register in this area. It is likely that the majority of these sites consist of visible sections of a continuous deposit of shell and stone artefacts. Two fairly continuous exposures were noted during the current study and were recorded as such. However, it is likely that areas of exposure are continuously changing – some areas are covered over by ground cover or soil, as others become exposed by processes such as wave action, fire, or native wildlife (many of the shell exposures occurred in areas where the ground surface had been disturbed by bandicoots or rabbits). An isolated find was also located on the rock platform in this area.

The survey commenced at the Tahlee Bible College hall and proceeded west along the rocky platform and immediate foreshore. Ground surface visibility was extremely poor. The foreshore within the Bible College grounds is covered by exotic plants such as prickly pear and agapanthas, as well as large Gynea lilies. To the west of the Bible College boundary, the foreshore is densely vegetated by lantana and other introduced species. Native species noted were forest oaks (*Allocasuarina torulosa*), scribbly gums (*Eucalyptus signata*) and red bloodwoods (*Eucalyptus gummiifera*). The foreshore was followed for approximately one kilometre, an unsealed vehicle track was then followed back to Tahlee house. This track generally ran within 100 metres of the shoreline but provided minimal visibility.

The section of foreshore between the Bible College and Carrington was then inspected. This area is highly disturbed. A well maintained but unsealed track runs parallel to the foreshore and the majority of the area in between has been cleared. The remains of a post and rail fence runs along the sand and rock shoreline, and another line of timber posts runs parallel and south to this post and rail fence. These indicate that a number of structures were once present along this shoreline. The entire shoreline is being affected by bank erosion. The casuarinas at the edge of the foreshore along the eastern section of this bay are being undermined and many have already toppled over. Bank erosion was also noted within the bay to the east of the settlement of Carrington. In the vicinity of a reburial (see below), a timber wall was constructed adjacent to the outlet of a nearby creek in an attempt halt erosion in the area. This has not been successful. The bank has receded approximately one metre during the three years since the wall was constructed. (David Feeney, pers. comm. September 2005.)

An isolated find and three middens were recorded during the targeted survey of the Tahlee/Carrington area. The isolated find consisted of a chert flake found in a rocky area between a rock platform and the low bank. This location is inundated regularly, however the artefact does not display evidence of water wear. Its original location is likely to have been the slope above the beach.

The middens were noted within the bank profile and on the lower slope behind the beach (generally exposed by wildlife activity). The maximum depth of the deposits exposed in bank profiles was 30 centimetres. The depth of deposits further inland could not be ascertained but appeared to be substantially less than 30 centimetres. Shell species noted included cockles (*Anadara trapezia*), rock oysters and drift oysters (*Crassostrea commercialis* and *Ostrea angasi*), and whelks (*Pyrazus ebenius*). Proportions of these varied between

deposits (see site cards for detailed site descriptions). The shell generally occurred within a dark grey to black loam substrate and large cobbles of ignimbrite were common.

The Tahlee foreshore area is densely vegetated with weeds and exotic species associated with Tahlee House. This vegetation provides a good degree of protection to the archaeological deposits located in the area, however, degrades the natural context of the area, particularly to the west of the Bible College grounds. It is recommended that a native bush regeneration program is implemented in this area. Weed removal methods must take into consideration that any ground surface disturbance is likely to disturb heritage material. Any landscaping of the foreshore in front of Tahlee House should also be undertaken in a way that ensures minimal disturbance to the ground surface. Karuah LALC and DEC should be consulted during the planning and implementation of bush regeneration work, and landscaping within Tahlee House.

The foreshore area between the settlements of Tahlee and Carrington, and also to the east of Carrington (only a limited section was inspected in this area) appears to be eroding fairly rapidly. The processes causing this erosion need to be understood prior to the implementation of any erosion control works. Any such works should ensure that all heritage sites are managed appropriately, including close consultation with Karuah LALC and DEC.

Proposed development of any kind in the Tahlee/Carrington area should ensure that Karuah LALC is consulted and involved throughout the entire project.

6.6.2 North Arm Cove

The shoreline in the area inspected (see **Figure 6.1**) remains undeveloped and is covered by native vegetation, including mangrove. Shell material was noted in a 5 x 5 metre area of ground surface disturbance. The deposit appears to be shallow in this location (less than 5 centimetres) but is likely to continue beneath the dense vegetation around a large part of the foreshore. Cockles dominated the deposit, followed by whelk and rock oyster. The shell was located within a dark brown loam, and large cobbles of volcanic stone (ignimbrite) were common.

A ceremonial ground (carved trees and bora ground) in this area was recorded by David Bell in 1990. The site was described as follows:

‘Site was situated on the crown of a ridge. The area in which the site was probably located consists of ridges and spurs overlooking North Arm Cove. The area remains largely forested however there are extensive areas of pine forests on the east side of North Arm Cove. The foreshores of the cove have holiday homes and more of the area is being developed for housing.’ (Site card 38-5-0005).

Directions for site relocation detailed on the site card consisted of:

On crown of ridge ½ mile from Bundabah Station. About 8km east of Karuah.

These descriptions suggest that this site was on the eastern side of North Arm Cove, however the grid co-ordinates provided place the site on a ridge on the eastern side of the cove, immediately to the south west of Bulga Creek.

The site card states that the trees (‘at least 2’) were probably all destroyed. A reference for the origin of all the information on the site card is not provided. Despite the uncertainties regarding the location of this site, an inspection of the rocky ridge on the eastern side of the cove (based on the grid co-ordinates provided) found it to be overgrown with lantana. None of the existing trees were mature enough to have been scarred by a traditional Aboriginal person.

All residents and land owners in the foreshore area of North Arm Cove should be aware that there is a high probability that Aboriginal sites occur on their property and that disturbance of such sites is illegal.

7.0 Discussion and Conclusion

Numerous Aboriginal sites have been recorded around the foreshore of Port Stephens. These include numerous scarred trees in the Shoal Bay, Little Beach and Bagnalls Beach areas; middens scattered along the entire foreshore but particularly concentrated on the Tilligerry Peninsula and in the Tahlee/Carrington area; artefact scatters and ceremonial sites. It is likely that sites other than those registered on the AHIMS database exist. These may be obscured by soil and/or vegetation, may not yet have been discovered, or are known of by the Aboriginal community but choose not to make this information publicly available. It is also likely that a large proportion of foreshore Aboriginal sites have been destroyed by natural processes and development of the foreshore. Remaining sites provide a limited but important insight into the traditional Aboriginal culture of Port Stephens.

In addition to archaeological sites, there are many places (including the entire foreshore itself) which are of significance to the Aboriginal community but which do not necessarily have physical evidence of Aboriginal occupation. These include Tomaree and Yacaaba Headlands, Soldiers Point, Mambo and other wetlands. Fishing and the resources of the Port Stephens estuary also remain extremely important to the contemporary Aboriginal community.

Natural threats to Aboriginal heritage on the foreshore include foreshore erosion, sea level rise, and termite infestation (scarred trees). Such threats are difficult to mitigate against. Threats associated with human activity include vegetation clearance and development, maintenance and land care activities undertaken by Council and community groups, and vandalism. These threats can be minimised through implementing adequate land assessment procedures and procedures which ensure that relevant people are aware of their responsibilities with regard to Aboriginal heritage.

7.1 Current Management

The Port Stephens LEP (Division 3 Heritage Provisions) and the Great Lakes LEP (Special Provisions – Heritage) set out each Council's responsibilities when assessing development applications that affect known or potential Aboriginal sites. Under the heading of *Development of Known or Potential Archaeological Sites*, the Great Lakes LEP states:

- (7) The Council may grant consent to the carrying out of development on an archaeological site that has Aboriginal heritage significance (such as a site that is the location of an Aboriginal place or relic within the meaning of the National Parks and Wildlife Act 1974) or a potential archaeological site that is reasonably likely to have Aboriginal heritage significance only if:
 - (a) it has considered an assessment of how the proposed development would affect the conservation of the site and any relic known or reasonably likely to be located at the site prepared in accordance with any guidelines for the time being notified to it by the Director-General of National Parks and Wildlife; and
 - (b) it has notified the Director-General of its intention to do so and taken into consideration any comments received from the Director-General within 28 days after the notice was sent; and

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- (c) it is satisfied that any necessary consent or permission under the National Parks and Wildlife Act 1974 has been granted.

The Port Stephens LEP has similar provisions but point (c) is not included. Neither LEP sets out how the potential for an Aboriginal site can be established. Both Councils are dependent on the AHIMS database to identify previously recorded sites. This database can be unreliable, and, as mentioned above, may not contain all sites known to the Aboriginal community. Additionally, some sites cannot be defined as one point (as they are on the database) but may extend over a large area of the surface and subsurface.

Some activities which have the potential to affect Aboriginal heritage sites do not require development approval from Council. These activities are consequently undertaken without consideration of the threat posed to previously recorded or potential Aboriginal heritage material. An example of this is maintenance works undertaken by Councils in reserves, or bush rehabilitation and improvement works undertaken by land care and tidy town committees.

7.2 Identified Management Actions

Clear identification of those parts of the landscape which have, and have the potential for, Aboriginal heritage significance is required. This could be in the form of a regional Aboriginal heritage study(s) that would provide the knowledge base required for a management plan(s) to guide the immediate and long term conservation and management of Aboriginal heritage.

The Aboriginal Cultural Landscape Planning Process, along with the numerous small scale Aboriginal heritage studies undertaken in the foreshore area will provide a solid knowledge base for the production of an Aboriginal Heritage Study and Management Plan for the Great Lakes and Port Stephens regions. Such strategic planning is required to achieve sustainable cultural heritage management on a Local Government Area scale.

With regard to the foreshore, the most immediate requirement is a set of guidelines for the maintenance and management of Council and Crown Land. Such guidelines should include a reference to the protection of Aboriginal Heritage. **Appendix 4** of the Port Stephens Foreshore Management Plan details the activities and issues that should be addressed in the *Parks and Reserves Maintenance Guidelines*.

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APPENDIX 1

Summary of Available Archaeological Reports

Appendix 1 – Summary of Available Archaeological Reports

Moore 1967

Brayshaw reports (1984:6) that Moore located two shell middens on Baromee Point in 1967 (AHIMS #38-5-0003 and #38-5-0004). In 1968 Moore excavated the most easterly of the two sites (38-5-0004). During the 1967 survey Moore also located and recorded an extensive shell midden deposit between Carrington and Tahlee (38-5-0001) which has since been disturbed by road construction. This site lies outside the current project area.

In a personal communication with Brayshaw, Moore also spoke of a larger more extensive midden site west of Tahlee that he considered might be of considerable antiquity. No further details are available.

Navin Officer notes that Moore also recorded another midden site at Mulwee Headland, 4 km south of Karuah (38-4-0064). He described the site as a 'midden all along foreshore with flakes and implements eroding out on to beach' (NPWS Site Card as cited in Navin Officer, 1999:27).

Cubis 1981

Two areas in the Lemon Tree Passage area were surveyed by Cubis in relation to a proposed residential development and a proposed commercial oyster farm depot (west of Gibber Point). One shell midden was located in the extreme south-eastern corner of the residential subdivision area bounded to the south by the banks of Tilligerry Creek. The midden consists of cockles (*Andara trapezia*) and mudwhelk (*Pyrazus ebeninus*) in equal proportion. The midden is shallow but extensive.

Haglund 1982

Haglund's archaeological study was undertaken on behalf of the Land Board Office, Maitland Homes Sites Branch in respect of a proposed housing development on Site 32, Bagnalls Beach, which is located between Salamander Bay and Nelson Bay, on the south side of Port Stephens. Two shell scatters were located during the survey – one appears to be of fairly recent origin, the other most probably the remains of a small Aboriginal midden, although judging from the physical state and their matrix neither scatter could be seen as definite evidence of the presence of an Aboriginal site.

Shell scatter 1 was determined to be of recent origin, made by fisherman and campers in a post contact context. The age of shell scatter 2 was a little ambiguous and uncertainty exists as to it being a midden of Aboriginal origin. In the absence of further clarification, and erring on the side of caution, Haglund concluded that the second shell scatter was likely to be the remains of a small and shallow Aboriginal site of relatively recent origin. This site is now totally disturbed and of no scientific value. Haglund recommended that a Consent to Destroy application be made to the Director-General of the NPWS.

Haglund was not surprised by the lack of results from this survey given the topography and vegetation of the study area. It is anticipated that any other surface scatters of archaeological material would be small and ephemeral and would not be visible except in cleared areas, in which case the process of clearing would most likely destroy the archaeological context of the finds. Sub-surface scatters would be unlikely, except perhaps along the northern border (in the narrow strip of marine sand) and towards the southwest where the creek runs into a more flat and sandy area. Haglund's survey did not find any surface archaeological material in this area.

The probability of an archaeological horizon in the survey areas appears so low and the disturbance of the sand so extensive, that neither augering nor test excavation have been recommended.

Brayshaw 1984

In 1984 Brayshaw undertook an archaeological survey in the Carrington area of Port Stephens on behalf of Bradfield Properties Pty Ltd, in relation to their proposed rural/residential development. The survey started east of Carrington and covered the entire foreshore incorporating Carabeen Creek and the western side of the lower reaches of Corrigan Creek. Prior to Brayshaw's survey no systematic archaeological surveys had been undertaken in the Carrington area.

Two shell midden sites were located along the shoreline, in addition to a scarred tree and an area of stone structures similar to those found at North Arm Cove and Rollands Plains.

Midden site 1: the predominant shell species was the cockle (*Anadara trapezia*). Other species included whelks (*Pyrazus ebenius*) and oysters; both rock oysters (*Crassostrea commercialis*) and drift oysters (*Ostrea angasi*). A heavy brown core was also found in front of the midden.

Midden site 2: was located about 60 m to the south-east of Midden site 1, and featured the same shell species but this time oysters were predominant. It is possible that these two sites were once part of the same site.

The scarred tree is an Iron Bark (*Eucalyptus creba*) (Site ID: 38-5-0084). The proportions of the scars on the tree were generally consistent with the bark being removed for use in canoe construction. Although in terms of raw material, earlier evidence suggests that stringy bark and bark from river gums was most likely used for canoe construction in the region (Scott, 1929; Brayshaw, 1984b).

On the western side of Balberook Cove, approximately 100 m south-east of the scarred tree on a rocky ridge above the mouth of the Corrigan Creek estuary, were five or six stone structures, of proportions similar to other stone arrangement sites which have been found (i.e. circular stone structures between 30 and 130 cm), and in varying stages of disrepair. The site (Site ID: 38-5-0085) covers an area of 75 x 75 m. As this survey was only preliminary Brayshaw did not record the arrangements in detail but discussed the erection of 'rock nests' and their use in male initiation ceremonies as a 'boombit' ring. Historical accounts of the area reveal that the boys of the local Gringai tribe undertook initiation ceremonies at selected sites usually close to a seashore, a hill, or a flat part of a valley. A feature of such seashore sites was the erection of 'rock nests' to house the boombits (male initiates) before and during the period of initiation. Generally the nests were located relatively close to the Bora ring where the boys were initiated, however, activities such as farming, logging and agistment occurring in proximity to these sites has caused varying degrees of surface disturbance. This, Brayshaw suggests is why it is possible to find evidence of boombit nests but often with no sign of the associated ceremonial circles. Also noted was the number of old trees in the area ringed with stones at the base. This is also a feature of such ceremonial areas. Umwelt, 2003 discuss in detail the nature of stone arrangements.

Donlon 1988

Donlon undertook an archaeological survey in respect of a proposed glass sand mining development on Tilligerry Peninsula, Tanilba Bay. Her survey identified four sites, three of which are relevant to this study: Sites: 38-3-0039; 38-3-0040; 38-3-0041. All three sites fall just outside the project boundary but close enough for consideration. All three sites are middens consisting predominately, if not entirely (Site 38-3-0041) of cockle shell.

Donlon assessed these sites as having high archaeological significance due to the fact that there is an absence of significant sites on the Northern Dune; the sites appear to be undisturbed which is an unusual feature of middens that have been found on the Tilligerry Peninsula, and therefore have high research potential; and due to the extent of mining, residential and commercial development and the likelihood of flooding to the west of the Peninsular there is little likelihood of many more sites still remaining.

Brayshaw 1989

Brayshaw undertook this archaeological study on behalf of ACI Operations Pty Ltd in relation to their proposed sand mining on the Tanilba Bay northern dune which runs parallel to the southern shore of Big Swan Bay at the western end of Port Stephens. Her survey identified four Aboriginal archaeological sites. All sites were situated on northern slopes of sand dunes. Stone artefacts were present at all sites and shells at two of the sites:

38-4-0181 (#3 Tanilba Bay) – Open campsite – 34 stone artefacts (flakes and flaked pieces)

38-4-0182 (Oyster Cove #1) – Midden of scattered shell with one flaked stone artefact (silcrete flaked piece)

38-4-0183 (#2 Tanilba Bay) – Midden – eight stone artefacts with dispersed estuarine shell fragments

38-4-0184 (#4 Tanilba Bay) – Open campsite – ten stone flakes and flaked pieces.

All sites lay just outside the project area and were therefore not picked up in the AHIMS database search. Sites 38-4-0181 and 38-4-0182 have been included on the project map as they are situated just on the outer edge of the project's landward boundary and as such are noting.

It appears that Sites 38-4-0181 and 38-4-0184 are the same sites as Sites 38-4-0289 and 38-4-0288 respectively which were identified by Dean-Jones in the Newcastle Bight Survey 1990.

Nicholson 1989

Nicholson was commissioned to conduct an archaeological survey on the northern margin of Tilligerry Creek in respect of a proposed sand mining development. Her survey identified four midden sites, two isolated shells, and a site with three artefacts and two shell fragments. The sites are small and disturbed making interpretation difficult. These sites lie outside of the project area.

Resource Planning Pty Limited 1991b

Resource Planning Pty Limited was engaged by RZM Pty Ltd to undertake an archaeological survey for the proposed mineral sand mining on Mining Leases 134 to 138 west of Tanilba Bay, Port Stephens. The Mining Leases (ML) extend approximately parallel with the Port Stephens shoreline, west of Tanilba Bay.

The survey identified 10 Aboriginal sites including six previously recorded sites which were relocated and re-recorded during the survey:

Previously Recorded Sites:

- Four sites (two middens and two open campsites) had been previously recorded by Brayshaw in 1989 (#38-4-0181 to 38-4-0184). Sites 38-4-0182 and 38-4-0184 were assessed as having low archaeological value in the survey undertaken by Resource Planning. Sites 38-4-0181 and 38-4-0183 were assessed as having moderate archaeological value.
- Two open campsites had been previously recorded west of Oyster Cove by Dean-Jones in 1990 (#38-4-0290 and 38-4-0291). Both sites were assessed as having moderate archaeological value. These sites lie outside the project area.

New Sites:

Three midden sites and one campsite were located on the Port Stephens shoreline during the survey:

- Site 38-4-0316 comprises an extensive scatter of midden shell located within the tidal zone on the Port Stephens' shoreline. The shell material included large examples of drift oysters (*Ostrea angasi*), interspersed with cockles (*Anadara trapezia*) and mud whelk (*Pyrazus ebeninus*). Stone artefacts in the form of flaked cobbles also occur sparsely scattered within the intertidal zone. This site was assessed as having moderate archaeological value.
- Site 38-4-0317 comprised scattered shell midden material and 30 moderately large stone artefacts over a distance of 100 m around the headland. All stone artefacts were within the intertidal zone and immediately adjacent the eroding foreshore. The shell material, comprised as for 38-4-0316, occurs both as a lag in the intertidal zone and as *in-situ* deposit exposed in the face of the shoreline (Resource Planning Pty Limited, 1991b:16). This site was assessed as having high archaeological value.
- Site 38-4-0318 is a midden site comprising cockles, mud whelk and drift oysters. A small area of shell is exposed in the intertidal zone but no flaked stone visible. The shell is densely packed. This site was assessed as having high archaeological value.
- Site 38-4-0319 is an open campsite located on a cuspidate headland at the entrance to Saltwater/Twelve Mile Creek and comprises flaked stone with no shell. This site is located within saltmarsh but is less than 50 m from a mangrove lined estuarine shoreline, and 50 m from former beach ridges and low dunes raises. Dean-Jones notes that the location of this site within saltmarsh:

'raises questions about potential environments for occupation. Estuarine wetland is not normally attributed a high occupation potential. However, the presence of wetland at this locality may be a quite recent phenomenon' (Resource Planning Pty Limited, 1991b:17).

This site was assessed as having high archaeological value.

All other sites recorded away from the Port Stephens shoreline are on disturbed dune surfaces.

It is noted by Resource Planning (1991b:18) that the lack of surface visibility on transgressive dunes is a 'major constraint to testing hypotheses about the distribution of Aboriginal sites. There was zero surface visibility in all areas of transgressive dune where archaeological material was not located'. Their report advocates the need for subsurface investigation in order to clarify the real archaeological significance of the area, particularly in the case of transgressive dunes with low vegetation cover which are 'very poorly represented in Aboriginal site records for the Port Stephens district' (Resource Planning Pty Limited, 1991b:18).

Effenberger (Envirosciences Pty Ltd) 1993

Envirosciences Pty Ltd undertook an archaeological assessment in relation to the reticulation lines of the proposed Lemon Tree Passage sewerage Scheme at Tilligerry Peninsula. The survey area was located within the built up area of Lemon Tree Passage, including foreshore areas of Port Stephens, and Tilligerry Creek and followed a route west of Gibber Point to the site of the Tanilba Bay sewerage treatment plant. Several sites were located the majority of which had been recorded during previous surveys. Sites located by Effenberger that fall within the current project area include:

- 38-5-0140 – Rose Street Reserve

Artefact scatter of one tuff flake, one blade and one discoid flake all showing evidence of retouch and all manufactured from grey tuff. Assessed as having a high degree of archaeological significance.

- 38-5-0141 – Mallulaba Point

Sandstone shelter with no evidence of art, or artefacts, however, two cockle shells were found. Note this site is listed on the AHIMS database as an isolated find but in the site card as a shelter and deposit. The site card description has been accepted for the purposes of this report. Assessed as having a moderate degree of archaeological significance.

- 38-5-0142 – John Parade

Shelter with art and deposit found at the southern end of John Parade. Shell and volcanic porphyry artefact scatter. The artefacts scatter includes one flake, one backed blade (both with retouched edges), and the remaining artefacts are flaked pieces. Assessed as having a high degree of archaeological significance.

- 38-5-0144 – Kooindah Park

Midden – scatter of predominantly *Pyrazus* (mud whelk) shell. This is a remnant of a midden at the end of Marine Drive, at the northern end of Kooindah Park. The midden is eroding into the Bay and very little was left of the midden at the time of the survey. Assessed as having no archaeological significance due to its level of disturbance and lack of scientific potential.

Navin Officer Heritage Consultants 1998

Note report was not available at the time of research.

In 1998 Navin Officer was commissioned by Ove Arup and Partners Pty Ltd on behalf of the NSW Roads and Traffic Authority to undertake a cultural heritage assessment as part of a

route selection study for the proposed Karuah Bypass and Duplication. The study assessed the heritage values of two possible road option corridors (the northern and southern route options). The survey located a total of 15 Aboriginal heritage sites, 19 Aboriginal archaeological sites and two areas of potential archaeological deposit (PAD). The sites that fall within this project area are Sites: 38-1-0030 (KA22); 38-4-0498 (KA1); 38-4-0499 (KA2); 38-4-0501 (KA4); 38-4-0507 (KA10); and 38-4-0516 (KA19).

Navin Officer Heritage Consultants 1999

Following the Route Selection Study, Navin Officer was again commissioned by Ove Arup and Partners Pty Ltd on behalf of the NSW Roads and Traffic Authority to undertake the cultural heritage assessment component of the proposed Pacific Highway Karuah Bypass and Duplication EIS. This assessment focussed on the preferred bypass route – the far northern route – and built upon the results of the 1998 Route Selection Study. The preferred bypass route is located along an alignment through Horse Island, approximately 4 km upstream from, and north of the existing highway at the time, extending north-east of the existing highway just west of the Reedy Creek crossing and rejoining the highway close to a wayside stop north of Yalimbah Creek.

Only 10 Aboriginal sites and two PADS located during the 1998 Route Selection Study were situated within the survey area of this EIS project. Further subsurface investigation was undertaken at relevant sites. Only seven of these sites fall within the Project Area. The available descriptions are provided below.

KA10 (38-4-0507) – artefact scatter, shell and estuarine midden exposures located on the eastern side of the Karuah River. The scatter was discontinuous along a 70 m stretch of river bank and artefacts continued upstream for at least 300 to 400 m. All visible stone artefacts and shell deposits were located within 10 to 15 m of the immediate creek bank. The shell material was highly weathered and fragmentary and included rock oyster (*Crassostrea commercialis*) as the dominant shell type. Stone artefacts included flakes, bondi points, an elouera, a utilised microblade, microblade cores, and bondi point perform fragments. Note this site is registered as an isolated find on the AHIMS database (see email from David Gordon clarifying site feature). As the site card was not available at the time of writing this report we cannot determine where the error in classification has occurred. For the purposes of this report we have kept the site type consistent with the AHIMS record.

KA19 (38-4-0516) isolated find (chert core rejuvenation flake) located on top of, and adjacent to, the edge of a small scarp/slope on the far south-eastern point of Horse Island.

KA20 (38-4-0535) – isolated find located on a broad shoulder on the south-eastern edge of Horse Island. Assessed as low archaeological significance

KA21 (38-1-0029) – isolated find – assessed as low-moderate archaeological significance.

KA22 (38-1-0030) – isolated find – assessed as low archaeological significance.

KA18 isolated find (flake) located in beach gravels of the shoreline on the easternmost point of Horse Island. This flake may have derived from upslope deposits.

In addition to the above sites, two Aboriginal scarred tree sites, an isolated find and ten areas of archaeological potential were identified during the 1999 survey. None of these fall within the project area.

Navin Officer Heritage Consultants 2000

Subsequent to the Cultural Heritage Assessment they undertook as part of the 1999 Karuah Bypass EIS, Navin Officer Heritage Consultants were again commissioned by Ove Arup and Partners Pty Ltd on behalf of the NSW Roads and Traffic Authority to conduct a supplementary archaeological survey and excavation. The survey area still focuses on the proposed upgrade to the section of the Pacific Highway which passes through the Karuah township. Subsequent to the EIS additional areas were identified which required archaeological surveying. The supplementary survey also included a limited program of subsurface testing between two previously identified sites KA10 (midden material and stone artefact scatter) and Site KA21 (PAD with high archaeological potential which is situated on an elevated knoll behind KA10) to determine if the two sites were in fact distinct. The subsurface testing confirmed that Sites KA10 (38-4-0507) and KA21 (38-1-0029) were two distinct sites.

During the course of the survey two *possible* Aboriginal scarred trees (KA27 and KA28) were identified. KA27 (probably a Eucalypt) is located approximately 400 m north of the Pacific Highway on the crest of a low and broad spurline, about 3.5 km west of the Karuah River. KA28 is located approximately 2.5 km east of the Karuah River and one kilometre north of the Pacific Highway on the basal slopes of a range of hills. These sites lie outside of the Project Area.

Australian Museum Business Services (AMBS) 2001

AMBS conducted an archaeological survey within the Salt Ash Air Weapons Range as part of the Aboriginal Heritage Assessment component of an Environmental Assessment being undertaken for the range by the Department of Defence. The weapons range is located approximately 6 km north-east of the RAAF Base Williamtown and 16 km east of Raymond Terrace. The following four sites were found around Twelve Mile Creek:

- Twelve Mile Creek 1 (TMC1) – a site complex consisting of stone artefact scatters along two beaches on the western side of the Saltwater Creek Estuary. (398100E:6378100N (southern limit) to 398450E:6379180N (northern limit) (AMG). A total of 93 artefacts were located in this complex. The largest exposure in this complex was on the sand spit where the two beaches converge.
- Twelve Mile Creek 2 (TMC 2) – a single artefact located in a heavily disturbed exposure. (398710E:6381070N (AMG).
- Pipeclay Creek 1 – two stone artefacts were located on a dam wall next to a drain from the dam to Pipeclay Creek. The artefacts were in a disturbed context and were most likely transported to their present location when earth was moved to construct the dam wall. (397480E:6381430N (AMG). This is shown on Figure XX as PCC1.
- Saltwater Creek 1 – stone artefacts were found along two adjacent and eroding areas of sandy beach at the western shore edge of estuarine mangrove mudflats. The artefacts were predominantly silcrete, unretouched broad platform flakes. Similar artefacts were found made from chert and tuff. A retouched volcanic stone artefact reminiscent in shape of a stone hatchet head blank was also found. (398110E:6377370N to 398370E:6376870N (AMG). This is shown on Figure XX as SWC1

Twelve Mile Creek 1 and Saltwater Creek 1 sites are assessed as having high archaeological significance due to its rarity and considerable research potential.

The sites are locally rare within the Medowie Lowlands and rare in their lack of associated midden despite their estuarine context. The lack of estuarine midden suggest that the artefacts pre-date the development of the Twelve Mile Creek estuary. (AMBS, 2001:21)

AMBS suggest that these sites *contain evidence of Aboriginal occupation which complements that of Moffats Swamp*¹ (21).

Twelve Mile Creek 2 and Pipeclay Creek 1 are assessed as having low significance given the disturbed nature of their current location and the evidence suggesting they have not been found in their original context.

Umwelt 2002

The focus of this Umwelt survey was Tanilba Bay which is located on the Tilligerry Peninsula on the southern shoreline of the Port Stephens embayment. The survey commenced after development consent had been granted by council to the developer (Landcom) and after earthworks had commenced due to the fact that the developer had been advised by Council that an archaeological investigation would not be required given the impact of past sand mining in the area. Archaeological material (small numbers of stone artefacts and shell material – cockle (*Anadara* sp.) and whelk (*Pyrazus* sp.)) was, however, exposed during Stage 1 of the subdivision development. There were also areas of vegetation in proximity to Stage 1 that indicated that that area had not been impacted upon by sand mining.

The shell material was interpreted to have derived from an Aboriginal shell midden that was located within the quarry supplying fill for the development. Application was made for a 'Consent to Destroy with Salvage'. The salvage operation resulted in the collection of 16 stone artefacts two of which were interpreted as having been brought into the site in the fill material. All material collected was manufactured from raw material exotic to the area of the subdivision but available within either the lower Newcastle or upper Tomago Coal Measures. Fifteen of the artefacts were manufactured from tuff, one from quartzite. Artefact types included two cores, six flakes, five broken flakes, two retouched flakes (an elouera and a Bondi Point) and a flaked piece.

One of the conditions of the Stage 1 'Consent to Destroy with Salvage' was that further archaeological survey and sub-surface investigations be undertaken prior to the commencement of further work. Subsequent investigations into the geomorphic history of the Tanilba Bay area indicated that the proposed subdivision area contains relict Pleistocene beach ridges, a landform type not previously subject to intensive survey or subsurface investigation for evidence of Aboriginal occupation (Umwelt, 2002:5). Intensive survey of the beach ridge system is very difficult due to the thickness of the vegetation and consequent lack of ground surface visibility therefore systematic subsurface sampling is recommended as the only satisfactory method to adequately assess "the archaeological sensitivity of this landform (Umwelt, 20002:6). Umwelt believes that the relict beach ridges within the proposed subdivision

'may offer an opportunity to obtain information related to the Aboriginal use of an entirely different landscape that can be compared with that from the Pleistocene transgressive dune systems' (Umwelt, 2002:26).

There is also the possibility, although small, that the ridges may yield both faunal and stone assemblages that could potentially 'show the differential exploitation of resources over time with changes in climate and sea levels' (Umwelt, 2002:26).

In order to optimise the possibility of locating artefacts *in situ*, (i.e. in an undisturbed context) the proposed survey methodology was confined to the areas of greatest archaeological potential, the core of the ridge i.e. ridge crest and ridge flanks. Only the least disturbed

¹ Evidence found at Moffats Swamp (to the west of current study area/east of the township of Medowie) suggests Aboriginal occupation of the Dune dating back to around 15,000 to 7,500 years ago. The Moffats Swamp Dune site is outside the scope of this Foreshore Management Plan.

beach ridge, the southernmost ridge, was recommended for systematic sampling followed by further subsurface investigation should artefactual material be encountered.

Umwelt 2003

In 2003 Umwelt was commissioned by the NSW NPWS to prepare an Aboriginal Place name nomination assessment for the North Arm Cove Stone Arrangements. An Aboriginal Place, defined under Section 84 of the *National Parks and Wildlife Act 1974*, provides a statutory mechanism for the State Government to formally recognise an area of Aboriginal cultural significance that extends beyond the physical evidence of past occupation. An Aboriginal Place is afforded the same protection as a 'relic' which means it cannot be knowingly destroyed, defaced or damaged without the consent of the Director-General of the NPWS. The only criterion for declaration is that the place is or was of special significance to Aboriginal culture. In saying that, extensive specialist investigations (historical, anthropological, archaeological) and community consultations are undertaken during an independent review process of the nomination.

The North Arm Cove Stone Arrangements are located on Baromee Hill on the North Arm Cove Peninsula at Port Stephens (AHIMS Site #38-5-0062). Ray Kelly, the original recorder of the site in 1978 and a NPWS Aboriginal Sites Officer at the time, described the arrangements in his report to NPWS, as consisting of 15 distinct circular structures ranging in size from two-thirds to one and third of a metre in diameter. When the site was first seen

there were at least 27 distinct circular mounds..... these may have reached 35 to 40 before being destroyed by white invasion.Most of these structures have not been tampered with however many have been totally destroyed by Bulldozer tracks.

A total of 13 stone arrangements were recorded by Umwelt in 2003. This number is less than previously recorded due to the decision to include 'only those stone clusters that could be positively identified as having been humanly constructed' (Umwelt, 2003:5.1). One arrangement (#13) is most likely a natural formation but was included in the count as it was not possible to discount its human construction completely (Umwelt, 2003:5.19). All of the stone arrangements were found to have openings with the majority of the arrangements opening towards the crest of the hill. The arrangements were constructed by simply stacking rocks of varying sizes to produce the walls. The stone arrangements are distributed so as to be clustered in two areas which is a pattern exhibited by other recorded Aboriginal stone arrangement sites in NSW, although there is evidence that not all the arrangements belong to the same period of construction. The Aboriginal oral history demonstrates that these stone structures were used as part of the male initiation ceremony. The arrangements are often found in close association with Bora grounds.

At the time of the assessment some ambiguity existed regarding the Aboriginal origins of the structures and their purpose (Brayshaw, 1984:7). McBryde also notes the 'lack of historical reference to their existence and use' but advises that this lack of information needs to be balanced to some degree with the strong possibility that Aboriginal informants may be unwilling or unable to discuss sacred matters with which these arrangements are thought to be associated (McBryde, 1974:44).

It has been suggested that the structures may have been built as gun nests, an overnight military emplacement during WWII, or part of a defensive training exercise. It has also been suggested that these stone arrangements could have been constructed as shepherd's huts, storehouses or as pens for sheep during the period that the AACo ran sheep in the area. All these possibilities were largely discounted and ruled out by Umwelt's Aboriginal Place name nomination assessment. From the interviews provided by the Aboriginal community, Umwelt (2003:6.4) concluded that:

-
- the stone arrangements or the majority of the stone arrangements were constructed by Aboriginal people;
 - the stone arrangements were used for ceremonial purposes and that the site is a spiritual place;
 - most feel that the stone arrangements are related to a section of the male initiation cycle; and
 - a non-Aboriginal origin of the stone arrangements is not supported by the Aboriginal oral history.

Consultation with the Aboriginal community, specifically Lennie Anderson (Chief Executive Officer and Consultant of the Worimi LALC) and Michael Rodgers (Coordinator of the Karuah LALC, revealed the possible existence of another set of stone arrangements on the other side of the river:

I also know of another lot of stone arrangements on the other side of the river to the east of here. Those stone arrangement should be located again and they should also be preserved (Michael Rodgers in Umwelt, 2003:6.1).

There are also some other stone arrangements recorded on the other side of the cove only about 1200 metres northwest of here. Some attempt should be made to try and locate these. (Lennie Anderson in Umwelt, 20032:6.2)

The site referred to by Lennie Anderson is most likely the stone arrangement recorded by Brayshaw in 1984 (38-5-0085 on the western side of Balberook Cove).

STUDY 3

European Heritage

Port Stephens Council

Port Stephens Foreshore Plan of Management – European Heritage

August 2009



Port Stephens Foreshore Plan of Management – European Heritage

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Port Stephens Council

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1.0 The European History of Port Stephens

The following overview of the history of European settlement in the Port Stephens area has been extracted from Armstrong (1996) and Scott (2003).

The first land grant in the Port Stephens area was to William Cromarty, a retired navigator, who was granted 300 acres at the site of today's Nelson Bay Village and part of Salamander Bay. Further grants in the early 1820s and 1830s were brought into production using convict labour. For example, Tanilba House was built by convicts in 1831 for Lieutenant Caswell who received a grant of fifty acres at Tanilba Bay for services to the British Admiralty. It was also during the early part of the 19th century (1820s) that a small garrison of soldiers was established at Soldiers Point. This point provided the narrowest crossing of Port Stephens for escaped convicts from Port Macquarie who were attempting to reach the settled areas further south.

After 1860, the Robertson Land Acts allowed indentured farm workers and tenant farmers to secure small holdings in their own right. Consequently, parcels of land that had generally been divided up into 640 acre lots or larger up until about 1830, were surrounded by parcels of 40 to 60 acres which are characteristic of post-1860.

Up until the early 1900s, the link between Newcastle and Nelson Bay was a sandy track from Stockton to Salt Ash, followed by a boat trip to Nelson Bay via Tilligerry Creek. Slowly sections of road were formed and in 1925, a wheeled motor vehicle could reach Nelson Bay, although the road was impassable in rainy weather. Many of the roads in Nelson Bay were built by local unemployed men during the depression. Many out of work miners moved to the area and built waterfront shacks in which to live and subsisted on fish and oysters during this time. By 1943, 96 families lived in Nelson Bay (Hunter 2001).

The Australian Agricultural Company was the largest early land owner and manager on the northern side of Port Stephens. The company was granted one million acres stretching from Port Stephens to the Manning River in the north, and from the coast westward to the Karuah and Gloucester River valleys. The company's purpose was to breed livestock, establish a fine wool industry and cultivate crops (Smith 2003:27-28). The first manager of the company, Robert Dawson, established the first settlement at Carrington in 1826. Tahlee House, huts, a lumber yard, mill, slaughterhouse, storehouse, dairy, temporary church, military guard house and boat harbour were built by convict labour (Smith 2003:27). The stone church at Carrington was completed later in the 1840s. The company's venture, however, was not successful, mainly due to unsuitable soils. Agricultural efforts were moved to the Booral and Stroud areas by the early 1830s.

Tahlee House was bought by R.H.D White, at one time a member of the NSW Parliament, in 1880. He made major additions to the estate and laid out the gardens. In 1949, a waterfront cottage, and some other buildings were leased by the Gospel Fishermen Mission. The entire estate was then purchased by the Mission in 1959 and became the Tahlee Bible College.

While cedar cutters preceded the Australian Agricultural Company, a substantial timber industry around Port Stephens was not established until the mid 1800s. Up until around the 1890s, timber cutting was generally confined to areas adjacent to a waterway for ease of transport (Smith 2003:34). Having depleted the readily accessible timber, networks of access roads and privately owned timber tramways were built to access the timber further inland. Small independent mills operated throughout the area, as well as larger ones like the one built by the Taylor family at Winda Woppa. These larger mills provided housing for the mill workers and so private villages with shops, social amenities and community life were often associated with the more substantial mills (Smith 2003:35). The industry evolved again

following World War II when harvesting machinery became available and road transport became the most efficient mode of transport.

Port Stephens also supported a large boat building industry. This commenced with a small paddle steamboat called the *Karuah* that was built on the instruction of Sir Edward Parry of the Australian Agricultural Company in 1831 (Smith 2003: 37). The boat serviced Port Stephens and the farms along the lower reaches of the Karuah River. A boat building industry was also established along the banks of the Myall River and Lakes. According to Smith (2003:38), Witts Island at Tea Gardens contains the remains of a slipway. Eight vessels, including two droghers and three storeboats had been operated from the slipway by the Engel family.

Fishing and the harvesting of shellfish such as oysters was carried out by Aboriginal people thousands of years prior to the arrival of Europeans. Commercial fishing began in the early 1800s when Chinese fishermen used nets and lines to catch snapper, garfish, salmon and lobsters. The fish was preserved by salting or drying, and lobsters were cured. The catches were dispatched to the goldfields or to merchants in Sydney and Melbourne. Chinese fishermen had generally left the area by the 1880s and the industry was continued by Europeans. However, the European industry concentrated on fresh fish and the remoteness from large markets prevented the industry from prospering. The Fishermens Co-op, established in 1956, improved the situation by erecting refrigerated storage sheds. Other fishing ventures in the area have included a shark processing station at Pindimar (1927-1933) which was replaced by the Port Stephens Canning Co. The canning company also folded in 1838.

The first method utilised in the commercial harvesting of oysters was to dredge the beds of the estuary (Smith 2003:39). This method quickly denuded stocks and the NSW government progressively implemented regulations regarding size and harvesting methods during the second half of the 19th century. The first oyster leases in Port Stephens were established during this time and the industry remains strong today. Very little historic evidence of the early industry remains because the sheds, jetties and cultivation racks have been continually replaced to this day (Smith 2003:40).

There were visionary plans for Port Stephens in the early 1900s. The area was identified as a suitable location for an international deepwater port in 1910-11, and a large parcel of land at Salamander Bay was acquired by the Federal Government for a proposed naval base (Smith 2003:52). In 1919-20, Sir Walter Burley Griffin and surveyor-entrepreneur released plans for Port Stephens City between Balberook Cove and North Arm Cove. Work commenced on the city in 1818. More than 2000 blocks were subdivided and streets were laid out. The sale of the subdivision was not successful for a variety of reasons including the Depression and the fact that the naval base was eventually built in Singapore (Smith 2003:52). In 1963, the Great Lakes Council closed many of the roads and the majority of the area was zoned non-urban. Sir Walter Burley Griffin also planned a city to the east of North Arm Cove called Pindimar City. This project also failed due to lack of finance and a slow selling rate.

During World War II, Australian and American training centres were established in the Shoal Bay/Nelson Bay area. The United States VII Amphibious Force trained using landing craft, tanks and mechanised vehicles in this area where the waterway and beaches were ideal training grounds for amphibious warfare (Armstrong 1996:12). The main defence establishment was the land base HMAS Assault at Fly Point. Facilities such as boatsheds, wharves, mooring blocks, roads, and slipways were constructed. Additionally, Tomaree Head was transformed into a garrison to guard the entrance of the port. The facility was equipped to fire shells and discharge torpedoes.

All of the activities have resulted in the historic sites that are located around the foreshore today.

2.0 Heritage Items Located on the Foreshore

Heritage Schedules within the Port Stephens and Great Lakes LEPs identify and protect heritage items through their planning and development assessment processes. Items listed on these schedules are included in **Tables 2.1** and **2.2**. This table also includes items identified by the Great Lakes Heritage Study. These items will eventually be added to the LEP Heritage Schedule.

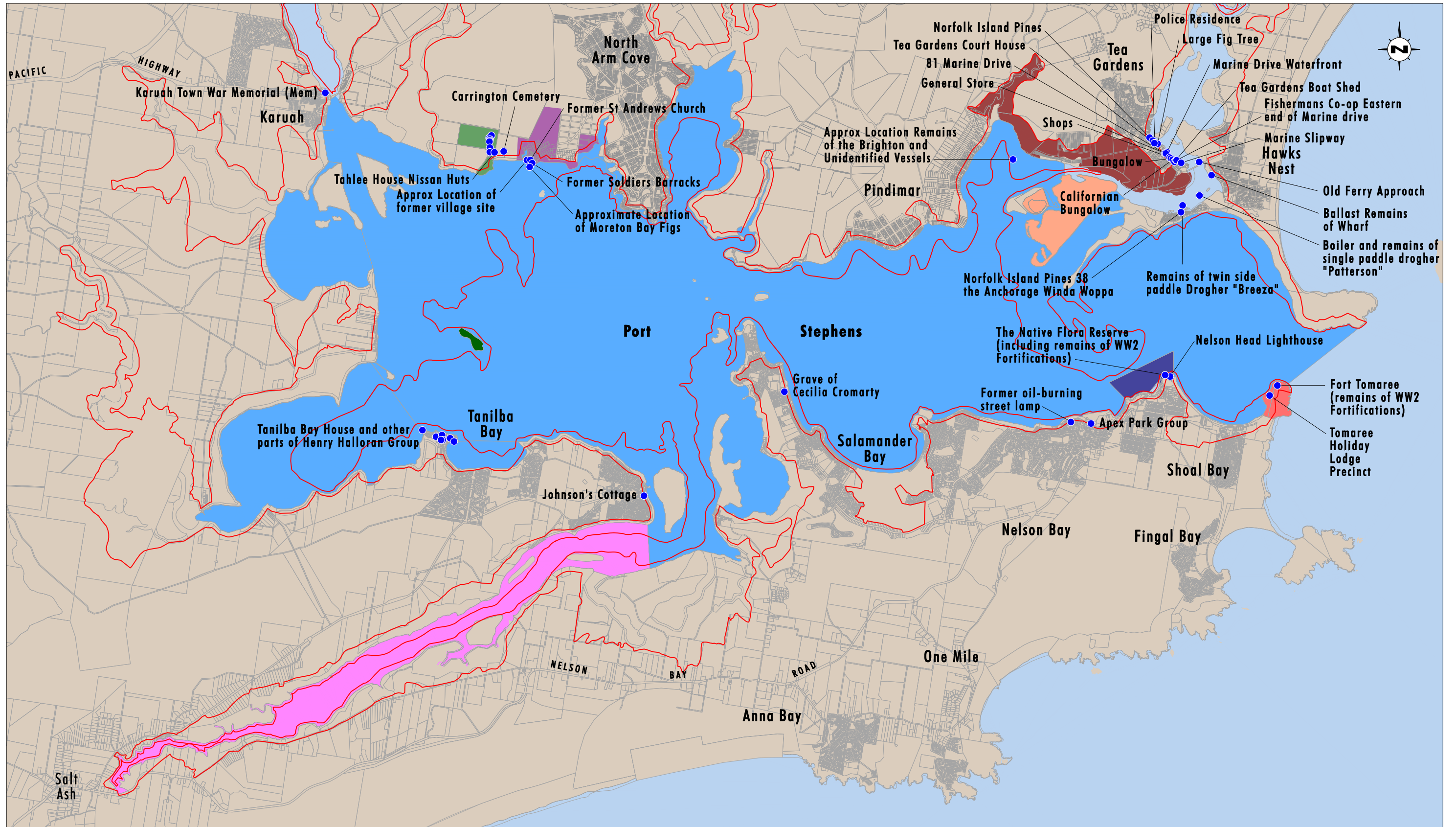
The State Heritage Register is managed by the NSW Heritage Council and comprises a list of heritage items of particular importance to the people of NSW. Items listed on this register are afforded statutory protection under the *NSW Heritage Act 1977*. Items listed on this register that are relevant to the current study are also listed on the LEP Heritage Schedules. **Table 2.3** summarises foreshore places that are listed on the State Heritage Register.

The Australian Heritage Database includes places in the World Heritage List, the National Heritage List, the Commonwealth Heritage List and the Register of the National Estate. A number of places within the foreshore zone are listed on the Register of the National Estate (see **Table 2.4**). The Commonwealth Government is the only body whose actions are constrained by a listing on this Register.

All heritage items located on the Port Stephens Foreshore are shown on **Figure 2.1**.

Table 2.1 – Heritage Items Listed in the Port Stephens LEP

Part 1 – Heritage Items of State Significance		
Foreshore Management Zone	Location	Description
A1	Lot 427, DP 39728 5A Lighthouse Road Nelson Bay	Nelson Head Lighthouse, cottage and reserve.
A1	Lot 454, DP 705463 2 Shoal Bay Road Shoal Bay	Remains of World War II fortifications, Fort Tomaree, including gun bases and torpedo tube bases, torpedo tube jetty.
A1	Lot 453, DP 705463 4 Shoal Bay Road Shoal Bay	Tomaree Holiday Lodge Precinct.
C2	Lot 1, DP 182666 Reserve No. 63326 2B and 2C Caswell Crescent Tanilba Bay	Part of Henry Halloran Group – Sunset Park, including two stone seats, large stone table, stone fire place and kilns.
C1/C2	Lot 2, DP 548644 30 Caswell Crescent Tanilba Bay	Part of Henry Halloran Group – Stone wall west of Tanilba House.
C2	Lot 13, DP 16873 30A Caswell Crescent Tanilba Bay	Part of Henry Halloran Group – Palm Circle – specimens of <i>Livistona australis</i> (Cabbage Tree Palm).



Source: LPI NSW (2000), Great Lakes Council (2006), Port Stephens Council (2006)

0 1 2 4km
1:80 000

Legend

- Study Area
- Carrie Island
- Halifax Park Aquatic Reserve
- Port Stephens Estuary
- Proposed Carrington Heritage Conservation Area
- Tomaree Headland
- Snapper Island
- Tahlee House and Grounds
- Tea Gardens Wetlands
- Tilligerry Creek
- Heritage Sites

FIGURE 2.1

European Heritage Sites

Table 2.1 – Heritage Items Listed in the Port Stephens LEP (cont)

Part 1 – Heritage Items of State Significance		
Foreshore Management Zone	Location	Description
C1	Lot 1, DP 548644 32 Caswell Crescent Tanilba Bay	Tanilba House, including remnants of convict barracks, garden cottage, water tank, stone walls, circular drive, wishing chair, direction finder, olive tree, rustic pergola and wisteria vine and garden setting including Bunya Pine and fig tree.
C1	Lot 2 DP 182666, Lot 1 DP 848809, Lot 7018 DP 1052527, 37A, 37B and 37C Caswell Crescent Tanilba Bay	Part of Henry Halloran Group – Meridian Park – including six <i>Phoenix canariensis</i> (Canary Islands Date Palm), remains of circle planting of <i>Livistona australis</i> (Cabbage Tree Palm), stone seat, relocated barbecue and possible site of three burials.
C1	Lot 36 DP 16873 44 Caswell Crescent Tanilba Bay	Part of Henry Halloran Group – former summer house, remains of former barbecue and commemorative stone work.
C1	Road Reserve Pomona Place Tanilba Bay	Part of Henry Halloran Group – former bathers' changing room and circular rock wall.
A1	DP 753204 1 Lighthouse Road Nelson Bay	The Native Flora Reserve, including site of former migrant camp, foundations of HMAS Assault, Aboriginal scar tree, burial site and below water artefacts and items including Higgins landing barges, army jeeps, various munitions and anchor of USS Henry S Grant.
A3	Lot 321 DP 595752 147A Soldiers Point Road Soldiers Point	Grave of Cecilia Cromarty – adjacent to Seaview Crescent.

Table 2.2 – Heritage Items Listed in the Great Lakes LEP 1996 and identified in the Great Lakes Heritage Study

Foreshore Management Zone	Item	Comments
D	Remains of Allworth Wharf, eastern side of Karuah River, Allworth	Relates to early twentieth century hardwood timber milling. Nothing remains of the wharf.
D	Weatherboard cottage with bull nose iron verandah, overlooks wharf site, right side of road approaching wharf, Allworth	
E	Carrington historical and archaeological conservation area	Relates to A.A.Co's first settlement.
E	Carrington Cemetery, Pt Portion 206 (not inspected)	Important early cemetery of State significance. Relates to first settlement in the Great Lakes area and the A.A. Co.

Table 2.2 – Heritage Items Listed in the Great Lakes LEP 1996 and identified in the Great Lakes Heritage Study (cont)

Foreshore Management Zone	Item	Comments
E	Former St Andrews Church	Important 1847 church built of local and imported stone, relates to A.A. Co.
E	Former soldiers' barracks cottage	Small cottage relates to A.A. Co. and first settlement. Much changed but still identifiable.
E	Carrington Boat Harbour and limekiln (Cock Renoyo Point – could not locate)	Early relics relating to A.A. Co. Of state significance.
E	Tahlee House Estate	Important group of items relating to the A.A. Co. and early pastoral endeavour in Australia. Of state and national significance. Relate to the other use by R.H.D. White.
E	Carrington former village site and other archaeological sites, require assessment	Relates to A.A. Co's first settlement. Requires full assessment. Is of state significance and should require excavation permit within conservation area (see Figure 2.1).
E	Tahlee House, main building	As above.
E	Tahlee House reception and ballroom wing	Important historically. Relates to the R.H.D. White period, 'gentleman's' life style of the period.
E	Tahlee House – other outbuildings	Relate to the above items, State and National significance.
E	Tahlee House – boat harbour	Important early relic relating to the A.A. Co. State and national significance.
E	Tahlee House – grounds and gardens	Important relics of garden and landscaping styles relating to the above significance and periods. State and national significance.
E	Tahlee Nissan Huts, later additions	Relates to WWII and migrant use, later to the Bible College use and history. Probably of State/National significance but no need to keep all.
F3	Three Morton Bay fig trees on waterfront near oyster lease	
F3	Court House 53 Marine Drive Tea Gardens	Significant item remaining from Tea Gardens early twentieth century development.
F3	103 Marine Drive Tea Gardens	Distinctive Californian bungalow style dwelling in original condition (some change to verandah) and interesting detail including grooved front weatherboards in imitation of stone. Reflects Tea Gardens early 20 th century growth.
F3	97 Marine Drive Tea Gardens	Distinctive bungalow style dwelling with original windows faceted bay window to the front projecting room. Important association with the Engel family.
F3	Police residence 51 Marine Drive	Group with Courthouse.

Table 2.2 – Heritage Items Listed in the Great Lakes LEP 1996 and identified in the Great Lakes Heritage Study (cont)

Foreshore Management Zone	Item	Comments
F3	Large fig tree near 59 Marine Drive, large fig tree outside Police Residence, 51 Marine Drive, Tea Gardens	Strong streetscape value. The first item in particular is an excellent example of its type. Both appear to be native to the area.
F3	General Store 83 Marine Drive Tea Gardens Includes adjacent residence and the Snorkelling and Dive Shop (original general store) in Maxwell Street	Historically significant group reflecting past retail methods but still operating today.
F3	Shops, 89 Marine Drive, Tea Gardens	Record Tea Gardens early 20 th century development and local retailing methods of the time as a complete emporium rather than separate shops. Closed in the 1950s. Built and operated by the Engel family.
F3	Marine slipway, eastern end of Marine Drive	Has been in continued use for many years. Reflects Tea Gardens' past shipping history.
F3	Norfolk Island pines, near 45-47 Marine Drive Tea Gardens	Prominent streetscape elements and historically popular and significant plantings in seaside and riverbank localities (one suffering dieback).
F3	Remains of droghers, etc, slipways, Witts Island, Myall River	Important historical remains relating to boat building and repairs, and to local river and ocean going transport.
F3	109 Marine Drive Tea Gardens	
F3	37 Marine Drive Tea Gardens	
F3	81 Marine Drive Tea Gardens	
F3	The Marine Drive waterfront	
F3	Fisherman's co-op, eastern end of Marine Drive, Tea Gardens	
F3	Tea Gardens boat shed, Marine Drive	
F3	Old ferry approach and ferry side, Hawks Nest side	Historically significant as a relic of previous transport systems.
F3	Ballast, remains of wharf timbers, eastern bank of Myall River, Hawks Nest	Records Tea Gardens – Hawks Nest's historical association with maritime and river transport.

Table 2.2 – Heritage Items Listed in the Great Lakes LEP 1996 and identified in the Great Lakes Heritage Study (cont)

Foreshore Management Zone	Item	Comments
F3	Boiler and remains of the single paddle drogher <i>Patterson</i> , Hawks Nest	Records Tea Gardens – Hawk Nest’s historical association with maritime and river transport and the past importance of the timber industry.
F3	Remains of the twin side paddle drogher <i>Breeza</i> , Hawks Nest	Records Tea Gardens – Hawk Nest’s historical association with maritime and river transport and the past importance of the timber industry.
F2	Norfolk Island pines, 38 The Anchorage Winda Woppa	Landmark qualities, age, example of species, community concerns. Norfolk Island pines were early popular plantings in coastal areas and have special significance in such areas.
E	Remains of the <i>Brighton</i> and unidentified vessels, Pindimar	Pindimar Bay contains the remains of several ships in a shipping ‘graveyard’. The <i>Brighton</i> is the only identified ship.

Table 2.3 – Items Listed on the State Heritage Register

Foreshore Management Zone	Item	Statement of Significance
A1	Tomaree Holiday Lodge – Landscape Shoalhaven Road, Shoal Bay, Lot 453, DP 705463	The natural vegetation of the Tomaree Headland is of environmental significance.
C1	Tanilba House and The Temple Admiralty Avenue, Caswell Crescent, Cnr Caswell Avenue, Tanilba Bay Lot 45 DP 16873, Lot 1 DP 548644, Lot 2 DP 548644	No statement provided.
E	Tahlee Bible College Tahlee Road, Carrington Lot 340 DP 735514, Lot 341 DP 740621, Part Lot 342 DP 740621	Tahlee Estate is of very high local, regional, state and national significance, contributing to our understanding of the history and development of Australia in every aspect of cultural significance including pre-European and European settlement. Evidence of past use of the Estate and the reasons for its significance remains sufficiently intact for the interpretation of the heritage of the Estate.

Table 2.4 – Items Listed on the Register of the National Estate

Foreshore Management Zone	Heritage Item	Statement of Significance (Summary)	Legal Status
Whole	Port Stephens Estuary, Nelson Bay	The Port Stephens Estuary contains the largest area of mangroves (2700 ha) and the second most extensive area of seagrass (1000 ha) in NSW. It also contains a large area of saltmarsh (1400 ha). These communities are in a good condition and are prime examples of these vegetation types in northern NSW. They are also important for maintaining regional fish, prawn and crab populations. The area is an important feeding and staging area of migratory waders. The Fly Point – Halifax Bay area supports, for NSW coastal waters, a high diversity and abundance of sedentary marine animals, particularly sponges, and is separately listed in the Register of the National estate. It is possible that cultural values, both Indigenous and non-Indigenous, of National estate significance may exist in this place.	Register of the National Estate Registered
Whole	Port Stephens, Nelson Bay	Outstanding scenic beauty of offshore islands and dominant headlands and timbered, hilly foreshore of one of the most extensive waterways on the coast. The waters of Port Stephens are pristine, making it an important scientific reference area and a prime breeding area for oysters.	Register of the National Estate Indicative place
A1	Tomaree Headland (west section)	The historical significance of the site is secondary to the present aesthetic and cultural value it has for the residents and tourists alike. Tomaree and its twin headland, Yacaaba, were named by the Worimi. Retention of the headland, without commercial development, could be a memorial to the Worimi people. Port Stephens was a training centre for both Australians and US troops during WWII. Tomaree was fortified, including with two six inch naval guns. The Tomaree Headland (west section) had a war time jetty and a ramp from which torpedoes were loaded onto naval vessels. There is a number of wartime relics dotted over the headland.	Register of the National Estate Indicative place

Table 2.4 – Items Listed on the Register of the National Estate (cont)

Foreshore Management Zone	Heritage Item	Statement of Significance (Summary)	Legal Status
F1	Corrie Island, Limekilns Road, Tea Gardens	Corrie Island is an important component of the Port Stephens wader habitat, which is one of the six most important wader areas in NSW. The sandspit is a major roosting site for medium and large sized waders in the Port Stephens area. The island is amongst the most important nesting sites of the little tern (<i>Sterna albifrons</i>) in NSW, which is considered to be endangered in this state. The place also supports a breeding population of the mangrove kingfisher (<i>Halycon chloris</i>) which is considered to be vulnerable to extinction in NSW. It is possible that Indigenous cultural values of National Estate significance may exist in this place.	Register of National Estate Registered
B2	Tilligerry Creek Area, Lemon Tree Passage Road, Lemon Tree Passage	The eucalypt forest provide habitat and food for a large population of koalas (<i>Phascolarctos cinereus</i>), which is unusual in its proximity to urban areas. Koalas are a threatened species in NSW. The wetlands, including Fenninghams Island, are used as foraging habitat by migratory waders and other waterbirds.	Register of the National Estate Indicative place
C3	Snapper Island Nature Reserve, Tanilba Bay	Comprises an isolate of littoral rainforest and fringing mangroves on and around a regionally rare red toscanite outcrop in the estuarine setting of the drowned embayment of Port Stephens. The hairy silkpod vine (<i>Parsonsia velutina</i>) reaches its southern range limit at this locality. Of trees common in the well developed though somewhat species depauperate littoral rainforest patch, <i>Olea paniculate</i> and <i>Ficus fraseri</i> approach their southern most occurrence at Snapper Island. The reserve's rainforest assemblage is of considerable scientific interest in the regional context of plant associations and distributions. It also furnishes a significant habitat isolate for rainforest passerines and frugivorous pigeons.	Register of the National Estate Registered

Table 2.4 – Items Listed on the Register of the National Estate (cont)

Foreshore Management Zone	Heritage Item	Statement of Significance (Summary)	Legal Status
A1	Nelson Head Inner Lighthouse, Cottage and Reserve, Lighthouse Road, Nelson Bay	As part of a nation wide network of lifesaving maritime navigational facilities, the Lighthouse, Cottage and Reserve have played a significant role for over 125 years in the development of Australia. Their preservation and restoration to virtual original condition is enabling present and future generations to understand the tremendous historical significance and contribution to Australia's culture and development of these facilities; and to visually and physically experience the way of life during those pioneering times – an opportunity which is becoming increasingly restricted.	Register of the National Estate Indicative place
A1	Fort Tomaree, Shoal Bay Road, Shoal Bay	The Tomaree and Shoal Bay area was the first combined operations Australia/United States Amphibious Landing Training Establishment in the south-west Pacific theatre. It was established at the express order of General Blamey who later relinquished control to General Macarthur. Fort Tomaree is an excellent example of fortification design and construction of this Coastal Defence area which was declared obsolete in the late 1950s. These structures are almost fifty years old and will never be duplicated.	Register of the National Estate Indicative place
A1	Fly Point, Halifax Park Aquatic Reserve, Victoria Parade, Nelson Bay	The place supports a high diversity, for NSW coastal waters, of sedentary marine animals, particularly sponges. The sponge gardens deep sublittoral cliffs and the variety of marine life present combine to create a spectacular and aesthetic underwater landscape held in high esteem by the diving community.	Register of the National Estate Registered
E	Tahlee House Grounds, Structures and Outbuildings, Tahlee Road, Carrington	Attractive landscaping and interesting historical remains of the Australian Agricultural Company settlement which substantially add to the character and worth of the Tahlee House Estate.	Register of the National Estate Registered
E	Tahlee House Group, Tahlee Road, Carrington	An important historical building being the first company residence of the Australian Agricultural Company in Australia, which served as the home of the company's first four superintendants, Dawson, Parry, Dumaresq and King. The building is interesting architecturally and is beautifully sited on the shores of Port Stephens.	Register of the National Estate Registered

Table 2.4 – Items Listed on the Register of the National Estate (cont)

Foreshore Management Zone	Heritage Item	Statement of Significance (Summary)	Legal Status
E	Tahlee House Reception and Ballroom Wing, Tahlee Road, Carrington	Two large late Victorian buildings, built c1890 by the Honourable R.H.D. White (member for Gloucester in NSW Parliament), which substantially add to the interest of the Tahlee House estate.	Register of the National Estate Registered
F2	Tea Gardens Wetland, Myall Street, Tea Gardens	It provides a pristine habitat for a large number of indigenous and migratory bird species. It provides nursery ground and spawning area for significant commercial and non commercial fish and crustacean species. The site has recognised plant species regarded as being worthy of preservation in the most natural form possible. Here there is the potential educational observational facility for people to interact with a most important habitat. Local, national and world migratory birds (some endangered species) inhabit the area. Unspoilt naturalness and rarity.	Register of the National Estate Indicative place

3.0 Management Issues

The key considerations with regard to European heritage in the foreshore zone are:

- There has been piecemeal documentation and management of European heritage in the absence of a strategic regional management plan in the Port Stephens Local Government Area.
- All items identified in the Great Lakes Heritage Study will be incorporated into the Great Lakes LEP Heritage Schedule.
- The majority of foreshore heritage sites are located in the Shoal Bay/Nelson Bay (Management Zone A1), Tanilba Bay (Management Zones C1 and C2), Tahlee/Carrington (Management Zone E) and Tea Gardens (Management Zone F3) areas.
- The main threat to heritage items is lack of maintenance.

3.1 Current Management

The Port Stephens LEP (Division 3 Heritage Provisions) and the Great Lakes LEP (Special Provisions – Heritage) set out each Council's responsibilities for the assessment of development applications that affect European heritage sites. Additionally, both LEPs provide conservation incentives.

The Great Lakes Heritage Study investigates the rich history of Port Stephens and the rest of the Great Lakes region. It provides management recommendations for European heritage places in the Great Lakes Local Government Area.

Both the Port Stephens and Great Lakes Councils have Local Heritage Assistance Funds. The aim of these Funds is to encourage positive work on heritage items and to promote greater interest and concern for the conservation of heritage items.

The Port Stephens Historical Society is an active community group which works closely with Council. The Society provided many of the nominations of places now listed on the LEP Heritage Schedule. Its main aim is to study, collect and disseminate historical information about the Port Stephens area.

3.2 Identified Management Action

A strategic regional European heritage management study is required for the Port Stephens Local Government Area. Such a study would incorporate the many important heritage items within the foreshore area.

STUDY 4

Foreshore Stability

UMWELT (AUSTRALIA)

**Port Stephens Foreshore
Management Plan**

Coastal Engineering Advice

Report

Document Number 3001144.013



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GLOSSARY

Accretion	The accumulation of (beach) sediment, deposited by natural fluid flow processes.
ACES	A computer program, developed by the US Army Corps of Engineers, that is used to determine, among other things, levels of wave runup on natural beaches.
Aeolian	Adjective referring to wind-borne processes.
Astronomical tide	The tidal levels and character which would result from gravitational effects, e.g. of the Earth, Sun and Moon, without any atmospheric influences.
Backshore	(1) The upper part of the active beach above the normal reach of the tides (high water), but affected by large waves occurring during a high. (2) The accretion or erosion zone, located landward of ordinary high tide, which is normally wetted only by storm tides.
Bar	An offshore ridge or mound of sand, gravel, or other unconsolidated material which is submerged (at least at high tide), especially at the mouth of a river or estuary, or lying parallel to, and a short distance from, the beach.
Bathymetry	The measurement of depths of water in oceans, seas and lakes; also the information derived from such measurements.
Beach profile	A cross-section taken perpendicular to a given beach contour; the profile may include the face of a dune or sea wall, extend over the backshore, across the foreshore, and seaward underwater into the nearshore zone.
Berm	A nearly horizontal plateau on the beach face or backshore.
Breaker zone	The zone within which waves approaching the coastline commence breaking, typically in water depths of around 2 m to 3 m in fair weather and around 5 m to 10 m during storms
Breaking depth	The still-water depth at the point where the wave breaks.
Chart datum	The plane or level to which soundings, tidal levels or water depths are referenced, usually low water datum.
Coastal processes	Collective term covering the action of natural forces on the shoreline, and the nearshore seabed.
Datum	Any position or element in relation to which others are determined, as datum point, datum line, datum plane.
Deep water	In regard to waves, where depth is greater than one-half the wave length. Deep-water conditions are said to exist when the surf waves are not affected by conditions on the bottom, typically in water depths of around 60 m to 100 m.
Dunes	Accumulations of wind-blown sand on the backshore, usually in the form of small hills or ridges, stabilised by vegetation or control structures.
Dynamic equilibrium	Short term morphological changes that do not affect the morphology over a long period.
Ebb tide	A non-technical term used for falling tide or ebb current. The portion of the tidal cycle between high water and the following low water.
Erosion	On a beach, the carrying away of beach material by wave action, tidal currents or by deflation.
Flood tide	A non-technical term used for rising tide or flood current. In technical language, flood refers to current. The portion of the tidal cycle between low water and the following high water.

Geomorphology	That branch of physical geography that deals with the form of the Earth, the general configuration of its surface, the distribution of the land, water, etc.
High water (HW)	Maximum height reached by a rising tide. The height may be solely due to the periodic tidal forces or it may have superimposed upon it the effects of prevailing meteorological conditions. Non-technically, also called the high tide.
ICOLL	An acronym for Intermittently Closed or Open Lake or Lagoon
Inshore	(1) The region where waves are transformed by interaction with the sea bed. (2) In beach terminology, the zone of variable width extending from the low water line through the breaker zone.
Inshore current	Any current inside the surf zone.
Inter-tidal	The zone between the high and low water marks.
Littoral	(1) Of, or pertaining to, a shore, especially a seashore. (2) Living on, or occurring on, the shore.
Littoral currents	A current running parallel to the beach, generally caused by waves striking the shore at an angle.
Littoral drift	The material moved parallel to the shoreline in the nearshore zone by waves and currents.
Littoral transport	The movement of littoral drift in the littoral zone by waves and currents. Includes movement both parallel (long shore drift) and perpendicular (cross-shore transport) to the shore.
Longshore	Parallel and close to the coastline.
Longshore drift	Movement of sediments approximately parallel to the coastline.
Low water (LW)	The minimum height reached by each falling tide. Non-technically, also called low tide.
Mean high water (MHW)	The average elevation of all high waters recorded at a particular point or station over a considerable period of time, usually 19 years. For shorter periods of observation, corrections are applied to eliminate known variations and reduce the result to the equivalent of a mean 19-year value. All high water heights are included in the average where the type of tide is either semidiurnal or mixed. Only the higher high water heights are included in the average where the type of tide is diurnal. So determined, mean high water in the latter case is the same as mean higher high water.
Mean high water springs (MHWS)	The average height of the high water occurring at the time of spring tides.
Mean low water (MLW)	The average height of the low waters over a 19-year period. For shorter periods of observation, corrections are applied to eliminate known variations and reduce the result to the equivalent of a mean 19-year value.
Mean low water springs (MLWS)	The average height of the low waters occurring at the time of the spring tides.
Mean sea level	The average height of the surface of the sea for all stages of the tide over a 19-year period, usually determined from hourly height readings.
Morphology	The form of a river/estuary/lake/seabed and its change with time.
Nearshore	In beach terminology, an indefinite zone extending seaward from the shoreline well beyond the breaker zone.
Nearshore circulation	The ocean circulation pattern composed of the nearshore currents and the coastal currents.
Nearshore current	The current system caused by wave action in and near the breaker zone, and which consists of four parts: the shoreward mass transport of water; longshore currents; rip currents; and the longshore movement of the expanding heads of rip currents.

Refraction	The process by which the direction of a wave moving in shallow water at an angle to the bottom contours is changed. The part of the wave moving shoreward in shallower water travels more slowly than that portion in deeper water, causing the wave to turn or bend to become parallel to the contours.
Rip current	A strong current flowing seaward from the shore. It is the return of water piled up against the shore as a result of incoming waves. A rip current consists of three parts: the feeder current flowing parallel to the shore inside the breakers; the neck, where the feeder currents converge and flow through the breakers in a narrow band or "rip"; and the head, where the current widens and slackens outside the breaker line.
Runup	The rush of water up a structure or beach on the breaking of a wave. The amount of run-up is the vertical height above still water level that the rush of water reaches. It includes wave setup.
Salient	A build-up of littoral drift on the shoreline, usually located in and in response to the wave shadow caused by an offshore breakwater or island.
SBEACH	A computer program, developed by the US Army Corps of Engineers, that is used to determine, among other things, wave transformation across the surf zone, beach and dune erosion and levels of wave runup on natural beaches.
Setup	Wave setup is the elevation of the nearshore still water level resulting from breaking waves and may be perceived as the conversion of the wave's kinetic energy to potential energy.
Shoal	(1) (noun) A detached area of any material except rock or coral. The depths over it are a danger to surface navigation. (2) (verb) To become shallow gradually.
Shore	That strip of ground bordering any body of water which is alternately exposed, or covered by tides and/or waves. A shore of unconsolidated material is usually called a beach.
Shoreface	The narrow zone seaward from the low tide shoreline permanently covered by water, over which the beach sands and GRAVELS actively oscillate with changing wave conditions.
Shoreline	The intersection of a specified plane of water with the shore.
Significant wave	A statistical term relating to the one-third highest waves of a given wave group and defined by the average of their heights and periods.
Significant wave height	Average height of the highest one-third of the waves for a stated interval of time.
Spring tide	A tide that occurs at or near the time of new or full moon, and which rises highest and falls lowest from the mean sea level (MSL).
Storm surge	A rise or piling-up of water against shore, produced by strong winds blowing onshore. A storm surge is most severe when it occurs in conjunction with a high tide.
Sub-aerial beach	That part of the beach which is uncovered by water (e.g. at low tide sometimes referred to as drying beach).
Surf zone	The nearshore zone along which the waves become breakers as they approach the shore.
Swell	Waves that have traveled a long distance from their generating area and have been sorted out by travel into long waves of the same approximate period.
Tide	The periodic rising and falling of the water that results from gravitational attraction of the moon and sun acting upon the rotating earth. Although the accompanying horizontal movement of the water resulting from the same cause is also sometimes called the tide, it is preferable to designate the latter as tidal current, reserving the name tide for the vertical movement.

1 INTRODUCTION

Umwelt (Australia) is preparing the Port Stephens Foreshore Management Plan for the Councils of Port Stephens and Great Lakes. The study area extends around the entire foreshore of the Port, including the tidal section of the Karuah River (up to Allworth) and the lower Myall River.

In respect of foreshore erosion, the brief requires the identification of areas that are affected by erosion and/or have existing erosion protection structures in place and recommendations regarding the management of these issues. The recommendations are to form guidelines for the development of a *Development Control Plan (DCP) for Foreshore Stabilisation and Protection* by Council.

Figure 1.1 shows locations identified as being affected by erosion and/or having existing foreshore protection structures.

The aims of this report include:

- Review of and provide a brief explanation of the processes causing erosion at:
 - Corlette Beach/Sandy Point;
 - Salamander Bay;
 - Eastern shoreline of Soldiers Point;
 - Taylors Beach;
 - Lower Tilligerry Creek;
 - Lemon Tree Passage/Mullabula;
 - Karuah River (in the vicinity of the town of Karuah);
 - Tahlee/Carrington area;
 - North Arm Cove; and
 - Lower Pindimar and Pindimar.

- Present management strategies that address the various processes driving erosion and define zones where protection works are likely to be required so that they can be referenced specifically in the proposed DCP.
- Provide guidelines regarding the management of existing foreshore protection structures.
- Provide design guidelines for effective and appropriate foreshore protection structures.

Locations that are affected by erosion but have been addressed previously (through studies and management plans) include Shoal Bay, Tanilba Bay and Jimmys Beach (Winda Woppa). In regard to these locations, no further investigations have been undertaken.

In providing this advice we have relied on the reports of Manly Hydraulic Laboratory (MHL759, MHL880) defining water levels and wave conditions for the Port Stephens foreshores.

2 EROSION PROCESSES

2.1 Sandy Point

Sandy Point is located on the southern foreshore of the Outer Port, west of Dutchies and east of Corlette Point (Figure 2.1 (bottom)). Significant rock groyne and seawall construction attest to a severe coastal erosion problem there (Figure 2.3).

2.1.1 Coastal Processes and Causes of Erosion

Historical hydrographic surveys of Port Stephens, dating back to 1792, have indicated that the ocean entrance to the Myall River, originally, was located between what is now known as Corrie Island and what was once known as Myall Point (Figure 2.1 (top)). The Myall River was used to transport timber and, early last century, the Public Works Department improved the navigability of the river entrance by dredging a cut on the northern side of Corrie Island into Duckholes Bay. This new entrance channel, being sheltered from ocean swell and, hence, having a lower tailwater control, became the predominant inlet for the Myall River (Nielsen, 1994).

The dredging of the cut was the triggering cause of widespread changes felt both on the northern and southern shores of the Outer Port (Nielsen, 1994). These effects have included the erosion of Jimmys Beach, on the north-eastern foreshore, and erosion at Sandy Point as far away as Corlette on the southern shoreline.

The changes can be attributed to the effects of the dredging on the hydraulic characteristics of the Myall River entrance and its subsequent effect on Myall Point. Following dredging of *The Cut*, Myall Point deteriorated progressively as a result of the cessation of the sand transporting mechanisms that had maintained it. The Point was breached by severe gales in 1927 and 1929 and, today, it comprises a large area of subaqueous and inter-tidal sand shoals known as Paddy Marrs Bar.

The loss of Myall Point altered the pattern of wave propagation throughout the Outer Port of the estuary (Figure 2.1 (bottom) and Figure 2.2). The exposure of Jimmys Beach to westerly seas has resulted in its progressive recession with the dune sands, eroded by ocean swell, being transported away from the beach under westerlies to the Yacaaba isthmus. For the period 1951 to 1984 the average annual sand loss from a 1 km length of the beach was about 8,000 m³, leading to recession of the foreshore at an average rate of about 1 m/year (Wilson and Nielsen, 1987). Considerable public and private assets are now at risk and Council has been required to protect the beach on several occasions

with beach nourishment, the sand being won, initially, from Paddy Marrs Bar and, more recently, from Yacaaba Isthmus.

Further to sheltering Jimmys Beach from westerly seas, Myall point also prevented ocean swell from penetrating the Outer Port. With the loss of Myall Point, ocean swell now refracts over the low sand shoals of Paddy Marrs Bar and impinges onto the southern shoreline at Sandy Point (Figure 2.2). Since the 1950s this shoreline has experienced unprecedented erosion from ocean swells threatening the private development there and resulting in the construction of rock revetments and groynes by the residents (Figure 2.3 (1), (2)). What was once a sandy shoreline is now lost.

The dune on the eastern end of Corlette Beach has been eroded also (Figure 2.3 (3)). The cause of this has been the increased swell wave energy now impinging obliquely on this end of the beach and the loss of any littoral drift transport that may have been coming from Dutchies that has been caused by the rock groynes at Sandy Point.

2.1.2 Efficacy of Existing Management Protection Options

The seawalls and groynes at Sandy Point have not been constructed in accordance with sound coastal engineering principles. Generally, the armour stone is inadequate and most of the structures are unravelling. The vertical walls, apart from presenting a danger to the users of the public reserve as they have no safety railing and, in parts, present a large drop onto a rocky basement, are being undermined and will collapse in due course. Other aspects of the foreshore walkway are dangerous also as the path is uneven and there are various structures crossing the pathway.

The groynes are entirely inadequate in providing any protection to the foreshore. They do not work because they are of inadequate scale and there is insufficient littoral drift that can be captured to provide protection. What little littoral drift there is coming from Dutchies Beach is being diverted offshore to deeper water by the groynes and, therefore, is being lost to the foreshore littoral drift system.

The haphazard rock rubble revetment at the eastern end of Corlette Beach (Figure 2.3 (3)), dumped there to protect the dune from further erosion, is unsightly, ineffective and may be a cause of public danger.

2.2 Salamander Bay

Figure 2.4 shows protection works that have been constructed along both the western and eastern ends of the Salamander Bay foreshore, indicating a perception of foreshore erosion.

2.2.1 Coastal Processes and Causes of Erosion

Public Works Department NSW (1987) has undertaken tidal current measurements within Salamander Bay as well as a physical model study of tidal flows in Port Stephens and the Manly Hydraulics Laboratory (MHL, 1997) has undertaken a wave climate inundation study for the foreshore. The studies found that both flood and ebb tidal

currents in the bay were weak and, generally, were less than 0.2 m/s. Such currents, without superimposed wave stirring, would not be competent in transporting sand. While the Bay is exposed to north-westerly winds, the fetches are short and there is little opportunity for the generation of large waves along the foreshore.

The signature of natural foreshore recession is weak and, while a few trees are being undermined at some locations, there does not appear to be any assets at threat from foreshore recession. The structures at the western end of the Bay, simply, appear to be maintaining unauthorised reclamation from private properties across a public reserve. These structures have not been designed or constructed in accordance with sound coastal engineering practice. The reclamation that provides for the public reserve at the north-eastern end of the Bay is protected also but by a rock revetment that is adequate for its purpose.

Wave inundation is a risk to a few properties at the eastern side of the Bay. This problem has arisen because the alignment of the subdivision has intersected the natural curvature of the Bay (see Figure 2.4 (3)). Some houses along foreshore drive have floor levels that are below the calculated 1% AEP design level for wave runup.

2.2.2 Efficacy of Existing Management Protection Options

The small vertical seawalls constructed at various residential properties at the western end of the Bay (Figure 2.4 (1)) have been effective in protecting the land reclamation there and do not appear to be having any adverse impact on neighbouring properties.

Similarly, the small walls constructed to protect residences from inundation at the eastern end of the bay (Figure 2.4 (3)) do not appear to be having any adverse impact on neighbouring properties or the beach.

The rock rubble revetment protecting the reclamation and foreshore walkway at the north-eastern end of the bay (Figure 2.4 (4)) appears sound and effective in protecting this asset from wave action.

2.3 Bob Cairns Reserve

Figure 2.5 shows the beach at the Bob Cairns Reserve

2.3.1 Coastal Processes and Causes of Erosion

While there is some seawall and groyne construction at the northern end of the beach, there does not appear to be any significant erosion at this beach. The reserve foreshore fronting the residences to the south of the parkland presents a gently sloping foreshore down to the water.

By contrast, at the northern end of the beach, steep rock walls and vertical concrete and timber walls preclude easy access from the public reserve to the beachface and there are some “private” boat-ramp structures that cross the reserve, hindering alongshore access.

There does not appear to be any threat of erosion to homes along this beach.

2.3.2 Efficacy of Existing Management Protection Options

The need for coastal protection structures is not established at this beach. Some of the revetments at the northern end of the beach have not been built in accordance with sound coastal engineering practice, and may present some danger to the public. The rock groyne is entirely ineffective and, being submerged at high tide but not marked, could pose a danger to swimmers.

2.4 Wanda Beach

Figure 2.6 shows aspects of Wanda Beach

2.4.1 Coastal Processes and Causes of Erosion

There does not appear to be any signature of erosion at this beach, other than that caused by storm water discharge.

2.4.2 Efficacy of Existing Management Protection Options

There are no erosion protection structures on this beach.

2.5 Kangaroo Point

Figure 2.7 shows aspects of Kangaroo Point.

2.5.1 Coastal Processes and Causes of Erosion

The Kangaroo Point development is founded on a bedrock headland and there is no process signature of long term erosion. While various seawalls and groynes have been constructed at Kangaroo Point, it does not appear that there is any significant threat to the residential development. Nevertheless, reclamation has taken place and some protection of that reclamation has been put in place, clearly, to protect the reclamation from the occasional storm waves from the north-east.

2.5.2 Efficacy of Existing Management Protection Options

The groyne structures appear to be efficacious in retaining some sand and/or gravel on their eastern flanks. The seawall structures are not built to sound coastal engineering practice standards. One structure presents a cracked and broken footpath along its crest, which may present a danger to public access. That groynes may be retaining some littoral drift material indicates a loss of material to other parts of the foreshore, exacerbating local erosion. The significant vertical timber seawall structure inhibits public access across the foreshore and reflects wave energy.

2.6 Taylors Beach

Views of Taylors Beach are given in Figure 2.8.

2.6.1 Coastal Processes and Causes of Erosion

Taylors Beach is exposed to waves arriving obliquely to the foreshore across a large fetch from the north-west sector. The beach is exposed also to a much smaller fetch to the south-west. The obliquity of the wave direction to the foreshore alignment results in the southerly transport of littoral drift. This is evidenced by the significant accumulation of sediment on the northern side of the pontoon-landing groyne. That entrapment has starved the foreshore to the south of sediment transport, which has exacerbated foreshore erosion of the parkland.

2.6.2 Efficacy of Existing Management Protection Options

The existing rock revetment has not been constructed in accordance with sound coastal engineering practice. Along parts of it the interstices of the stones have been grouted and in other areas the fabric is unravelling. Access across the revetment to the water is restricted.

The pontoon-jetty groyne has resulted in a large build-up of beach sand on its northern side, which has enhanced the foreshore amenity there and has provided good protection there from foreshore erosion. Concomitantly, the groyne has starved the foreshore to the south of beach sand and the foreshore there has been receding. Removal of the groyne and its replacement with a jetty structure would release this large volume of sand to replenish the beach to the south. In time, however, the beach would revert to the situation as seen today unless further groynes were constructed to create a similar sandy beach amenity for the parkland. Nevertheless, there is no threat to assets other than the foreshore parkland and some mature trees.

The seawall along Taylors Beach is unravelling in parts and needs maintenance work. Access across this unravelling seawall structure may present a danger to the public. The number of cross-shore access-ways is limited and could be increased.

2.7 Lower Tilligerry Creek

Views of the lower Tilligerry Creek foreshore are in Figure 2.9.

2.7.1 Coastal Processes and Causes of Erosion

The Estuary Processes Study (DPWS, 1999) indicated that erosion of the west bank of lower Tilligerry Creek is likely to be a result of wind wave activity.

2.7.2 Efficacy of Existing Management Protection Options

The bank protection works comprise both vertical walled timber structures and dumped brick bats and have not been constructed in accordance with sound engineering practice. These structures inhibit public cross-shore access.

Shallow nearshore revetments would be efficacious in managing this erosion process. However, the existing treatments are unsatisfactory and could pose a danger to persons using the reserve.

2.8 Lemon Tree Passage

Foreshore conditions at Lemon Tree Passage are depicted in Figure 2.10.

2.8.1 Coastal Processes and Causes of Erosion

Some foreshore erosion has occurred at Lemon Tree Passage but there are no significant assets at threat. The causes of foreshore erosion are locally-generated wind waves and, possibly, a slight increase in mean sea level.

2.8.2 Efficacy of Existing Management Protection Options

The existing treatments comprise dumped rock rubble. This construction is not in accordance with sound engineering practice, the works done are unsatisfactory and they could pose a danger to persons using the reserve. Shallow nearshore rock rubble revetments, judiciously sited to form headlands around trees and other assets that may need protection, could result in the development of small embayments, which would be efficacious in managing this minor erosion process.

2.9 Carrington

The Carrington foreshore is depicted in Figure 2.11.

2.9.1 Coastal Processes and Causes of Erosion

The cause of foreshore erosion at Carrington is not known. However, tidal currents here would be low although the foreshore is exposed to a considerable southerly fetch. Abandoning of oyster leases and removal of infrastructure may have changed the foreshore wave energy climate.

2.9.2 Efficacy of Existing Management Protection Options

Where they exist, the rock rubble revetment works appear to provide some reasonable resistance to wave erosion, notwithstanding that they do not comply fully with sound coastal engineering practice. However, the dumped rock rubble inhibits cross-shore

access. Where rock rubble has not been dumped the erosion appears to be progressing and, in due course, may threaten the road.

2.10 North Arm Cove

Aspects of the residential area on the western foreshore of North Arm Cove are presented in Figure 2.12.

2.10.1 Coastal Processes and Causes of Erosion

The settlement here is founded, essentially, on bedrock which underlays a silty sandy beach. While the threat to mature trees on the foreshore presents some evidence of foreshore recession, it would appear that the “erosion problem” exists where the foreshore has been reclaimed and reclamations have been protected with seawalls.

2.10.2 Efficacy of Existing Management Protection Options

Most of the sea wall structures comprise vertical, grouted sandstone walls and none of these structures have been built to accepted, coastal engineering practice standards. It would appear that some of these structures may pose a hazard to the public. Many are difficult to traverse and they are encrusted with oyster shell.

2.11 Lower Pindimar

Foreshore aspects of the western part of Lower Pindimar are presented in Figure 2.13.

2.11.1 Coastal Processes and Causes of Erosion

It would appear from the site inspection that foreshore recession has occurred where mangroves are absent from the nearshore zone. Localised erosion is evident adjacent to the boat ramp structure (Figure 2.13 (1), (2)) and erosion protection works in the form of seawalls and log groynes have been constructed in front of reclamations undertaken at residences with absolute foreshore frontage (Figure 2.13 (3)). There is a stretch of residences at the western end on the developed area that enjoy a natural beach frontage (Figure 2.13 (4)).

2.11.2 Efficacy of Existing Management Protection Options

Erosion protection works undertaken adjacent to the boat ramp are not in accordance with good coastal engineering practice. Strewn rock rubble to the east of the boat ramp may pose an injury danger to beachgoers there. The log retaining wall around the pine tree reflects wave energy to the adjacent foreshore and may pose a danger also to any of the public wandering around there.

The log groynes in front of the residential development to the west Figure 2.13 (3) are entirely ineffective as coastal protection works and the protection to the foreshore reclamation, comprising grouted boulders, is not in accordance with coastal engineering practice standards.

2.12 Pindimar(Orungall Point)

Foreshore aspects of the eastern part of Lower Pindimar (Orungall Point) are presented in Figure 2.14.

2.12.1 Coastal Processes and Causes of Erosion

Everywhere there is foreshore erosion the mangrove stands appear to have been cleared, apparently to allow boat access to the Port Stephens waterway (see Figure 2.14 (1)). This allows much more wave energy to reach the shore, thereby causing erosion. Areas where the mangrove stands have been retained show healthy sand accumulation (Figure 2.14 (4)).

2.12.2 Efficacy of Existing Management Protection Options

The vertical, grouted rock walls are not appropriate foreshore protection. The groynes are not very effective in building up the beach and they pose a hazard to public users of the reserve.

2.13 Pindimar

Aspects of the Pindimar foreshore are presented in Figure 2.15.

2.13.1 Coastal Processes and Causes of Erosion

The Pindimar foreshore is well protected from wave action, being exposed to a narrow wind wave fetch to the south-east. The mangrove stands attest to this being a depositional area for sediment and there does not appear to be any signature of long term foreshore recession. There has been some considerable reclamation undertaken there, supplemented with *ad hoc* rock wall and groyne protection works. There are several jetties crossing the foreshore.

2.13.2 Efficacy of Existing Management Protection Options

The groyne structures are ineffective and none of the seawalls have been built in accordance with sound coastal engineering practice standards. Some of these structures crossing the foreshore may present a danger to the public accessing the foreshore reserve. The drainage outlet is not maintained (Figure 2.15 (4)) and the outfall structure does not appear to have been authorised.

3 EROSION MANAGEMENT

3.1 Introduction

There are various measures that can protect coastal developments at risk of erosion and enhance and preserve a beach amenity. These include groynes, offshore breakwaters, artificial headlands, seawalls, beach nourishment and dune rehabilitation.

The successful design, construction and operation of coastal protection works must be based on a sound understanding of the coastal processes and hazards at the site. This is because protection works have the potential to impact adversely on areas beyond those being protected. Therefore, any proposal for protection works must take account of their wider impacts, including the marine environment.

Installations of groynes, headlands and offshore breakwaters, particularly without any beach nourishment, have the greatest potential for impacting adversely on adjacent shorelines as well as on offshore seagrass meadows. This is because they work by interrupting the natural drift of sand along the shoreline, thereby causing the build-up of protective beach salients using sand from the adjacent shoreline areas that are unprotected. This results in the erosion of adjacent foreshores and the burial of nearshore benthos. Invariably, for these reasons, groynes, headlands and offshore breakwaters can not be recommended as erosion management structures for individual properties within a foreshore sub-division and no further consideration to such structures is given herein.

A seawall (or revetment) is a structure built along the shoreline to protect the development behind it by limiting foreshore erosion. Seawalls are not well suited to the protection of isolated properties because they can induce erosion on adjacent unprotected areas. Further, erosion around the ends of a seawall can lead to its collapse. Therefore, seawalls should be designed as continuous and uniform structures protecting all properties over the length of coastline that is suffering erosion.

Seawalls can be rigid or flexible, vertical or sloping. Rigid seawalls, usually, are vertical and may comprise masonry or concrete gravity walls. Other vertical structures include steel, concrete, timber or plastic sheet piling. Advantages of vertical seawalls include their compact nature (minimum plan area) and their tendency not to harbour rubbish. However, while many vertical seawalls have been built along the NSW coastline in the past, they are seldom favoured these days. This is because they restrict access across the foreshore and because vertical structures reflect wave energy, often causing the erosion

and disappearance of the beach in front of the wall as well as erosion elsewhere. Scour at the base of a masonry seawall can result in its catastrophic failure.

Flexible seawalls are sloping structures that may be constructed from quarry rock and shingle, gabions and concrete or ceramic units manufactured especially for the purpose. While not as compact as rigid seawalls, sloping flexible rock rubble revetments are the most suitable system for foreshore protection around Port Stephens. A sloping rubble revetment absorbs wave energy, minimises wave run-up and reflection, it can be made from rock occurring naturally in the area and is able to adjust to differential settlement. Such structures are maintained and repaired easily if or when necessary. They can permit pedestrian access across the foreshore through the installation of stepping stones at appropriate locations. However, because of the uneven nature of their surface, sloping rock rubble seawalls tend to harbour rubbish.

Where sand has been lost from a beach, sand can be brought in to replenish that loss. This is referred to as beach nourishment. It is a favoured means of beach management and protection because it works with the natural processes, it promotes the beach amenity and, unlike some other structural measures, rarely does it have any adverse impacts on adjacent areas of the coastline.

Beach nourishment can provide total protection. However, it may be an expensive means of control because it needs to be done periodically and dune management measures, such as fencing, access-ways and planting, would be needed to accommodate the increased sand volume and to inhibit wind-blown sand loss. To prevent excessive offshore losses, the sand should be of a similar grading and size or, preferably, slightly coarser than the natural beach material.

Almost all of the seawalls and groynes built on the foreshores of Port Stephens that have been inspected for this study have not been constructed in accordance with sound coastal engineering practice. Many of the structures are vertical, which causes reflection of wave energy that may cause erosion problems elsewhere, which restrict access across the foreshore and, with some of the larger structures, may be presenting a danger to people using the foreshore. In this section design guidelines are presented for the rehabilitation of existing seawall structures and for the design of new seawalls.

3.2 Management Guidelines for Existing Structures

Most of the existing seawall structures around the Port Stephens foreshore are grouted vertical walls needing rehabilitation. The rehabilitation comprises converting the walls to porous sloping (2:1 H:V) rock rubble revetments. This can be done simply by placing, on geo-textile, the requisite armour stone in a wedge in front of the wall, as shown in Figure 3.1. If the wall is masonry and needs to be broken out, this can be done as shown in Figure 3.2.

In most cases, the wave action is relatively low. Based on the wave climate estimates in MHL (1997 & 1998), design breaking wave heights on the protected revetments would be around 0.9 m. Accordingly, this would require a revetment stone armour size of $D_{50} = 420$ mm ($D_{\min} = 380$ mm; $D_{\max} = 450$ mm) having $W_{50} = 125$ kg ($W_{\min} = 90$ kg;

$W_{\max} = 160 \text{ kg}$ – see Appendix A). Requisite sizes for under-layers and granular fill (if required) are in Appendix A.

Many of the rock rubble revetments also are in need of rehabilitation. These should be rehabilitated in accordance with the Structural Design Guidelines below. Existing rock rubble material can be incorporated into the new structure as under-layers.

3.3 Structural Design Guidelines

Generally, new revetments should comprise rock rubble and be sloping, preferably not steeper than 2:1 (H:V). Suitable revetment schema are presented in Figure 3.3 for new structures against a natural bank and in Figure 3.4 for reclamations.

The revetment crest should be above that which would allow significant overtopping. The revetment crest levels can be assessed from the Manly Hydraulic Laboratory Report MHL880. The size of armour stone cannot be determined accurately without a nearshore/foreshore survey to determine existing levels. Nevertheless, for protected areas, such as Pindimar, Carrington, Lemon Tree Passage and Salamander Bay, where the crest levels should be around 2.5 m AHD, the armour stone size should be $D_{50} = 420 \text{ mm}$ ($D_{\min} = 380 \text{ mm}$; $D_{\max} = 450 \text{ mm}$) having $W_{50} = 125 \text{ kg}$ ($W_{\min} = 90 \text{ kg}$; $W_{\max} = 160 \text{ kg}$ – see Appendix A). Requisite sizes for under-layers and granular fill (if required) are in Appendix A.

For severely exposed areas, such as Sandy Point, more robust structures would be required. There the design wave height would be around 2.6 m, giving a revetment stone armour size of around $D_{50} = 1.2 \text{ m}$ ($D_{\min} = 1.1 \text{ m}$; $D_{\max} = 1.3 \text{ m}$) having $W_{50} = 3.0 \text{ t}$ ($W_{\min} = 2.2 \text{ t}$; $W_{\max} = 3.7 \text{ t}$ – see Appendix A). Requisite sizes for under-layers and granular fill (if required) are in Appendix A. Requisite crest levels for a revetment here are indicated in MHL880 to be around 2.4 m AHD. This appears low and it is recommended that this level be reviewed prior to finalisation of a design for the rehabilitation of the seawalls at Sandy Point.

4 DEFINED PROTECTION ZONES

4.1 Introduction

Outside of Shoal Bay, Tanilba Bay and Jimmys (Wanderrebah) Beach, where management plans dealing with severe erosion have been implemented, this review of the current status of foreshore erosion around Port Stephens and the protection works that have been implemented has identified two protection zones where works are needed urgently. These are both on the southern shoreline of the Outer Port at Sandy Point and Corlette Beach.

4.2 Sandy Point

Neither the groynes nor the revetments at Sandy Point have been constructed to acceptable coastal engineering standards.

The groynes at Sandy Point are not providing protection to the foreshore but they could be preventing any littoral drift material from being transported from Dutchies to Corlette Beach. It is recommended that the groynes be removed and their material be used to strengthen the revetments.

The existing revetments are inadequate, dangerous and need to be re-constructed to a standard design. Guidelines are presented above in Section 3.3.

4.3 Corlette Beach

The eastern end of Corlette Beach has suffered considerable erosion and rock has been dumped there. This area could be rehabilitated by the construction of a suitable revetment, which could be buried in sand nourishment material sourced from the very large accumulation of sand that has occurred against the marina breakwater at the western end of the beach. Transferring this sand would have no adverse environmental impacts and would have several benefits including:

- obviating siltation of the storm water outfall;
- obviating siltation of the The Anchorage marina;

- obviating the permanent loss of good beach sand from the southern shore of the Outer Port;
- rehabilitation of the beach near Sandy Point, thereby restoring a valuable public recreation reserve.

The sand could be transferred easily using mechanical shovels and trucks.

5 CONCLUSIONS AND RECOMMENDATIONS

Foreshore areas of Port Stephens that have a perceived erosion problem and where structures have been built have been inspected. Apart from Shoal Bay, Tanilba Bay and Jimmys Beach (Winda Woppa), which are affected by erosion and have been addressed already by management plans, severe erosion is evident at Sandy Point and at the eastern end of Corlette Beach. Erosion is evident also on foreshores where mangrove stands appear to have been removed and where foreshore reclamations have been undertaken. Minor frittering of foreshore reserves is evident at Salamander Bay and Lemon Tree Passage. Many areas have been treated, apparently unauthorised, in an *ad hoc* way through the installation of groynes and various types of seawall revetments.

Generally, the unauthorised groynes and seawalls that have been installed to deal with the perceived erosion processes have not been constructed in accordance with sound coastal engineering principles. Many of the structures present a hazard to the public that may be using the foreshore reserves.

It is recommended that, apart from the public groyne facility at Taylors Beach, all of the unauthorised groynes be removed, with the rock from those structures being used for seawall rehabilitation. Design guidelines for the rehabilitation of seawalls and for any new seawall structures have been presented.

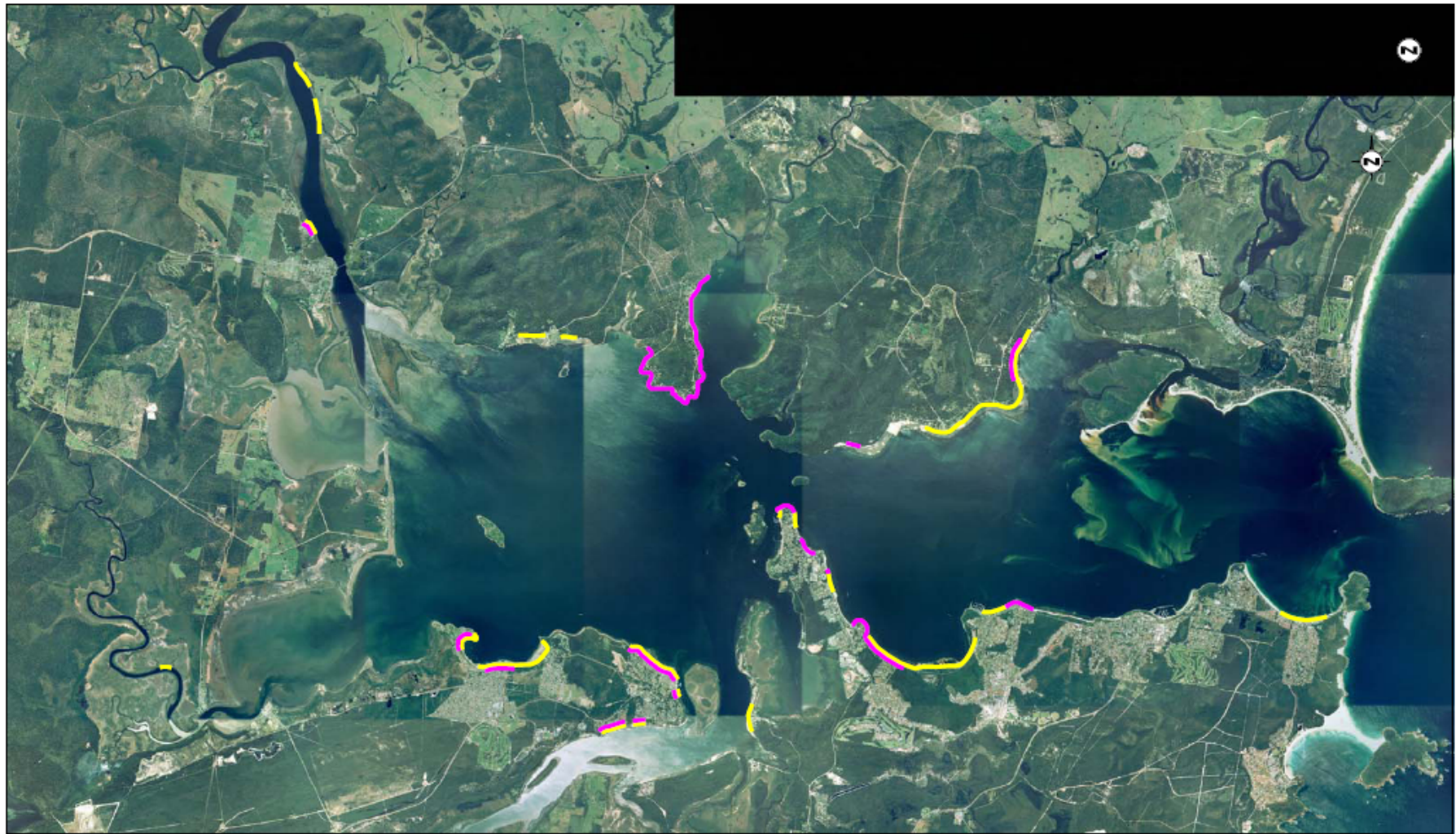
Urgent attention is required to rehabilitate the erosion protection works at Sandy Point. This foreshore is used regularly by the public for walking exercise and it would appear that, given the dilapidated nature of the structures and the haphazard construction of the footpath, with uneven surfaces and no guard rails, there is a serious accident waiting to happen there.

At the eastern end of Corlette Beach the *ad hoc* dumped rock revetment needs to be rehabilitated urgently and the area can be enhanced with sand nourishment borrowed from the western end of the beach where large volumes of sand have accumulated against the marina breakwater.

6 REFERENCES

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Figures

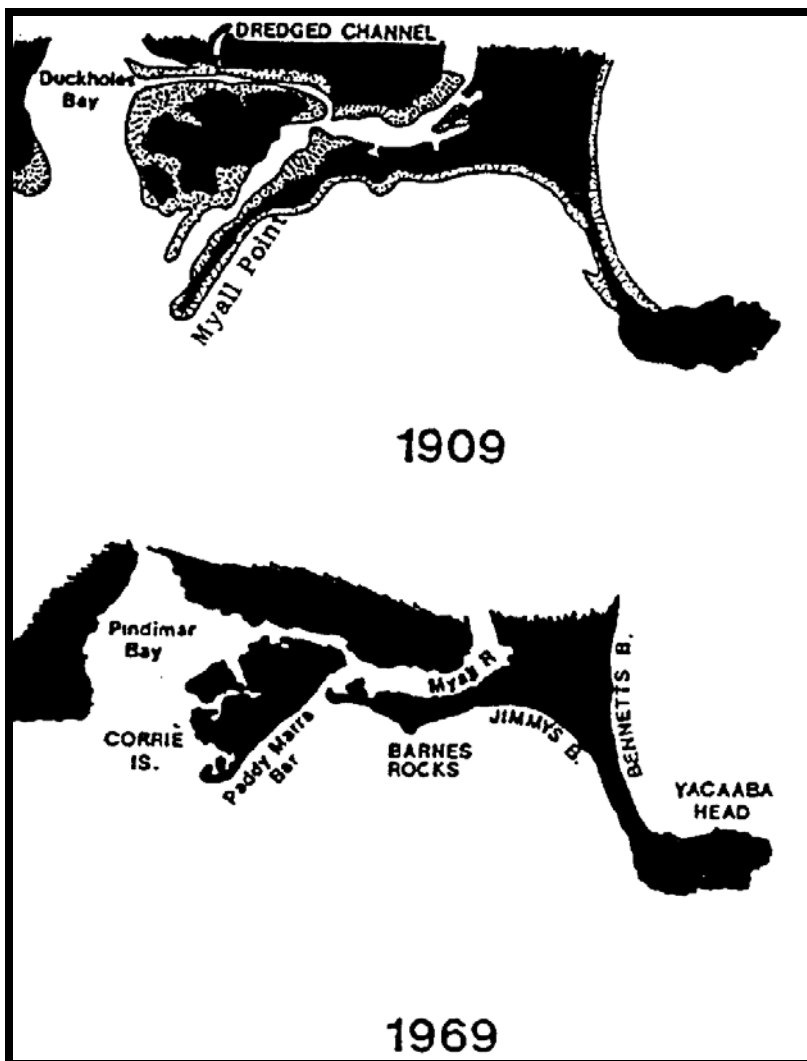


Source: Port Stephens Council

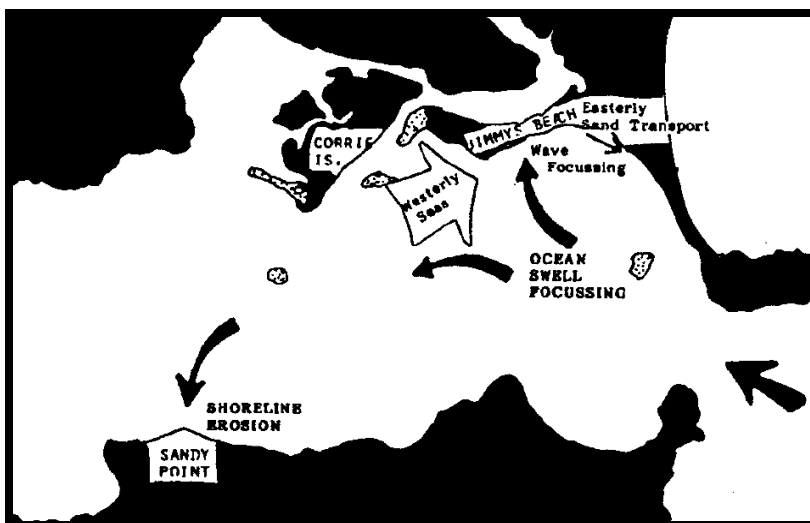
Legend

- Significant Foreshore Erosion
- Foreshore Structures

Figure 1.1. Locations of perceived significant foreshore erosion and structures
(source: Umwelt)

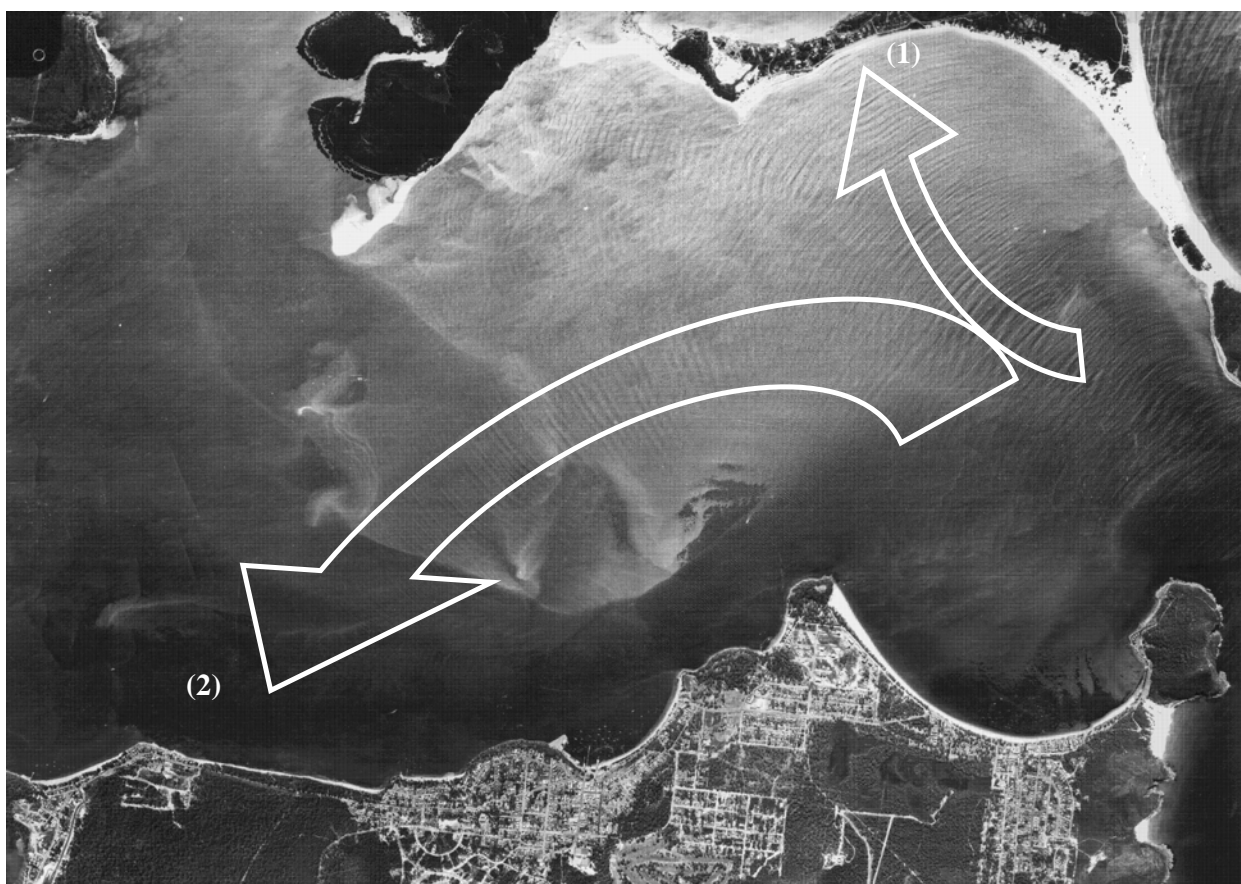


(1) Changes to the northern foreshore of the Outer Port 1909 – 1969



(2) Impact on coastal processes as a result of the demise of Myall Point

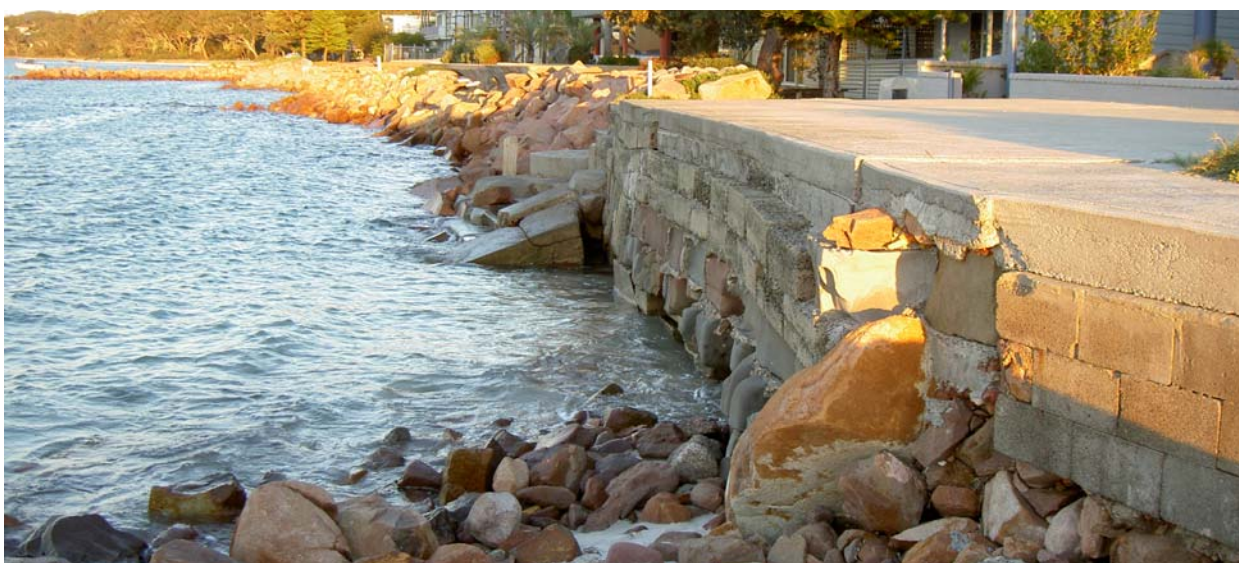
Figure 2.1. Foreshore changes and coastal processes in the Outer Port (after Nielsen, 1994)



**Figure 2.2. Swell Wave Refraction within the Outer Port.
1976 Census Aerial Photograph (taken 27/5/1975) showing impacts of
wave refraction on swell wave transformation into Port Stephens.
Arrows show general directions of swell wave focussing onto:
(1) Jimmys Beach; and
(2) Sandy Point.**



(1) Revetments and groynes protecting development on the north-eastern side of Sandy Point



(2) Dangerous and unsound seawalls at Sandy Point



(3) Erosion of the dune and haphazard rock “protection” at the eastern end of Corlette Beach

Figure 2.3. Sandy Point (top & centre) and Corlette Beach



(1) Protection of foreshore reclamation at western end of Salamander Bay



(2) Foreshore erosion of the “natural” parkland east of (1) above



(3) Residential development at risk of wave inundation at the eastern end of Salamander Bay



(4) Protection of parkland reclamation north-eastern end of Salamander Bay

Figure 2.4. Salamander Bay.



(1) Beach looking south from reserve



(2) Northern residences with rock protection works



(3) Rock groyne at the northern end of the beach

Figure 2.5 Bob Cairns Reserve



(1) Beach foreshore fronting residences



(2) Stormwater outlet on the beach.

Figure 2.6 Wanda Beach



(1) A range of seawalls and groynes along this foreshore



(2) Boat-ramps crossing the foreshore

Figure 2.7 Kangaroo Point



(1) Groyne effect on littoral drift transport.



(2) Southern foreshore as viewed from pontoon.



(3) Foreshore detail.

Figure 2.8. Taylors Beach



(1) Timber revetment and boat-launching ramp.



(2) Concrete rubble revetment.



(3) Concrete and brick-bat revetment.

Figure 2.9. Lower Tilligerry Creek



(1) Dumped rock rubble at foreshore reserve.



(2) Foreshore erosion around trees and dumped rock rubble.



(3) Stormwater outlet.

Figure 2.10. Lemon Tree Passage



(1) Foreshore erosion around trees beyond dumped rock rubble.



(2) Dumped rock rubble.



(3) Relict piling and rubble from oyster industry.

Figure 2.11. Carrington



(1) Foreshore reclamation and grouted vertical masonry sea wall – north end.



(2) Foreshore reclamation and grouted vertical masonry sea wall – south end.



(3) Local boat ramp access from reserve.



(4) Typical reclamation with rock rubble protection – south end.

Figure 2.12. North-west coast of North Arm Cove



(1) Boat ramp looking east.



(2) Foreshore west of boat ramp.



(3) Foreshore reclamation, masonry sea wall and log groynes.



(4) Natural foreshore.

Figure 2.13. Lower Pindimar



(1) Foreshore protection at boat access way through mangroves.



(2) Strewn rock rubble, tyre, rock and pole groyne foreshore protection structures.



(3) Foreshore reclamation and boat ramp access flanked by rubble protection.



(4) Natural foreshore with beach accretion behind protective mangrove stands.

Figure 2.14. Orungall Point



(1) Foreshore reclamation, sea wall protection and Jetty.



(2) Foreshore reclamation and seawall protection.



(3) Foreshore reclamation, seawall and groyne protection.



(4) Stormwater drainage across reserve.



Figure 2.15. Pindimar

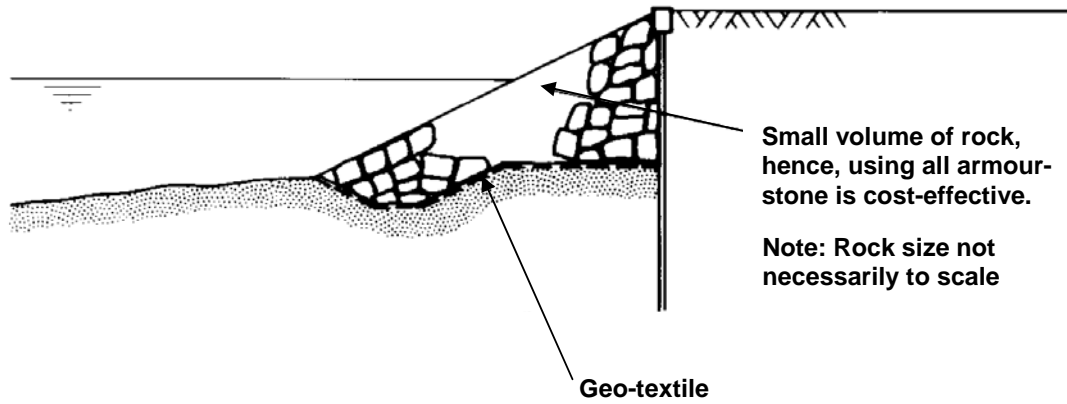


Figure 3.1. Rehabilitation schema for small vertical revetment.
(after CIRIA, 1991)

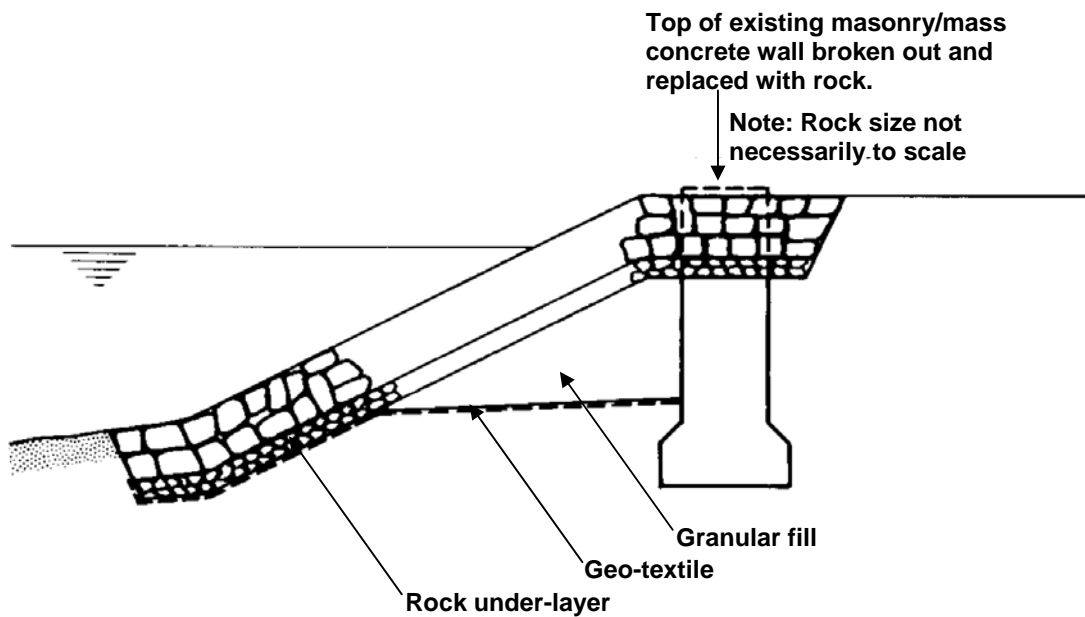


Figure 3.2. Rehabilitation schema for a vertical masonry revetment needing some breaking out.
(after CIRIA, 1991)

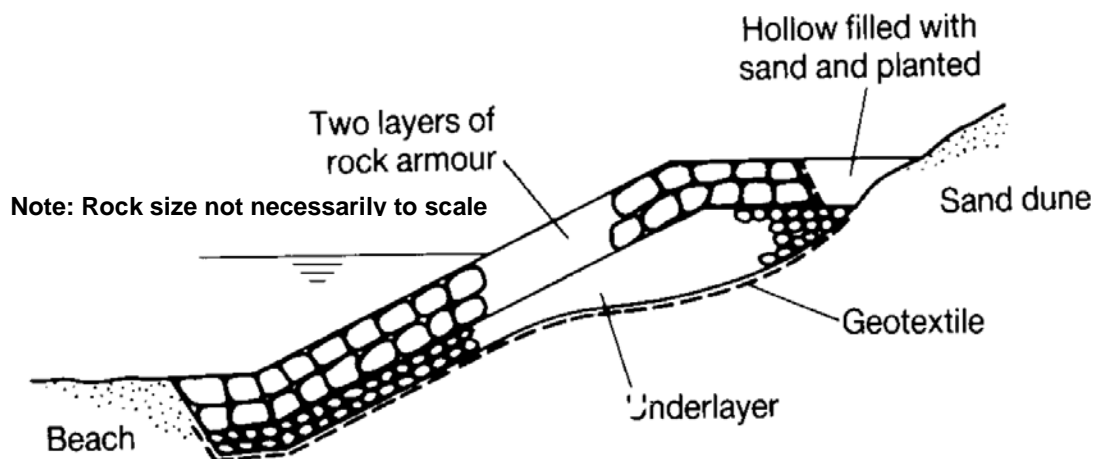


Figure 3.3. Revetment schema on a natural foreshore.
(after CIRIA, 1991)

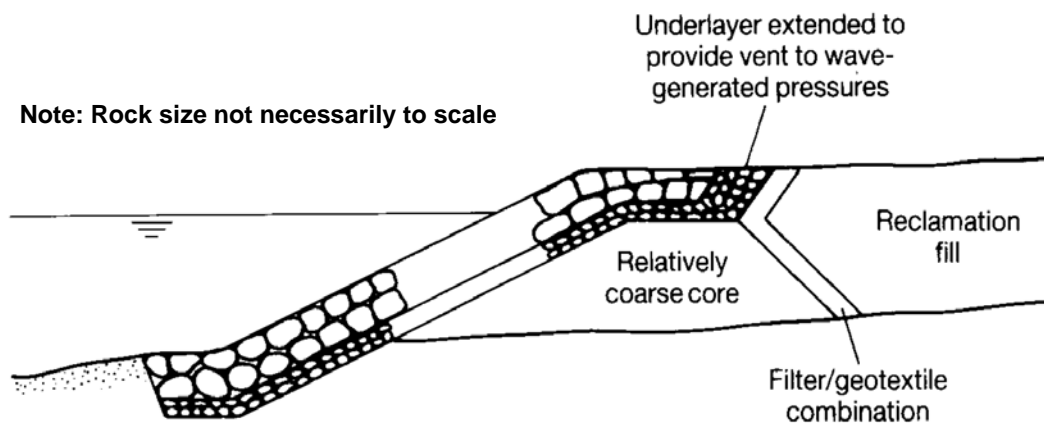


Figure 3.4. Revetment schema to suit reclamation.
(after CIRIA, 1991)

Appendix A

Revetment Armour Stone Sizing

Armour Layer Sizing for Low to Moderate Wave Action

Type of Unit: Rough Angular Quarystone
Unit Wt: 2,650 kg/cu m
Design Wave Ht (H10): 0.9 m
Stability Coefficient (KD): 2.0
Layer Coefficient: 1.00
Porosity: 37 %
Cotan Structure Slope: 2.0
No. Units Comprising Layer: 2

Cover Layer

Wmin:	93 kg	Dmin	0.38 m
W50:	124 kg	D50	0.42 m
Wmax:	155 kg	Dmax	0.45 m
		Layer Thickness:	0.72 m
		Minimum Crest	
		Width:	1.08 m
		No. Units per	
		Surface Area:	9.70

Underlayer

Wmin	9 kg	Dmin	0.17 m
W50	12 kg	D50	0.19 m
Wmax	16 kg	Dmax	0.21 m
		Layer Thickness:	0.33 m

Core

W15>	0 kg	D15>	48 mm
W50>	1 kg	D50>	71 mm
W85>	1 kg	D85>	85 mm

Armour Layer Sizing For High Wave Action at Sandy Point

Type of Unit: Rough Angular Quarystone
Unit Wt: 2,650 kg/cu m
Design Wave Ht (H10): 2.6 m
Stability Coefficient (KD): 2.0
Layer Coefficient: 1.00
Porosity: 37 %
Cotan Structure Slope: 2.0
No. Units Comprising Layer: 2

Cover Layer

Wmin: 2,245 kg	Dmin 1.10 m
W50: 2,993 kg	D50 1.21 m
Wmax: 3,741 kg	Dmax 1.30 m
	Layer Thickness: 2.08 m
	Minimum Crest
	Width: 3.12 m
	No. Units per
	Surface Area: 1.16

Underlayer

Wmin 209 kg	Dmin 0.50 m
W50 299 kg	D50 0.56 m
Wmax 389 kg	Dmax 0.61 m
	Layer Thickness: 0.97 m

Core

W15> 4 kg	D15> 138 mm
W50> 15 kg	D50> 206 mm
W85> 25 kg	D85> 246 mm

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