

FINAL REPORT

Species Impact Statement Proposed Port Botany Expansion

Prepared for

Sydney Ports Corporation

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43027-013

URS

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Glossary of Terms

Benthic invertebrates	Animals without a backbone such as worms living in sediments on the bottom of the sea or in lakes and estuaries which provide food for migratory shorebirds.
Biota	All the animal and plant life a given area.
Conservation	The management of natural resources in a way that will benefit both present and future generations.
Ecosystem	An interdependent system of interacting plants, animals and other organisms together with the non-living (physical and chemical) components of their surroundings.
Endangered species	Those plant and animal species listed under Part 1 of Schedule 1 of the NSW Threatened Species Conservation Act 1995 or listed as <i>endangered</i> under Subdivision A of Division 1 of Part 13 of the Commonwealth Environment Protection and Biodiversity Conservation Act 1999.
Estuary	The part of a river in which water levels are affected by oceanic tides, and where fresh water and salt water mix.
Fauna	Animals.
Flora	Plants.
Floristic composition	The plant species present in a particular community, sub-community or site.
Migratory Shorebirds (wader)	Trans-equatorial migrants such as whimbrel, godwits, plovers and sandpipers which feed on intertidal estuarine flats on the south-eastern coast of Australia generally from spring through to autumn.
Terrestrial	Of or pertaining to the land as distinct from the water.
Threatened species	Animals or plants listed as endangered or vulnerable under the NSW Threatened Species Conservation Act 1995 or the Commonwealth Environment Protection and Biodiversity Conservation Act 1999.
Vulnerable species	Those plant and animal species listed under Part 1 of Schedule 2 of the NSW Threatened Species Conservation Act 1995 or listed as <i>vulnerable</i> under Subdivision A of Division 1 of Part 13 of the Commonwealth Environment Protection and Biodiversity Conservation Act 1999.

Executive Summary

The aim of this document is to address the requirements of a Species Impact Statement (SIS) as defined by the NSW *Threatened Species Conservation Act 1995* (TSC) and prescribed in the NSW National Parks and Wildlife Service (NPWS) Director-Generals' SIS requirements.

Sydney Ports Corporation propose to expand the existing container terminal facilities at Port Botany, Sydney, New South Wales (NSW). The proposal involves the creation of a new container terminal extending approximately 550 metres west of the existing Patrick Stevedore container terminal and then 1300 metres north towards Foreshore Beach. A total of about 60 hectares of reclamation work is proposed to be undertaken for the new terminal. The existing railway network would also be extended to the additional port land via the upper reaches of Penrhyn Estuary and a new road access bridge would connect the new terminal to Foreshore Road.

Penrhyn Estuary provides feeding and roosting habitat for shorebirds, including a total of 23 migratory and non-migratory shorebird species and one seabird species listed under the TSC and/or Commonwealth *Environment Protection and Biodiversity Conservation Act* (EPBC Act). These 24 species, considered as regular or occasional visitors to Penrhyn Estuary, may be significantly impacted upon as a result of the proposal if appropriate mitigation measures are not implemented. Predicted impacts to these species include potential flyway barriers and disturbance to feeding and roosting activity.

Enhancement of existing shorebird habitat at Penrhyn Estuary is proposed to ameliorate the predicted impacts of the proposal on these species. The proposal comprises the creation of an estuary area of about 27 ha including intertidal flats, saltmarsh and seagrass habitat coupled with the removal and on-going control of mangroves which have proliferated on the mudflats at the estuary in recent times and which will act to reduce the available feeding and roosting habitat for shorebirds. The objective of the habitat enhancement works is to, by enhancing existing habitat, increase the likelihood of shorebirds continuing to use Penrhyn Estuary for feeding and roosting following the proposed port expansion and to potentially increase bird numbers.

1.1 Introduction

URS Australia Pty Ltd was engaged by Sydney Ports Corporation (Sydney Ports) in April 2002 to undertake a terrestrial flora and fauna assessment for the proposed Port Botany Expansion.

A total of 23 migratory and non-migratory shorebirds and one seabird listed under the NSW *Threatened Species Conservation Act* 1995 (TSC) and/or the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act), considered as regular or occasional visitors to Penrhyn Estuary, were assessed under Section 5A of the NSW *Environmental Planning and Assessment Act* 1979 (Eight Part Tests) by URS in the initial stages of this commission. The 8 Part Tests, submitted to NSW National Parks and Wildlife Service (NPWS) and Environment Australia in June 2002, concluded that these species may be significantly impacted upon as a result of the proposal and consequently the preparation of a SIS would be required as part of the Environmental Impact Statement (EIS) investigations. The 8 Part Tests are provided in **Appendix A**.

NSW NPWS Director-General's Requirements for the SIS were subsequently issued to Sydney Ports and form the basis of this report. The NSW NPWS Director General's requirements for the proposal and SIS are reproduced as **Appendix B** along with general SIS provisions prescribed in Sections 109-111 of the TSC Act.

Sydney Ports Corporation initiated a referral of the proposed Port Botany Expansion to Environment Australia under the Commonwealth EPBC Act. The Commonwealth Minister for the Environment decided, pursuant to section 75 of the EPBC Act, that the proposal is a Controlled Action. Therefore, the proposal requires approval from the Commonwealth Minister for the Environment. The controlling provisions or matters of particular concern to Environment Australia included migratory species listed under the EPBC Act.

In February 2002, Environment Australia advised that the NSW assessment process had been accredited for the project, meaning that the NSW assessment process, involving the preparation of a single EIS and SIS under the Environmental Planning and Assessment Act 1979 (EP&A Act), could also satisfy the assessment requirements of the Commonwealth under the EPBC Act.

1.2 Background

Botany Bay has long been identified as an important area for shorebirds as an over wintering site for migratory shorebirds nesting in the Arctic tundra and as a staging area for birds flying south to south east Australia and New Zealand (Avifauna Research Services 2003).

Until the 1940s much of Botany Bay consisted of extensive areas of intertidal mud and sand flats providing important feeding habitat for many species of shorebirds (waders). These areas included the estuary at the mouth of the Cooks River and Mill Stream and extensive tidal flats at the former Botany Beach (refer to **Figures 1 and 2 in Appendix G**) where "several thousand" shorebirds of "ten or eleven" species occurred (Avifauna Research Services 2003).

During the expansion of Sydney Airport in the early 1950s the lower reaches of the Cooks River was diverted and a large proportion of the most important feeding habitat destroyed. Further losses of feeding habitat resulted during the infilling of the shoreline along the former Botany Beach and construction of the North-South Runway. The most recent losses occurred when Runway Beach, the western end of Foreshore Beach, and the Pilots Embayment were filled in during the construction of the Parallel Runway (Avifauna Research Services 2003). Consequently shorebird feeding habitat on the northern shores of Botany Bay is a fraction of that previously available and is chiefly restricted to Penrhyn Estuary, an area that was created by the Maritime Services Board during the construction of Port Botany in the late 1970s (Avifauna Research Services 2003).

Some species that occurred at Penrhyn Estuary and Foreshore Beach in flocks of several hundred during the 1970's to 1990's are now only observed in small groups of a few individuals while other species are now locally extinct. This may be due to:

- increased disturbance by people and dogs using Foreshore Beach and entering Penrhyn Estuary (formerly fenced off at the remains of the old Government Jetty) and;
- habitat deterioration due to the steepening of Foreshore Beach due to wave erosion and the recent invasion of mangroves over former saltmarsh roost sites and intertidal feeding areas at Penrhyn Estuary.

Penrhyn Estuary is essentially the only habitat remaining for shorebirds formerly abundant in the north-eastern part of the Bay except for the highly disturbed narrow strip of sandflat at Foreshore Beach during very low tides.

Although Botany Bay still has extensive shorebird habitat these are mangrove-fringed soft mudflats on the southern shores of the Bay between Taren Point and Bonna Point at Kurnell. These mudflats provide suitable habitat for Grey-tailed tattlers, Whimbrel, Eastern Curlew and a few Terek Sandpipers and their numbers have remained relatively stable. One species, the Bar-tailed Godwit, has been able to adapt to changes in conditions in the Bay and has also remained relatively stable in numbers.

Species such as most sandpipers and plovers that cannot utilise most of the habitats in the southern parts of the Bay are now virtually absent except for small populations at Penrhyn Estuary where their short bills can obtain prey on the relatively firmer sandy mud/muddy sand substrate.

1.3 Environmental Setting

1.3.1 Study Area

The study area, for the purposes of this report, comprises Penrhyn Estuary, Foreshore Beach, the section of the Mill Stream downstream of Foreshore Road and the area of sand dune and scrub at the end of the Patrick Stevedore Terminal (**Figure 1**). The study area was generally limited to those areas that would be

impacted upon as a result of the proposed works, although additional shorebird habitat areas elsewhere in the Botany Bay locality have been discussed in this report.

The study area is situated on the north eastern shores of Botany Bay between the existing Port Botany facilities at Brotherson Dock and the Parallel Runway at Sydney Airport.

Penrhyn Estuary can be described as a small tidal estuary on the northern shores within Botany Bay formed from the reconfiguration of the northern shores of the Bay in the late 1970s as a result of the construction of Port Botany. The estuary is essentially comprised of sand (outer estuary) and mudflats (upper estuary) and is bisected by a creek channel running from the upper most reaches at two stormwater outlets through to the estuary mouth. Stormwater from the Botany/Banksmeadow catchment discharges into the upper reaches of the estuary in two locations via Springvale and Floodvale Drain outlets, which essentially form two deltas.

The Penrhyn Road (southern) side of the estuary is currently used as a boat launch by recreational boat users and fisherman via a concrete boat ramp. Fish cleaning facilities are also provided in this area.

Foreshore Beach can be described as a newly formed beach comprised of estuarine sands dredged from Botany Bay during previous Port Botany and Sydney Airport construction activities. The Maritime Services Board subsequently planted the various shrubs and small trees on the dune areas of the beach that can be seen today. Foreshore Beach is commonly used by dog walkers and pedestrians.

The section of the Mill Stream downstream from Foreshore Road can be described as a 10 metre wide concrete lined stormwater channel that drains the Botany Wetlands. Estuarine sands have silted large portions of this section of the channel.

1.3.2 Surrounding Land Uses

Surrounding land uses comprise Port Botany to the east, the embayment of Botany Bay to the south, the Parallel Runway and Sydney Airport to the west and Foreshore Road, Botany Golf Course and the industrial/residential suburbs of Banksmeadow and Botany to the north.

1.4 Structure of this Report

Section 1 provides a brief background to the study, defines the study area under investigation and provides a brief description of surrounding land uses in the study area.

Section 2 outlines the NSW NPWS Director-General's requirements for the proposal and SIS, the general SIS provisions prescribed in Section 109-111 of the TSC Act, and an indication of where the requirements have been addressed in this report. **Section 2** also outlines the relevant Commonwealth requirements (Environment Australia) and the required approvals for the SIS.

Section 3 provides a description of the proposed development and justification for the proposal as described in the EIS (URS 2003).

Section 4 provides an outline of the survey methodology, results and an assessment of impact of the proposal on flora in the study area. This includes an assessment of the likely occurrence of threatened flora species within the study area and in the vicinity of the site and a description of plant communities and their conservation value within the study area.

Section 5 provides an outline of the survey methodology, results and an assessment of impact of the proposal on fauna in the study area. This includes an assessment of the likely occurrence of threatened species, particularly threatened and/or migratory shorebird species, within the study area and in the vicinity of the site. **Section 5** discusses the impact of the proposal on shorebirds such as the effect of disturbance of shorebirds, changes in lighting regime, noise, potential entry/exit flyway barriers and loss of habitat. This section also discusses remaining shorebird habitat elsewhere in Botany Bay and the potential impacts on these habitats as a result of the Port Botany Expansion.

Section 6 describes mitigative measures to ameliorate the potential impacts on flora and fauna at Penrhyn Estuary. This includes noise and lighting mitigation measures and enhancement of existing shorebird habitat at Penrhyn Estuary including saltmarsh protection, re-vegetation, mangrove removal and control and the restriction of public access to the site. Management and monitoring of the site is also outlined.

Section 7 presents the conclusions of this SIS.

Section 8 presents references cited throughout this report. This section is followed by **Plates, Figures** and **Appendices** of raw or additional data.

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2.1 Requirements for a Species Impact Statement

The EP&A Act requires that a SIS be prepared for a development proposal that is likely to significantly affect threatened species, populations or ecological communities or their habitats listed under the TSC Act. Section 5A of the EP&A Act sets out an Eight Part Test to determine whether there is likely to be a significant effect on threatened species, populations or ecological communities or their habitats.

Eight Part Tests carried out as part of this assessment found that the proposal may significantly affect threatened species listed under the TSC Act (refer to **Appendix A**). In accordance with section 78A(8)(b) of the EP&A Act, a SIS was therefore required to accompany the development application for the proposed Port Botany Expansion. This SIS was prepared in accordance with Division 2 of Part 6 of the TSC Act, which includes a requirement for persons requiring a SIS under the EP&A Act, to request requirements from the NSW NPWS Director-General concerning the form and content of the SIS.

In accordance with section 111 of the TSC Act, the NSW NPWS Director-General's Requirements for an SIS were requested and issued. The NSW NPWS Director-General's Requirements for the SIS are contained in **Appendix B**.

Table 2-1 below lists the NSW NPWS Director-General's Requirements for the proposal as well as general SIS provisions (Sections 109-110 of the TSC Act) and indicates where these requirements have been addressed in this document.

Table 2-1

Fulfilment of the Director-General's and Species Impact Statement Requirements

Requirements	Addressed in Section
Statutory Requirements	
TSC Act Section 110(1). A species impact statement must include a full description of the action proposed, including its nature, extent, location, timing and layout and, to the fullest extent reasonably practicable, the information referred to in this section.	Section 3.1 and detailed in the accompanying EIS Figures 1 and 2
TSC Act Section 110(2)(a). A species impact statement must include the following information as to threatened species or population: a general description of the threatened species known or likely to be present in the area that is the subject of the action and in any area that is likely to be affected by the action.	Section 4.3.1- Flora Section 5.3.1- Fauna
TSC Act Section 110(2)(b). A species impact statement must include the following information as to threatened species or population: an assessment of which threatened species or populations known or likely to be present in the area are likely to be affected by the action.	Section 4.3.1- Flora Section 5.3.1- Fauna
TSC Act Section 110(2)(c). A species impact statement must include the following information as to threatened species or population: for each	Section 4.3.1 - Flora Section 5.3.1- Fauna

Requirements	Addressed in Section
species or population likely to be affected, details of its local, regional and State-wide conservation status, the key threatening processes affecting it, its habitat requirements and any recovery plan or threat abatement plan applying to it.	Appendix F
TSC Act Section 110(2)(d). A species impact statement must include the following information as to threatened species or population: an estimate of the local and regional abundance of those species or populations.	Appendix E and F - Fauna
TSC Act Section 110(2)(f). A species impact statement must include the following information as to threatened species or population: a full description of the type, location, size and condition of the habitat (including critical habitat) of those species and populations and details of the distribution and condition of similar habitats in the region.	Section 1.2 and 5.3.2 - Fauna
TSC Act Section 110(2)(h). A species impact statement must include the following information as to threatened species or population: a description of any feasible alternatives to the action that are likely to be of lesser effect and the reasons justifying the carrying out of the action in the manner proposed, having regard to the biophysical, economic and social considerations and the principals of ecologically sustainable development.	Section 3.2 and detailed in the accompanying EIS
TSC Act Section 110(2)(i). A species impact statement must include the following information as to threatened species or population: a full description and justification of the measures proposed to mitigate any adverse effect of the action on the species, including compilation (in a single section of the statement) of those manners.	Section 6
TSC Act Section 110(2)(j). A species impact statement must include the following information as to threatened species or population: a list of any approvals that must be obtained under any other Act or law before the action may be lawfully carried out, including details of any conditions of any existing approvals that are relevant to the species or population.	Section 2.3
TSC Act Section 110(4). A species impact statement must include details of the qualifications and experience in threatened species conservation of the person preparing the statement and of any other person who has conducted research or investigations relied on in preparing this statement.	Appendix I
Director Generals Requirements	
<i>General</i>	
The following Section 110 matters need only be addressed where relevant:	
<ul style="list-style-type: none"> All reference to threat abatement plans. 	No threat abatement plans have currently been approved in accordance with the TSC Act which are relevant to the

Requirements	Addressed in Section
<ul style="list-style-type: none"> Recovery plans: the Draft Little Tern Recovery Plan. Key threatening processes including: <ul style="list-style-type: none"> High frequency fire resulting in the disruption of life cycle processes in plants, animals, and loss of vegetation. Clearing of native vegetation. Anthropogenic climate change. 	<p>proposal.</p> <p>Appendix F</p> <p>N/A. The proposal is not expected to alter fire regimes.</p> <p>Section 4.4</p> <p>N/A. The proposal is not expected to alter climate.</p>
<i>Description of the Proposal, Subject Site and Study Area</i>	
Include a full description of the action proposed, including its nature, extent, location, timing and layout. A full description of the action includes a description of all associated actions, including, but not restricted to: installation and maintenance of utilities, fire protection zones, access and egress routes; and changes in surface water flows. These actions may occur on or off the subject land.	Section 3.1
<i>Provision of Relevant Maps</i>	
Provide relevant maps and plans of the study area (including topographic and aerial photograph). Detail the location of the proposal and location of the works on site.	Figures 1 and 2
<i>Land Tenure Information</i>	
Provide information about the land tenure across the study area.	Detailed in accompanying EIS.
<i>Initial Assessment- Identifying Subject Species</i>	
Identify subject species, consider habitat types present in the study area, recent records of threatened species or populations in the locality and the known distribution of threatened species. Databases such as the NPWS Atlas of NSW Wildlife, Australian Museum and Royal Botanic Gardens should be consulted to assist in compiling the list.	<p>Section 4.3.1- Flora</p> <p>Section 5.3.1- Fauna</p>
The following shall be considered for inclusion in the list:	Section 5.3.1 and Appendix F
<i>Calidris alba</i> (Sanderling)	
<i>Calidris tenuiorstris</i> (Great Knot)	
<i>Charadrius leschenaultii</i> (Large (Greater) Sand Plover)	
<i>Charadrius mongolus</i> (Mongolian Plover)	

Requirements	Addressed in Section
<i>Limicola falcinellus</i> (Broad-billed Sandpiper)	
<i>Haematopus longirostris</i> (Pied Oystercatcher)	
<i>Haematopus fuliginosus</i> (Sooty Oystercatcher)	
<i>Xenus cinereus</i> (Terek Sandpiper)	
<i>Sterna albifrons</i> (Little Tern)	
Taren Point Shorebird Community (NSW Scientific Community 1998).	Section 5.3.1
<i>Survey</i>	
<i>Requirement to Survey</i>	
A flora and fauna survey is to be conducted in the study area. Previous surveys and assessments may be used to assist in addressing this requirement.	Section 4.2.2 – Flora Section 5.2.2 – Fauna
<i>Documentation of Survey Effort and Technique</i>	
Describe survey techniques, outlining survey technique employed. Survey sites should be identified on a keyed map.	Section 4.2.2 - Flora Section 5.2.2 - Fauna Figures 3 and 4
Survey proformas used by field staff, the time invested each time a survey technique is applied, personnel details of the surveyor(s) and environmental conditions during the survey should be summarised in the SIS.	Appendix H
<i>Assessment of Likely Impacts on Threatened Species and Populations</i>	
Assess impacts including indirect impacts and those of associated activities. These actions or impacts may occur on or off the subject land.	Section 4.4- Flora Section 5.4- Fauna
Identify which threatened species or endangered populations may be affected and the nature of the impact.	Section 4.3.1 - Flora Section 5.3.1- Fauna
Discuss the local and regional abundance of those species or populations that may be affected including: other known local populations; habitat utilisation; vegetation present within the study area; and movement corridors.	Section 4.3.2 Section 5.3.2 Section 5.4.4 Appendix F
<i>Description of Habitat Values</i>	
Describe specific habitat features and the condition of the habitat in the study area.	Section 4.3.2 – Flora Section 5.3.2 - Fauna

Requirements	Addressed in Section
<i>Discussion of Conservation Status</i>	
Discuss the conservation status of for each threatened species or population likely to be affected by the proposal. Assessment should include reference to the threatening processes affecting the species or populations that are likely to be caused or exacerbated by the proposal. Assessment should also include reference to any approved or draft recovery plans.	Section 4.3.1 - Flora Section 5.3.1- Fauna
<i>Description of Feasible Alternatives</i>	
Describe feasible alternatives to the proposal.	Section 3.2
<i>Ameliorative Measures</i>	
Describe long term management strategies, compensatory strategies, ongoing monitoring and translocation of threatened species.	Section 6 Figure 5a and 5b
<i>Assessment of Significance of Likely Effect of Proposed Action</i>	
Provide an eight part test for each of the affected threatened species identified in the SIS. On the basis of these assessments a conclusion is to be provided concerning whether, based on more detailed assessment through the SIS process and consideration of alternatives and/or ameliorative measures proposed in this SIS, the proposal is still considered likely to have significant effect on threatened species, populations or ecological communities.	Section 1.1 Appendix A
<i>Additional Information</i>	
Provide qualifications and experience of the person preparing the statement and of other persons who have conducted research or investigations.	Appendix I and G
Other approvals required for the development	Section 2.3
Obtain appropriate licences/approvals under relevant legislation for persons conducting flora and fauna surveys.	NSW NPWS Scientific Investigation No. A1958

2.2 Commonwealth Requirements

Sydney Ports Corporation initiated a referral of the proposed Port Botany Expansion to Environment Australia (EA) under the EPBC Act. A referral was submitted to Environment Australia in November 2001. In January 2002, the Commonwealth Minister for the Environment decided, pursuant to section 75 of the EPBC Act, that the proposal is a Controlled Action. The controlling provisions were set out by Environment Australia (EA) as follows:

- under Part 3 Division 1:

-
- sections 16 and 17B (Wetlands of international importance);
 - sections 20 and 20A (Listed migratory species); and
 - under Part 3, Division 2:
 - sections 26 and 27A (Protection of the environment from actions involving Commonwealth land).

The proposed development will therefore require the approval of the Commonwealth under Part 9 of the EPBC Act.

In February 2002, Environment Australia advised that the NSW assessment process had been accredited for this project, meaning that the NSW assessment process, involving the preparation of an EIS and SIS under the EP&A Act, would also satisfy the assessment requirements of the Commonwealth under the EPBC Act.

Given the requirement for Commonwealth approval, EPBC listed species (in addition to TSC-listed species) considered as possibly occurring within the study area have been addressed in this report. This approach to the assessment of EPBC listed species has been subsequently confirmed with Environment Australia.

International treaties such as the Agreement between the Governments of Japan and Australia for the Protection of Migratory Birds and their Environment (JAMBA), the Agreement between the Governments of Australia and the Peoples Republic of China for the Protection of Migratory Birds and their Environment (CAMBA) and the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals) were considered in this SIS.

2.3 Required Approvals

In summary, the following approvals in relation to terrestrial flora and fauna are required for the proposal to proceed:

- The Commonwealth Minister for the Environment has declared the proposal to be a controlled action and thus approval under Part 9 of the EPBC Act will be required from the Commonwealth Minister for the Environment;
- Approval under Part 4 of the EP&A Act will be required from the NSW Minister for Planning;
- The NSW Minister for Planning will also be required to consult the NSW Minister for the Environment prior to making a decision in respect of the proposal in accordance with section 79B(3) of the EP&A Act;
- A permit will be required under section 205 of the NSW *Fisheries Management Act* 1994 for the proposed mangrove removal and control and saltmarsh removal and restoration works. These proposals are discussed further in Section 6.0 of this report.

3.1 The Proposal

The Port Botany Expansion would involve the creation of a new container terminal extending approximately 550 metres west of the existing Patrick Stevedore container terminal and then 1300 m north towards Foreshore Beach. This would require reclamation of approximately 60 ha (**Figure 2**). The new development would create an additional five container ship berths to meet projected trade demand over the next 25 to 30 years.

The development of the Port Botany Expansion would comprise four major components:

- dredging and reclamation works;
- development of berths and port infrastructure for the new terminal;
- progressive development of terminal facilities for the operation of the new terminal; and
- protection and enhancement of Foreshore Beach and Penrhyn Estuary.

A full description of the proposed Port Botany Expansion is provided in **Chapters 6 to 8** of the EIS.

3.1.1 Dredging and Reclamation

The first component of the project would involve dredging and the reclamation of land for port purposes including:

- dredging of an access channel to the new berths to allow ships to manoeuvre and berth at the new terminal;
- reclamation of approximately 60 hectares of land for additional container terminal capacity using the dredged material;
- reclamation adjacent to Foreshore Road to create a public boat ramp and car park with direct access to Foreshore Road;
- ecological habitat enhancement works within Penrhyn Estuary and the channel separating the new terminal area from the existing shoreline; and
- foreshore works along the existing shoreline to enhance the beach and public recreation area.

3.1.2 Berths and Port Infrastructure

The second component of the project would involve the construction of primary port infrastructure including:

-
- provision of dedicated road access including a junction at Foreshore Road and an entrance bridge across the channel separating the existing shoreline from the new terminal;
 - provision of rail access to the new terminal area by means of an extension of the existing Botany Freight Rail Line parallel to Foreshore Road, together with necessary bridges and culverts;
 - construction of an inter-terminal access road joining the new terminal with the existing port for internal vehicle movements;
 - construction of a road-over-rail grade separation at the eastern end of Penrhyn Road;
 - wharf structures including fendering systems, mooring systems and crane rail beams;
 - provision of tug berths; and
 - channel markers and navigation aids.

3.1.3 Terminal Facilities

The third construction component of the project would involve the progressive completion and commissioning of operational port facilities on the reclaimed land. Five new berths would be brought into operation by the terminal operator(s) in accordance with actual trade growth. The operator(s) would lease land area from Sydney Ports Corporation.

The necessary facilities required to operate the port would include:

- pavements;
- container handling facilities including road and rail exchange facilities;
- buildings including offices, amenities, workshops, depots, and gatehouses;
- reticulation of utility services within the new terminal area; and
- landscaping.

The precise nature of the infrastructure to be used for the new terminal would be determined by the ultimate operator(s) of the port facilities.

3.1.4 Open Space Plan

Foreshore Beach

The Port Botany Expansion would include the following major landscape components to Foreshore Beach:

-
- protection, restoration and enhancement of existing foreshore interface and native vegetation buffer;
 - proposed elevated viewing platform and native planting landscaped areas near the mouth of the Mill Stream;
 - pedestrian path/cycleway and enhancement of pedestrian foreshore/beach linkages;
 - improved pedestrian linkages with Sir Joseph Banks Park including a pedestrian at grade crossing and pedestrian overpass;
 - relocated car park and boat ramp, boarding jetty, public amenities and associated facilities; and
 - road-side and median strip landscaping.

Penrhyn Estuary

The main components of the proposed Penrhyn Estuary ecological restoration and habitat enhancement would include the following:

- removal/excision of sand dune on the western side of Floodvale Drain to maximise the area of intertidal sand/mudflats habitat (1.5 ha existing area increased to 12.5 ha total area);
- expansion of saltmarsh habitat including retention/transplanting of existing areas and removal of colonising mangroves (1.4 ha existing area increased to approximately 6 ha total area);
- creation of seagrass habitat for transplanting seagrass that would be lost due to the reclamation and for the natural colonisation of additional seagrass (8 ha total area);
- restriction of access to a pedestrian boardwalk and viewing platform extending a short distance into the estuary to minimise disturbance of the migratory shorebirds and damage to seagrass/saltmarsh;
- fencing of estuary to control and restrict access to the location of the boardwalk only;
- establishment of a dune scrub community buffer strip along the southern slope of the rail corridor; and
- protection, restoration and enhancement of adjoining foreshore revegetated foredune areas (northeastern corner), including implementation of appropriate landscaping management strategies.

3.2 Justification and Alternatives

Justification for the proposal is detailed in **Chapter 4** of the EIS and alternatives for the proposal are detailed in **Chapter 5** of the EIS.

4.1 Introduction

The objectives of the flora survey and assessment were:

- to determine threatened flora previously recorded, currently occurring or considered likely to occur within the study area;
- to document the native flora and vegetation communities at the site and to assess their condition and conservation value;
- assess the impact of the proposal on flora; and
- to recommend safeguards to ensure that the ecological integrity and biological diversity of the site is not significantly compromised as a result of the port expansion.

4.2 Methodology

4.2.1 Threatened, Rare and Regionally Significant Flora Likely to Occur in the Study Area

A desktop study was undertaken prior to the flora survey to determine previous recordings of plant species of conservation significance at the site or in the vicinity of the site. The desktop study included:

- A search of the National Parks and Wildlife Service (NPWS) Wildlife Atlas database (10 km x 10 km search centred on Port Botany, 2002);
- Internet database searches on the Atlas of NSW Wildlife for the Botany LGA (2002);
- Internet database searches on the EPBC online database (10 km x 10 km search centred on Port Botany, 2002); and
- A review of previous ecological assessments such as the Proposed Third Runway Sydney (Kingsford Smith) Airport (Kinhill 1990), Botany Bay City Council State of the Environment Report (2000) and the Upgrade of Patrick Stevedores Port Botany Container Terminal (PPK 2002) to determine the likely presence of flora species and their habitats and, in particular, significant species.

4.2.2 Site Survey

Stereoscopic aerial photo interpretation (API) of the study area was undertaken using a 1:5000 colour aerial photograph (1994) provided by NPWS to determine vegetative structure and to map initial plant community polygons via subtle differences in height, tone and texture. A total of two 400 m² plots and

two linear transects were undertaken to inventory plant taxa and communities within the study area. The two plots were situated within the planted shrubland along Botany Beach and the two straight-line transects (each approximately 100 metres in length) were undertaken at spring low tide in the mid to upper reaches of Penrhyn Estuary across the upper and lower intertidal zones to target saltmarsh. Each plot was delineated with surveyors flagging tape and all vascular taxa observed within and overhanging the plot were recorded on proforma field data sheets containing information on key environmental attributes including slope, aspect, elevation, soils and geology, floristics, vegetative structure and health, degree of disturbance and weed invasion. Plant taxa observed along the transect lines were recorded on similar proforma field data sheets (refer to **Appendix H**).

The saltmarsh survey was augmented using the Random Meander Technique (Cropper 1993) wherein plant taxa were recorded until no new saltmarsh plants were observed after a period of thirty minutes.

A total of 12 hours were spent undertaking the flora survey.

In the absence of prescribed State and Federal regulatory survey guidelines, the methodology employed was considered adequate (standard industry practice) in obtaining an inventory of flora habitats within the study area, particularly given the homogeneity of the vegetation.

Locations of flora survey plots and transects are shown in **Figures 3 and 4**.

Plant specimens not readily identifiable in the field were collected and subsequently identified using standard botanical texts. Flora is described according to classifications made by Specht (1981). Plant identifications were made according to nomenclature in Harden (1990, 1991, 1992, 1993) and recent revisions prescribed by the NSW National Herbarium.

Plant taxa recorded in the field were subsequently compiled into a floristic list presented as **Appendix D**.

A Low, Moderate and High ranking system was used to assess the conservation value of plant communities recorded within the study area with reference to Adam (1981a, 1981b), Mitchell and Adam (1989a, 1989b), Saintilan (1997; 2000), Adam Wilson and Huntley (1988), particularly in relation to the saltmarsh and mangrove communities.

4.3 Survey Results

4.3.1 Desktop Review

Threatened Flora

Table 4-1 below lists the 13 Threatened flora identified from the desktop review, the conservation status of each species, known habitat requirements, distribution data and an assessment of the likelihood of occurrence of each species within the study area.

Table 4-1
Significant Flora Species Recorded in the Vicinity of the Study Area

Species	Conservation Status*	Habitat Requirements	Local Distribution and Likelihood of Occurrence In Study Area
<i>Acacia bynoeana</i> Bynoe's Wattle	E ¹ V ²	Heath and woodland on sandy soils.	Low likelihood of occurrence. Habitat not present within study area. No recent records of the species in the vicinity of the study area.
<i>Acacia gordonii</i>	E ^{1, 2}	Dry heath in eucalypt woodland, usually in shallow sandy soil amongst sandstone outcrops.	Low likelihood of occurrence. Habitat not present within study area. No recent records of the species in the vicinity of the study area.
<i>Acacia terminalis</i> subsp. <i>terminalis</i>	E ^{1, 2}	Scrub and dry sclerophyll woodland on sandy soil	Low likelihood of occurrence. Species was not recorded within the study area during the present study and is unlikely to recruit within the study area from local seed sources. Recent collections have been made only from Clifton Gardens, Dover Heights, Parsley Bay, Nielsen Park, Cooper Park, Chifley and Watsons Bay. Occurs locally in Botany Bay National Park. One of the largest populations has been lost at Matraville, to the south-east of the study area.
<i>Acacia pubescens</i> Downy Wattle	V ^{1, 2}	Open forest on clay soils.	Low likelihood of occurrence. Habitat not present within study area.
<i>Eucalyptus pulverulenta</i> Silver-leaved Mountain Gum	V ^{1, 2}	Mallee.	Low likelihood of occurrence. Habitat not present within study area.

Species	Conservation Status*	Habitat Requirements	Local Distribution and Likelihood of Occurrence In Study Area
<i>Melaleuca deanei</i>	V ¹	Heath and woodland on ridges and upper slopes on Hawkesbury Sandstone, often in <i>E. piperita</i> – <i>A. costata</i> association.	Low likelihood of occurrence. Habitat not present within study area. No recent records of the species in the vicinity of the study area.
<i>Syzygium paniculatum</i> Magenta Lilly Pilly	V ^{1,2}	Coastal rainforest	Low likelihood of occurrence. Habitat not present within study area. 1977 record of the species at Towra Point.
<i>Caladenia tessellata</i> Thick-lipped Spider orchid, Daddy Long Legs	V ^{1,2}	Low open forest with a heathy or sometimes grassy understorey, in sheltered moist places in forest and scrub particularly on stony laterites on coastal tops.	Low likelihood of occurrence. Habitat not present within study area. No recent records of the species in the vicinity of the study area.
<i>Tetratheca juncea</i>	V ¹	Ridgetops on south-east to south-west aspects on Munmorah Conglomerate geology and Awaba Soil Landscape Unit and is found growing in dense undisturbed understorey vegetation beneath an open forest dominated by <i>E. capitellata</i> , <i>A. costata</i> - <i>C. gummifera</i> (Payne 1998).	Species not recorded within study area during present study. This species is considered regionally extinct in Sydney.
<i>Cryptostylis hunteriana</i> Leafless Tongue-orchid	V ^{1,2}	Sandstone soils	Low likelihood of occurrence. Species occurs from the Kuring-gai area and recently from near Campbelltown.
<i>Prostanthera densa</i> Villous Mintbush	V ^{1,2}	Heath and sea coasts on sandstone.	Low likelihood of occurrence. Occurs from Cronulla south to the Royal National Park
<i>Pterostylis</i> sp Botany Bay Bearded Greenhood	E ^{1,2}	Coastal scrub.	Low likelihood of occurrence. No recent records of the species in the vicinity of the study area.

Species	Conservation Status*	Habitat Requirements	Local Distribution and Likelihood of Occurrence In Study Area
<i>Thesium australe</i> Austral Toadflax	V ^{1, 2}	Grasslands, grassy woodlands or sub-alpine grassy heathlands	Low likelihood of occurrence. Habitat not present within study area. No recent records of the species in the vicinity of the study area.

* Conservation Status is as follows:

E = Endangered

V = Vulnerable

where 1 = listing under TSC Act 1995

2 = listing EPBC Act 1999 Act.

Of the 13 flora species in the vicinity of the project site listed as having conservation significance, four are listed as Endangered and nine as Vulnerable under the TSC Act. Three are listed as Endangered and seven as Vulnerable under the EPBC Act.

Based on the above discussion, no plants listed under the TSC or EPBC Acts previously recorded in the locality would be expected to occur within the study area given the “man made” environment of Foreshore Beach and Penrhyn Estuary.

Threatened Plant Communities

The Eastern Suburbs Banksia Scrub in the Sydney Basin Bioregion (ESBS) is listed as an endangered ecological community under both the TSC and the EPBC Acts. Whilst some shrubs and small trees characteristic of ESBS occur (as dominants) within the planted shrubland of Foreshore Beach, the shrubland is not considered to constitute ESBS as per the provisions in the NSW Scientific Committee Final Determination (2002) for this plant community. Additionally, this community was planted in the 1970's and Foreshore Beach is not a remnant dune but was formed from dredged material during the development of the northern shores of the Bay. None of the study area is mapped as ESBS by the NSW NPWS.

A small remnant of ESBS occurs in Sir Joseph Banks Reserve, north of Foreshore Road. This is not considered any further in this report as this remnant would not be affected by the proposal.

4.3.2 Field Survey Results - Plant Community Descriptions

A total of three plant communities were recorded within the study area, supporting a total of 32 plant taxa from 17 families.

Summary descriptions of each of the three plant communities recorded within the study area during the present study are provided below.

Community No. 1**PLANTED SHRUBLAND****Occurrence**

This community occurs on marine sands and was recorded above the high tide mark along Foreshore Beach, along the Mill Stream (south of Botany Road) and along Penrhyn Road foreshore (refer to **Figure 3**).

Structure

This community comprised a planted shrubland with a tree stratum to 7 metres in height, a sparse to moderately dense and wind-pruned shrub stratum to 4 metres in height and a sparse groundcover to 0.5 metres in height comprising herbs and grasses.

Floristics**Trees**

Banksia integrifolia

Shrubs

Melaleuca armillaris, *Melaleuca ericifolia*, *Leptospermum laevigatum*, *Dodonea triquetra*, *Allocasuarina littoralis*, *Acacia longifolia* var. *sophorae*, *Acacia longifolia* var. *longifolia*, *Banksia serrata*, *Chrysanthemoides monolifera**

Groundcover (grasses, herbs)

Spinifex sericeus, *Atriplex semibaccata*, *Hydrocotyle bonariensis**, *Cakile maritima* ssp. *maritima*, *Acetosa sagittata**, *Cakile edentula* var. *edentula**

* Introduced Species

Conservation Value

Low to moderate. Whilst this community was planted by the then Maritime Services Board in the late 1970s, some of the plantings are considered to be indigenous to the locality (characteristic of the remnant Coastal Dune Heath plant community) and thus the community would be expected to possess local conservation value. The study area, in many places, has become infested with dense thickets of the exotic shrub Bitou Bush (*Chrysanthemoides monolifera*), and Lantana particularly along the Penrhyn Road foreshore. Bitou Bush was originally introduced to stabilise sand dunes and has become an aggressive colonist in coastal dune habitats.

Community No. 2

Sarcocornia quinqueflora – *Suaeda australis* HERBLAND

Occurrence

This community occurs on marine sands as well as alluvial deposits (muds) as a narrow fringe above the mangroves in the mid to upper intertidal zone (occasional tidal inundation) within the mid and upper sections of Penrhyn Estuary on both the eastern and western sides of the creek channel (**Figure 4**).

Structure

This saltmarsh community comprised a patchy herbland to 0.5 metres in height dominated by two succulent stemmed members of Chenopodiaceae and a dense rush meadow on the western side of the creek channel to 1.0 metre in height. The rush meadow occupied most of the saltmarsh zone. Scattered grey mangrove seedlings and shrubs to 1 metre in height were often recorded in the marsh zone. Small grassland patches were also recorded in the upper marsh zone on both sites of the creek channel.

Floristics**Shrubs**

Avicennia marina

Herbs

Sarcocornia quinqueflora, *Suaeda australis*

Graminoids (sedges, rushes, herbs)

Juncus kraussii, *Isolepis nodosa*

Grasses

Sporobolus virginicus

Corresponding Map Unit

Map Unit 4a – Estuarine Complex (Benson and Howell 1994)

Conservation Value

High. This plant community colonised Penrhyn Estuary (via seed dispersal through tide transport from saltmarsh colonies at Towra Point) following reshaping of the northern foreshore of Botany Bay in the late 1970s and remains the only saltmarsh on the northern shoreline of Botany Bay, following the destruction of two saltmarsh areas as part of the construction of the parallel runway in the mid 1990s (**Figure 4**).

Saltmarsh is of high ecological significance to fish and migratory shorebirds (Saintilan and Rogers 2002).

It should also be noted that the definition of “foreshore” in Section 204 of the *Fisheries Management Act* 1994 has been recently amended to provide protection for the saltmarsh zone via the term ‘highest

astronomical tide level'. Section 204 (2) (b), however, states that any areas above mean high water mark within a foreshore area can only be formally protected by a declaration of the Minister for Fisheries, by order published in the Gazette. To date, no areas above mean high water mark have been gazetted by the Minister. Should the "foreshore" area at Penrhyn Estuary be gazetted by the Minister prior to the habitat enhancement works proposed as part of the Port Botany Expansion, a Permit to destroy protected marine vegetation would need to be sought from NSW Fisheries.

Community No. 3

Avicennia marina (Grey Mangrove) LOW SHRUBLAND to OPEN SCRUB

Occurrence

This community is generally confined to the lower intertidal zone on both sides of the creek channel in the mid and upper sections of the estuary. This community was also frequently recorded encroaching into the saltmarsh zone (**Figure 4**).

Structure

This community receives daily tidal inundation and varies in structure from a low shrubland of scattered seedlings to dense pockets of mature shrubs to 2-3 metres in height. Scattered grey mangrove seedlings and shrubs to one metre in height were often recorded in the marsh zone.

Floristics

Shrubs

Avicennia marina

Corresponding Map Unit

Map Unit 4a – Estuarine Complex (Benson and Howell 1994)

Conservation Value

Low conservation value in the context of maintaining and enhancing migratory shorebird habitat at Penrhyn Estuary and in the context of establishing additional area of saltmarsh habitat at Penrhyn Estuary which comes at the expense of mangroves.

Whilst the value of mangroves for biodiversity, sediment stabilisation as well as fish nursery and some shorebird habitat is well known and is demonstrated by its protection under the *Fisheries Management Act* 1994, the presence of mangroves at Penrhyn Estuary is incompatible with the types of migratory shorebirds that utilise the estuary and with saltmarsh habitat that has been significantly reduced on the northern shores of the Bay.

The reduction of saltmarsh area in NSW caused by the landward expansion of mangroves has been documented in recent years (Saintilan 1997; Saintilan and Williams 2000; Saintilan and Rogers 2002) and has occurred locally at Towra Point, regionally in the Parramatta and Lane Cove Rivers, and in Moreton Bay, Tweed River and Kooragang Island. The landward encroachment of mangroves into the mid/upper

tidal marsh zone at Penrhyn Estuary is presently occurring (**Plate 4**) and will, in time, reduce the amount of saltmarsh area on the site. Mitchell and Adam (1989) note that such a landward encroachment suggests that mangroves have become physiologically tolerant to a wider environmental gradient, given that the mid to upper intertidal marsh zone typically experiences both a greater range of soil salinities and a higher maximum salinity than the lower intertidal. This is due to the fact that tidal inundation of the saltmarsh zone is relatively infrequent and between tides, evapotranspiration can lead to higher soil salinities, particularly in the absence of rain. Whilst the factors determining the distribution of mangrove and saltmarsh communities has never been well understood, it may be that mangroves are less tolerant of salinities higher than seawater, than saltmarsh species (Mitchell and Adam 1989). Consequently, a landward encroachment by mangroves possibly suggests a reduction of peak salinities in the marsh zone. The discharge of stormwater to many NSW estuary marshes has occurred and may be a significant contributing factor in such a salinity reduction and resulting mangrove spread. Groundwater discharge and stormwater from a large industrial (Botany) catchment discharges into Penrhyn Estuary via Floodvale and Springvale Drains and from a series of small drains along Penrhyn Road and thus a reduction in soil salinity in the marsh zone would not be unexpected.

Mangroves are opportunistic colonisers of newly accreted sediment and thus increased land clearing and urbanisation in the catchment over the years which has no doubt led to increased sedimentation and elevated nutrient levels at the estuary appears to have promoted the expansion and productivity of mangroves. Mangroves are proliferating in large numbers on the mudflats at Penrhyn Estuary. This, in turn, increases the number of seedlings germinating in the marsh zone and so a proliferation of mangroves on the mudflats in the lower intertidal will eventually be to the detriment of the saltmarsh and migratory shorebirds at Penrhyn Estuary unless active rehabilitation (mangrove removal and control) is carried out.

4.4 Impact of the Proposal on Flora

4.4.1 Planted Shrubland

The proposal would result in the direct removal of approximately 0.6 hectares of planted shrubland at Foreshore Beach (out of a total of approximately 12 hectares) as part of the construction of the port facilities. Enhancement of existing shorebird habitat at Penrhyn Estuary, a key component of the proposal detailed in Section 6.0 of this report, would result in the removal of an additional 10.5 hectares (approx.) of planted shrubland and its habitat at Penrhyn Estuary (out of a total of approximately 15 hectares).

The loss of this planted shrubland community at Penrhyn Estuary, whilst it possesses some local conservation value, is not considered to be significant in a local or regional sense. Approximately 4 hectares of the planted shrubland will be retained at the site. The loss of a portion of the plant community is a trade-off to enhance a recognised important migratory shorebird habitat site in Botany Bay and should be viewed in this overall context.

4.4.2 Mangroves

Under the proposed port expansion the small stand of mangroves (approximately 1.0 hectare) that has become established in Penrhyn Estuary would be removed to facilitate the growth of saltmarshes and to enhance the value of the area as habitat for shorebirds.

The loss of the small stand of mangroves at Penrhyn Estuary is not considered to be significant given that:

- the relatively small loss of mangroves in a Bay wide context (representing about 0.1 % of the mangroves of Botany Bay, based on West *et al.* 1985);
- the mangroves were never a naturally occurring (remnant) community on the northern shores of the Bay but have colonised (via dispersed seed) a newly formed estuary (formed from the construction of Port Botany) upon favourable environmental conditions (sediment accumulation and nutrient input); and
- Penrhyn Estuary has assumed an importance in becoming the last remaining migratory shorebird habitat on the northern shores of Botany Bay. Consequently, one of the key components of the proposal is the enhancement of shorebird habitat at Penrhyn Estuary via the creation of additional tidal flats and saltmarsh areas at the expense of incompatible mangrove habitat. Long term mangrove control would be required as a component of the shorebird habitat enhancement given the suspected mangrove soil seed bank and ongoing dispersal of seed.

The removal of mangroves would require a permit from NSW Fisheries under the *Fisheries Management Act 1994*. Further details of the removal and long term control of mangroves on the site are described in Section 6.1.3.

4.4.3 Saltmarsh

Saltmarsh habitat of up to 6 ha would be created as part of the habitat enhancement of Penrhyn Estuary, comprising existing saltmarsh, existing saltmarsh requiring transplantation due to the works and additional habitat for a combination of planting and natural colonisation. The creation of additional saltmarsh habitat is considered to be a positive impact as it will represent a substantial increase in the area of this habitat within Botany Bay, approximately 4%, based on West *et al.* (1985) and will help in restoring saltmarsh habitat on the northern shores of the Bay that was lost due to the construction of the Parallel Runway.

Further details of the saltmarsh habitat creation is described in Section 6.1.3.

5.1 Introduction

The objectives of the fauna assessment were:

- to determine threatened fauna species and endangered populations previously recorded, currently occurring or considered likely to occur within the study area;
- to identify fauna habitat present at the site and to assess the likelihood of occurrence of threatened fauna species within these habitats;
- assess the impact of the proposal on fauna; and
- to recommend safeguards to ensure that the ecological integrity and biological diversity of fauna habitat at the site is maintained.

5.2 Methodology

5.2.1 Threatened, Rare and Regionally Significant Fauna Likely to Occur in the Study Area

A desktop study was undertaken to determine previous recordings of fauna species of conservation significance within the vicinity of the study area. The desktop study included:

- A search of the National Parks and Wildlife Service (NPWS) Wildlife Atlas database (10 km x 10 km search centred on Port Botany, 2002);
- Internet database searches on the Atlas of NSW Wildlife for the Botany LGA (2002);
- Internet database searches on the EPBC online database (10 km x 10 km search centred on Port Botany, 2002).
- A review of previous ecological assessments such as the Proposed Third Runway Sydney (Kingsford Smith) Airport (Kinhill 1990), Botany Bay City Council State of the Environment Report (2000) and the Upgrade of Patrick Stevedores Port Botany Container Terminal (PPK 2002) to determine the likely presence of fauna species and their habitats and, in particular, significant species;
- Historical and recent aerial photograph interpretation (API) of fauna habitats within Botany Bay and the study area;
- Desktop literature search and review of shorebird disturbance studies in Australia and overseas (refer Reference list); and
- Compilation and review of NSW/Australasian Wader Study Group Count data (1994-2001) for Botany Bay and NPWS Botany Bay Action Plan wader counts (2001-2002) (Refer to **Appendix E**).

Following the desktop review and discussions with shorebird experts, Phil Straw (Avifauna Research), Geoff Ross (NSW NPWS) and Doug Watkins (Wetlands International), a total of 23 shorebirds and one seabird listed under the TSC and/or EPBC Acts considered as regular or occasional visitors to Penrhyn Estuary were assessed under Section 5A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) by URS. The assessments ('8 Part Tests') concluded that the proposal may significantly impact upon the life cycle requirements of these bird species that regularly or occasionally use Penrhyn Estuary for feeding and roosting if not appropriately mitigated (refer to **Appendix A** for the 8 Part Tests). Consequently, Director General's requirements for the preparation of this SIS were sought from NSW NPWS (**Appendix B**).

5.2.2 Field Surveys

No additional field surveys were undertaken (or considered to be required) as part of this study as it was considered that there was sufficient, existing information available (bird counts, shorebird disturbance) to make an assessment of the impacts of the proposal on fauna.

5.2.3 Habitat Enhancement

A site inspection of the study area was undertaken by URS on 16 and 27 May 2002 to assess the existing shorebird habitats at Penrhyn Estuary and to develop shorebird habitat enhancement options. Phil Straw (Avifauna Research) and Geoff Ross (NSW NPWS) accompanied URS on site at Penrhyn Estuary (May 27, 2002) to discuss a preferred shorebird habitat enhancement option for the site. Shorebird habitat enhancement is discussed in Section 6.0 of this report.

5.3 Survey Results

5.3.1 Desktop Review

Threatened Fauna

Table 5-1 below lists 86 fauna species listed as having conservation significance under the TSC Act and/or the EPBC Act identified from the desktop review as having been previously recorded in the Botany Bay locality or predicted to occur within the study area based on habitats present, their known habitat requirements, distribution data and an assessment of the likelihood of occurrence of each species within the study area. Advice on current shorebird habitat and distribution within Botany Bay Estuary has been provided by Avifauna Research Services through discussions with Phil Straw.

Table 5-1
Significant Fauna Species Previously Recorded or Predicted to occur in Botany Bay

Species	Conservation Status *	Habitat requirements	Likelihood of occurrence and comments
Threatened Fauna			
Frogs			
<i>Crinia tinnula</i> Wallum Froglet	V ¹	Confined to acid, paperbark swamps of the 'wallum' country.	Low. Suitable habitat not present in study area.
<i>Heleioporus australiacus</i> Giant Burrowing Frog	V ^{1,2}	Burrows in banks of small creeks.	Low. Suitable habitat not present in study area.
<i>Litoria aurea</i> Green and Golden Bell Frog	E ¹ V ²	Aquatic, found among vegetation within or at the edges of permanent water – streams, swamps, lagoons, farm dams and ornamental ponds. Often found under debris on low, oft – flooded river flats.	Low. Suitable habitat not present in study area.

Species	Conservation Status *	Habitat requirements	Likelihood of occurrence and comments
<i>Litoria littlejohni</i> Littlejohn's Tree Frog, Heath Frog	V ^{1,2}	Undisturbed woodland and heath communities at mid to high altitude. Shelters and feeds along permanent mountain streams with low water velocity. Also occurs near semi-permanent dams with some emergent vegetation. Shelters under rocks on high, exposed ridges during summer. It is not known from coastal habitats.	Low. Suitable habitat not present in study area.
Birds			
<i>Actitis hypoleucos</i> Common Sandpiper	M, J, C	Steep-sided muddy or rocky margins of various waterbodies, whether saline, fresh or brackish. In coastal sites it is typically found on the margins of salt or brackish watercourses, tending to occur in the upper rather than the lower parts of estuaries.	Moderate. Occurs most years in very low numbers in Botany Bay and presently roosts on a wooden jetty at Shell Point. The last sighting of the species at Penrhyn Estuary was a single sighting recorded by the NSW Wader Study Group in 1994.
<i>Anseranas semipalmata</i> Magpie Goose	V ¹ , M	Rush and sedge-dominated swamps, floodplains.	Low. Suitable habitat not present in study area. No recent records in the area.

Fauna Assessment

SECTION 5

Species	Conservation Status *	Habitat requirements	Likelihood of occurrence and comments
<i>Arenaria interpres</i> Ruddy Turnstone	M, J, C	Occur mainly on rocky coasts, sometimes on ocean beaches, seldom on estuarine mudflats. In northern Australia, prefer coasts with wide intertidal mudflats.	Moderate. Presently feeds and roosts on rock platforms at Boat Harbour and also roosts on wooden barges at Shell Point.. This species is seldom seen on estuarine mudflats although may occasionally forage at Penrhyn Estuary. more often on rocky platforms and ocean beaches
<i>Botaurus poiciloptilus</i> Australasian Bittern	V ¹	Dense reedbeds and swamps feeding on small fish and other aquatic life, sometimes in rice fields.	Low. Suitable habitat not present in study area. No recent records in the area.
<i>Burhinus grallarius</i> Bush Stone-curlew	E ¹	Lightly timbered, open forest or woodlands associated with casuarinas, eucalypts and acacias or epolycarpa. Dry, open grassland or cropland with cover nearby.	Low. Suitable habitat not present in study area.
<i>Cacatua leadbeateri</i> Major Mitchell's Cockatoo	V ¹	Mallee, mulga, Murray Pine and casuarina associations.	Low. Suitable habitat not present in study area.
<i>Calamanthus fuliginosus</i> Striated Fieldwren	V ¹	Saltmarsh where there are sedges and reeds present.	Low. No recent records in the area.

Fauna Assessment

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Species	Conservation Status *	Habitat requirements	Likelihood of occurrence and comments
<i>Calidris acuminata</i> Sharp-tailed Sandpiper	M, J, C	Saltmarsh and intertidal mudflats, but seem to prefer non-tidal wetlands, especially freshly exposed mudflats around drying lakes and swamps. May be found over a wide range of salinities, from freshwater wetlands through to hypersaline inland lakes. Generally roost and often feed amongst low vegetation. Occasionally visit mangroves, beaches and rocky shores.	High. Typically feeds and roosts in saltmarsh at the Barton Park (Eve Street) wetland and may occasionally forage and roost in the upper reaches of Penrhyn Estuary in mudflats and saltmarsh. Has been recorded at Penrhyn Estuary in 1995, 1996 (68 individuals) and 1997 (32 individuals).
<i>Calidris alba</i> Sanderling	V ¹ , M, J, C	Sandy ocean beaches, where they feed in the wave washed zone at low tide. At high tide roost on beaches or on nearby rocky reefs. Favour beaches near estuaries rather than long stretches of uninterrupted beach. Sometimes roost or shelter in estuaries but seldom feed there.	High. Occasionally seen in Botany Bay. Typically feeds in the wave zone of ocean beaches at Boat Harbour and will generally flee to the northern shores of the bay during rough weather for shelter and feeding (Penrhyn Estuary).
<i>Calidris canutus</i> Red Knot	M, J, C	Forage on intertidal sand and mudflats in estuaries. Usually roost at high tide on beaches and other open sites.	High. Presently feeds on intertidal sand and mudflats at Penrhyn Estuary and at Rocky Point and roosts at Penrhyn Estuary (typically in association with Godwits). Six individuals of the species have been recorded feeding at Woollooware Shorebird Lagoon on the southern shores of the Bay on bivalve molluscs (pers. com., Phil Straw). Up to about 200 individuals of the species may be present in the Bay in present times.

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Species	Conservation Status *	Habitat requirements	Likelihood of occurrence and comments
<i>Calidris ferruginea</i> Curlew Sandpiper	M, J, C	Forage on intertidal sand and mudflats in estuaries. At high tide roost on beaches or rock platforms, or continue to feed in saltmarshes and backwaters. Frequent muddy margins of shallow inland wetlands.	High. Presently feeds and roosts at Penrhyn Estuary on intertidal mudflats (feeding) and sandflats at the mouth of the estuary and on the north side of the channel (roosts).
<i>Calidris ruficollis</i> Red-necked Stint	M, J, C	Most numerous on intertidal sand and mudflats in estuaries. Frequent saltmarsh, ocean beaches and rocky shores. Inland, they are most numerous on the muddy margins of saline lakes, although they often occur at freshwater wetlands as well.	High. Presently feeds and roosts at Penrhyn Estuary and occasionally at Boat Harbour and Spit Island. The species also roosts on barges at Shell Point which demonstrates the general lack of adequate high tide roosts for shorebirds utilising the Bay. Straw (1996) notes that the birds roosting at Boat Harbour are likely a result of the displacement of these birds from Penrhyn Estuary due to disturbance in the area.
<i>Calidris tenuirostris</i> Great Knot	V ¹ , M, J, C	Forage on intertidal sand and mudflats in estuaries. Usually roost at high tide on beaches and other open sites.	High. Occasionally recorded feeding on mudflats at Penrhyn Estuary, particularly since it was displaced from its preferred habitat at the former Pilots Embayment which was lost due to the Parallel Runway construction.
<i>Calyptorhynchus lathamii</i> Glossy Black-Cockatoo	V ¹	Eucalypt forest and woodland. Feeds almost exclusively on casuarina fruit.	Low. Suitable habitat not present in study area. No recent records in the area.

Species	Conservation Status *	Habitat requirements	Likelihood of occurrence and comments
<i>Charadrius bicinctus</i> Double-banded Plover	M	Mainly found on intertidal sand and mudflats in estuaries, often preferring sites near saltmarsh or other low, moist vegetation, where the birds roost and feed at high tide. Also feed and roost on ocean beaches and rocky shores. Inland, they inhabit the margins of both saline and freshwater wetlands.	High Presently feeds on intertidal sand flats at Penrhyn Estuary. The species also roosts at Penrhyn Estuary, Boat Harbour and reportedly, at present, Molineux Point and on the end of the parallel runway. This species is thus quite vulnerable to disturbance due to fisherman, dogs and beach walkers given its key habitat at Penrhyn Estuary and Boat Harbour. This species used to feed at the former stockpile site and northern sections of Foreshore Beach which were both lost due to the parallel runway construction and have thus experienced a critical decline in their Bay habitat. Based on counts since the 1970s, Botany Bay is one of the three most important estuaries for the species in NSW (along with the Hunter and Shoalhaven Rivers).
<i>Charadrius leschenaultii</i> Greater Sand Plover	V ¹ , M, J, C	Forages on intertidal sand and mudflats in estuaries, and roosting during high tide on sand beaches or rocky shores.	High. Occasional visitor to Penrhyn Estuary and Boat Harbour (often in association with the Lesser Sand Plover) where it feeds on intertidal sand flats. Only 1 or 2 individuals are recorded in the Bay on an occasional basis (this is significant given the NSW estimate population for this species is only 80 birds with the majority occurring in the Clarence and Richmond estuaries).
<i>Charadrius mongolus</i> Lesser Sand Plover	V ¹ , M, J, C	Feed on intertidal sand and mudflats in estuaries, roosting on sandy beaches or rocky shores at high tide, and sometimes feeding at these sites.	High. Roosts every year on intertidal sand flats at Boat Harbour (up to about 10 individuals) and feeds at Penrhyn Estuary and possibly elsewhere in the Bay.

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Species	Conservation Status *	Habitat requirements	Likelihood of occurrence and comments
<i>Dasyornis brachypterus</i> Eastern Bristlebird	E ^{1,2}	Dense coastal and mountain heaths, taller swamps and stream thickets.	Low. Suitable habitat not present in study area. No recent records in the area.
<i>Diomedea amsterdamensis</i> Amsterdam Albatross	E ² , M,	Oceanic and coastal seas.	Low. Suitable habitat not present in study area.
<i>Diomedea antipodensis</i> Antipodean Albatross	V ² , M,	Oceanic and coastal seas.	Low. Suitable habitat not present in study area.
<i>Diomedea dabkena</i> Tristan Albatross	E ² , M	Oceanic and coastal seas.	Low. Suitable habitat not present in study area.
<i>Diomedea exulans</i> Wandering Albatross	E ^{1,2} , M	Oceanic and coastal seas.	Low. Suitable habitat not present in study area. No recent records in the area.
<i>Diomedea gibsoni</i> Gibson's Albatross	V ^{1,2} , M	Oceanic and coastal seas.	Low. Suitable habitat not present in study area.
<i>Gallinago hardwickii</i> Latham's Snipe	M, J, C	Wet grasslands; open, wooded swamps.	Low. Suitable habitat not present in study area.
<i>Gygis alba</i> White Tern	V ¹	Oceanic and breeds on islands.	Low. Suitable habitat not present in study area. No recent records in the area.

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Species	Conservation Status *	Habitat requirements	Likelihood of occurrence and comments
<i>Haematopus fuliginosus</i> Sooty Oystercatcher	V ¹	Rocky coasts within 50m of the shoreline. Breeds on islands	Low. Suitable habitat not present in study area.
<i>Haematopus longirostris</i> Pied Oystercatcher	V ¹	Favours ocean beaches and estuarine sand and mudflats..	High. Presently occurs in relatively large numbers (up to 60 individuals) at Sandringham Bay where it feeds and roosts and at Pennyhn Estuary where it feeds on intertidal sandflats. Presently 5 or 6 pairs nest at Woolboore Shorebird Lagoon, Towra Spit Island and at the airport. The volume of pedestrian traffic and shoreline steepness of Foreshore Beach would be expected to preclude the use of this area by the species for its life cycle requirements, particularly nesting activity.
<i>Haliaeetus leucogaster</i> White-bellied Sea-eagle	M, C	Large rivers, fresh and saline lakes, reservoirs, estuaries, coastal seas, and islands.	Low. Suitable habitat not present in study area.
<i>Hirundapus caudacutus</i> White-throated Needletail	M, C	Aerial, mainly in E. Australia; often associated with coastal and mountain regions.	Low. Suitable habitat not present in study area.
<i>Lathamus discolor</i> Swift Parrot	E ^{1,2}	Dry open forests, woodlands and gardens.	Low. Suitable habitat not present in study area. No recent records in the area.

Species	Conservation Status *	Habitat requirements	Likelihood of occurrence and comments
<i>Limicola falcinellus</i> Broad-billed Sandpiper	V ¹ , M, J, C	Favour intertidal sand and mudflats in estuaries.	Moderate. Up to 17 individuals of this species were recorded on the northern shores of Botany Bay in 1953 (Straw 1996) and mostly single individuals have been recorded in the Bay on an occasional basis since the mid 1970s (northern shoreline). This species may occasionally feed and roost at Penrhyn Estuary.
<i>Limosa lapponica</i> Bar-tailed Godwit	M, J, C	Intertidal sand and mudflats in estuaries. Also forage at times in saltmarsh, mangroves and ocean beaches. Usually roost at high tide on beaches and other open sites.	High. Presently feeds on intertidal sandflats at Penrhyn Estuary and at Rocky Point in the Bay and roosts on beaches at Penrhyn Estuary and Sandringham Bay.
<i>Limosa limosa</i> Black-tailed Godwit	M, J, C	Forages on intertidal sand and mudflats in estuaries, roosting at high tide in a variety of open sites. Also occurs on the muddy margins of inland wetlands.	Moderate. Feeds on intertidal mudflats and on muddy margins of wetlands. Occurs in very small numbers (1 or 2 individuals) in the Parramatta River Estuary at Homebush Bay and may occasionally forage and roost at Penrhyn Estuary although no recent sightings of this species have been recorded at Botany in recent years.
<i>Macronectes giganteus</i> Southern Giant-Petrel	E ^{1,2} , M	Oceans and bays.	Low. Suitable habitat not present in study area. No recent records in the area.
<i>Macronectes halli</i> Northern Giant-Petrel	V ² , M, P	Oceans and bays.	Low. Suitable habitat not present in study area.

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Species	Conservation Status *	Habitat requirements	Likelihood of occurrence and comments
<i>Monarcha melanopsis</i> Black-faced Monarch	M	Forests.	Low. Suitable habitat not present in study area.
<i>Myiagra cyanoleuca</i> Satin Flycatcher	M	Tall and medium open forests.	Low. Suitable habitat not present in study area.
<i>Neochmia ruficauda</i> Star Finch	E ^{1, 2}	Tall grass beside swamps and rivers.	Low. Suitable habitat not present in study area. No recent records in the area.
<i>Ninox strenua</i> Powerful Owl	V ¹	Tall open forests.	Low. Suitable habitat not present in study area.
<i>Numerius madagascariensis</i> Eastern Curlew	M, J, C	Intertidal sand and mudflats in estuaries, particularly where there are extensive seagrass beds and stands of mangroves. Usually roosts at high tide on beaches or in saltmarshes.	Moderate. Presently feeds over much of the intertidal mudflats of the southern parts of the Bay, including Woollooware, Quibray, Weeney and Stinkpot Bays and Towra Point. Preferred roost sites on the southern shores of the Bay include sand spits and shoals and wooden poles of oyster leases. The species does not normally use the northern shoreline of the Bay to feed or roost, but may do so on occasion.
<i>Numerius phaeopus</i> Whimbrel	M, J, C	Typically forages on intertidal mudflats near mangroves or along the banks of tidal creeks and rivers. They also often forage on intertidal rock shelves. Roost in mangroves or other shoreline trees, or on beaches or rocky shores.	Moderate. Presently feeds on exposed mudflats near and under mangrove trees at Towra Point Aquatic Reserve and roosts in mangrove trees at Woollooware, Weeney and Stinkpot Bays. This species may occasionally feed at Penrhyn Estuary.

Species	Conservation Status *	Habitat requirements	Likelihood of occurrence and comments
<i>Oxyura australis</i> Blue Billed Duck	V ¹ , M	Permanent freshwater swamps, lakes, dams and larger rivers, usually with a cover of dense vegetation.	Low. Suitable habitat not present in study area.
<i>Pandion haliaetus</i> Osprey	V ¹ , M	Fishes in fresh, brackish or salt water. Sometimes seen inland although breeding usually confined to the coast or islands.	Low. Suitable habitat not present in study area. No recent records in the area.
<i>Phippura rufifrons</i> Rufous Fantail	M	Wet forests, occasionally more open forests.	Low. Suitable habitat not present in study area.
<i>Pluvialis fulva</i> Pacific Golden Plover	M, J, C	Occurs mainly on estuarine sand and mudflats and nearby saltmarsh and short, most pasture. Typically roost at high tide in saltmarsh and pasture, and often feed in these areas as well. At some sites they feed on rocky intertidal areas, roosting at high tide on sandy beaches or rocks. Occasionally they visit coastal freshwater wetlands.	High Regularly feeds on intertidal mudflats at Penrhyn Estuary and roosts in saltmarsh at Penrhyn and on wooden barges at Shell Point (up to 6 birds use the barges on the southern side). Straw (1996) notes that a small number of birds also feed and roost at Boat Harbour which may be the result of disturbance to the birds at Penrhyn Estuary. Key feeding habitat of the species at the mouth of the Mill Stream and Runway Beach have been lost due to the Parallel Runway construction and may explain, in part, the marked decline in numbers of this species in the Bay since the mid 1980s. The erosion of intertidal sands off Towra Beach and increased 4WD usage of the Boat Harbour area may similarly explain the marked decline in usage of the southern part of the Bay by the species.

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Species	Conservation Status *	Habitat requirements	Likelihood of occurrence and comments
<i>Pluvialis squatarola</i> Grey Plover	M, J, C	Forages on intertidal sand and mudflats, and roosting at high tide usually on beaches.	High. Occasionally recorded feeding on intertidal sand and mudflats at Penrhyn Estuary, Quibray Bay and west of Taren Point. One known roost of the species in the Bay is on the sandy points on either side of the channel at Penrhyn Estuary. The species was historically recorded from the original mouth of the Cooks River.
<i>Polytelis swainsonii</i> Superb Parrot	V ^{1,2}	Riverine and floodplain open forest and woodlands, particularly River Red Gum.	Low. Suitable habitat not present in study area.
<i>Procelsterna cerulea</i> Grey Ternlet	V ¹	Oceanic and breeds on islands.	Low. Suitable habitat not present in study area. No recent records in the area.
<i>Pterodroma leucoptera leucoptera</i> Gould's Petrel	E ^{1,2} , M	Oceanic.	Low. Suitable habitat not present in study area.
<i>Pterodroma neglecta</i> Kermadec Petrel (western)	V ^{1,2}	Oceanic.	Low. Suitable habitat not present in study area. No recent records in the area.
<i>Pterodroma nigripennis</i> Black-winged Petrel	V ¹	Oceanic.	Low. Suitable habitat not present in study area. No recent records in the area.
<i>Pterodroma solandri</i> Providence Petrel	V ¹	Oceanic.	Low. Suitable habitat not present in study area. No recent records in the area.

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Species	Conservation Status *	Habitat requirements	Likelihood of occurrence and comments
<i>Ptilinopus superbus</i> Superb Fruit-dove	V ¹	Rainforest, but will feed in adjacent mangroves or eucalypt forest.	Low. Suitable habitat not present in study area.
<i>Puffinus assimilis</i> Little Shearwater	V ¹	Oceanic and breeds on islands.	Low. Suitable habitat not present in study area. No recent records in the area.
<i>Puffinus carneipes</i> Flesh-footed Shearwater	V ¹ , M, J	Oceanic and breeds on islands.	Low. Suitable habitat not present in study area. No recent records in the area.
<i>Rostratula benghalensis</i> Painted Snipe	M, C	Marsh with moderate cover.	Low. Suitable habitat not present in study area.
<i>Stagonopleura guttata</i> Diamond Firetail	V ¹	Woodland and forest with shrubby understorey for breeding.	Low. Suitable habitat not present in study area. No recent records in the area.

Species	Conservation Status *	Habitat requirements	Likelihood of occurrence and comments
<i>Sterna albifrons</i> Little Tern	E ¹ , M, J, C	Nest only on or near the coast of NSW, although in other parts of the world they may be found nesting beside rivers and lakes far from the sea. Some breeding sites in NSW are within estuaries or harbours. Other nesting sites are in dunes behind ocean beaches, but most are on sand spits or sand islands where rivers, creeks or lakes enter the sea.	Moderate. Forages at the mouth of Penrhyn Estuary for small fish and also roosts at the Estuary. This species has successfully nested in recent years on Towra Spit Island but was unsuccessful in the 2001/02 season due to the presence of foxes (pers. comm., Geoff Ross). The species aborted nesting on Towra Spit in 2001/02 and fled to Molineux Point to nest. NPWS note that upwards of 60 pairs of the bird nested on Spit Island during the past 10 years (pers. comm., Geoff Ross). The species returned to Towra Spit in 2002/03 for nesting. Fox baiting is reportedly underway throughout all areas at Towra Point Nature/Aquatic reserve in an attempt to minimise the chances of foxes predating on future Little Tern nesting sites on Spit Island (a concern given that the island is moving south and the foxes may be able to access the island via mangroves at Towra Point).
<i>Sterna fuscata</i> Sooty Tern	V ¹	Oceanic and breeds on islands.	Low. Suitable habitat not present in study area. No recent records in the area.
<i>Thalassarche bulleri</i> Buller's Albatross	V ² , M, P	Oceanic and coastal seas.	Low. Suitable habitat not present in study area.
<i>Thalassarche cauta</i> Shy Albatross	V ^{1,2} , M	Oceanic and coastal seas.	Low. Suitable habitat not present in study area. No recent records in the area.
<i>Thalassarche impavida</i> Campbell Albatross	V ² , M	Oceanic and coastal seas.	Low. Suitable habitat not present in study area.

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Species	Conservation Status *	Habitat requirements	Likelihood of occurrence and comments
<i>Thalassarche melanophris</i> Black-browed Albatross	V ¹ M	Oceanic and coastal seas.	Low. Suitable habitat not present in study area. No recent records in the area.
<i>Thalassarche salvini</i> Salvin's Albatross	V ² , M	Oceanic and coastal seas.	Low. Suitable habitat not present in study area.
<i>Thalassarche steadi</i> White-capped Albatross	V ² , M	Oceanic and coastal seas.	Low. Suitable habitat not present in study area.
<i>Tringa brevipes</i> Grey-tailed Tattler	M, J, C	Typically found in estuaries with extensive mangroves and intertidal mudflats, although it also inhabits rocky shores along the coast. Often roosts in mangroves at high tide, or on rocks in preference to beaches.	Moderate. Presently feeds on exposed mudflats on the southern part of the Bay and have been recorded resting at a number of locations including the groynes at Kurnell, the old rocky wharf at the mouth of Quibray Bay, in mature spreading mangroves and on platforms in mangroves at Quibray Bay. May occasionally feed in small numbers at Penrhyn Estuary.
<i>Tringa nebularia</i> Common Greenshank	M, J, C	Occur on all types of wetlands. Usually found beside shadow waters generally either saline, brackish or fresh, including intertidal sand and mudflats, saltmarsh, mangroves and freshwater wetlands.	Moderate. Recorded on the mangrove lined shores of Woollooware Bay and used to favour the pond at the Woollooware Shorebird lagoon site (H1 site). May be an occasional visitor to Penrhyn Estuary.

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Species	Conservation Status *	Habitat requirements	Likelihood of occurrence and comments
<i>Tringa stagnatilis</i> Marsh Sandpiper	M, J, C	Saline or freshwater wetlands, both coastal and inland. Common on intertidal mudflats in northern Australia. Typical of pools in saltmarshes. Often occurs at artificial wetlands such as sewage treatment works and saltworks.	Moderate. Presently feeds and roosts in the Hawkesbury Swamps and at the waterbird refuge at Homebush and Newington Wetlands in the Parramatta River Estuary in relatively low numbers (up to 17 birds have been recorded in the Hawkesbury Swamps). No recent records exist for this species in the Bay. One historical record for this species in the Bay was identified (in 1983 at the old mouth of the Cooks River). This species may feed on estuarine mudflats at Penrhyn on an occasional basis.
<i>Tyto novaehollandiae</i> Masked Owl	V ^{1,2}	Forests, woodlands and caves.	Low. Suitable habitat not present in study area. No recent records in the area.
<i>Xanthomyza phrygia</i> Regent Honeyeater	E ^{1,2} , M	Woodland and open forest. Uncommon, nomadic.	Low. Suitable habitat not present in study area.
<i>Xenus cinereus</i> Terek Sandpiper	V ¹ , M, J, C	Forages on intertidal sand mudflats, often near mangroves or in tidal creeks. Occasionally forages on sandy ocean beach or rocky shores. Typically roosts on or among mangroves, but also on open beaches.	Moderate. Presently feeds on intertidal mudflats between Taren Point and Woolooware Bay on the southern shores of the Bay and roosts on a disused jetty at Shell Point. This species may occasionally forage at Penrhyn Estuary (although no recent records exist of this species on the northern shores of the Bay).
Mammals			
<i>Chalinolobus dwyeri</i> Large-eared Pied Bat	V ^{1,2}	Dry sclerophyll forests and woodlands, sub-alpine woodland, rainforest and moist eucalypt forests. Roosts in caves, mine tunnels and the abandoned mud nests of Fairy Martins.	Low. Suitable habitat not present in study area.

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Species	Conservation Status *	Habitat requirements	Likelihood of occurrence and comments
<i>Dasyurus maculatus</i> Spotted-tail Quoll	V ^{1,2}	Rainforest, open forest, woodland, coastal heathland and inland riparian forest.	Low. Suitable habitat not present in study area.
<i>Dasyurus viverrinus</i> Eastern Quoll	V ¹	Dry sclerophyll forest, scrub, heathland and cultivated lands.	Low. Suitable habitat not present in study area. No recent records in the area.
<i>Miniopterus schreibersii</i> Common Bentwing-bat	V ¹	Forages in tall open eucalypt forests, dry sclerophyll forest, woodland, wet sclerophyll forest, rainforest, <i>Melaleuca</i> swamps and over grasslands and roost in caves and mines.	Low. May forage in Botany Bay whilst in transit between foraging and roosting sites.
<i>Myotis adversus</i> <i>Large-footed Myotis</i>	V ¹	Forages for insects over streams and pools in mangroves, paperbark swamps, rainforest, wet and dry sclerophyll forest and open woodland. Known to roost in caves, tree hollows, under bridges, in mines, tunnels and stormwater drains.	Low. May forage in Botany Bay whilst in transit between foraging and roosting sites.
<i>Petrogale penicillata</i> Brush-tailed Rock-wallaby	V ^{1,2}	Rocky areas in rainforest gullies, wet and dry sclerophyll forest, open woodland and rocky outcrops in semi-arid country. Sites with ledges, caves and crevices are favoured.	Low. Suitable habitat not present in study area.
<i>Potorous tridactylus</i> Long-nosed Potoroo	V ^{1,2}	Coastal heath and dry and wet sclerophyll forests in areas with relatively thick groundcover and an annual rainfall greater than 760 mm.	Low. Suitable habitat not present in study area.

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Species	Conservation Status *	Habitat requirements	Likelihood of occurrence and comments
<i>Pteropus poliocephalus</i> Grey Headed Flying Fox	V ^{1,2}	Canopy feeding frugivore, blossom eater and nectarivore of rainforests, open forests, woodland, <i>Melaleuca</i> swamps and <i>Banksia</i> woodlands. Roost in rainforest patches, <i>Melaleuca</i> stands, mangroves and riparian woodland or modified vegetation in urban areas.	Low. May forage in Botany Bay whilst in transit between foraging and roosting sites.
<i>Saccolaimus flaviventris</i> Yellow-bellied Sheath-tail-bat	V ¹	Forages for insects above the canopy in a wide range of habitats including rainforests, sclerophyll forests and woodlands. Roosts in tree hollows, abandoned nests of sugar gliders or in buildings. Known to travel from roost trees to favoured foraging areas.	Low. May forage in Botany Bay whilst in transit between foraging and roosting sites.
Reptiles			
<i>Hoplocephalus bungaroides</i> Broad-headed Snake	E ¹ V ²	Forest growing on shale adjacent to conglomerate slopes and bluffs.	Low. Suitable habitat not present in study area.

Species	Conservation Status *	Habitat requirements	Likelihood of occurrence and comments
Regionally Rare Species			
<i>Perameles nasuta</i> Long-nosed Bandicoot	P	A variety of habitats from rainforest to wet and dry woodlands to heathland.	<p>Low.</p> <p>The species is relatively common and widespread throughout NSW, however, the species is considered locally rare due to urban encroachment of their habitat. A population in Sydney Harbour National Park at Manly (North Head) has been listed as endangered under the TSC Act.</p> <p>Parsons Brinckerhoff (2002) reported the presence of "bandicoot footprints" in planted trees and shrubs along Penrhyn Road as part of an environmental assessment for the proposed expansion of the Patrick terminal to the east of the study area. No direct (sightings, road kills) or indirect (conical hole diggings, tracks) evidence of bandicoots within the study area was recorded by URS during the present study. The likelihood of occurrence of a species or viable population of bandicoot (presumably a Long nosed Bandicoot) within the study area is considered to be low given the small size, isolation and disturbance of the planted shrubland as well as the regular presence of predators such as cats, dogs and to a lesser extent, foxes. Heavy vehicular traffic along Penrhyn Road would also limit the chances of survival of any individuals should the species be present.</p>

* Conservation Status is as follows:

E = Endangered V = Vulnerable

where 1 = listing under TSC Act 1995

2 = listing EPBC Act 1999 .

M = Listed as Migratory under EPBC Act

C = Listed under CAMBA agreement.

J = Listed under JAMBA agreement

P = Protected under NSW National Parks and Wildlife Act 1974

Of the 86 Threatened and regionally rare species listed above, 23 shorebirds and one sea bird have the potential to be significantly impacted upon as a result of the proposed Port Botany Expansion, due to their likelihood of occurrence (moderate to high) at Penrhyn Estuary and are thus addressed in the SIS report. Of these 24 species, 23 are listed as migratory under the EPBC Act and 8 are listed either as Vulnerable or Endangered under the TSC Act.

The remaining 62 species listed above would not be expected to be significantly impacted upon as a result of the proposal due to an absence of their habitats within the study area and are thus not considered further in the SIS.

Ecological descriptions of the 23 shorebirds and one seabird species assessed in this report are provided in **Appendix F**.

Threatened Fauna Communities

The Taren Point Shorebird Community is listed as an endangered ecological community under Part 3 of Schedule 1 of the TSC Act. This community of shorebirds uniquely occur on the relict marginal shoal of the Georges River that occurs between Taren Point and Shell Point in Botany Bay. The bird community is dominated by shorebird species from the Order Charadriiformes (NSW Scientific Committee 1998).

The assemblage of shorebird species that make up the Taren Point Shorebird Community have been addressed individually in this SIS. The community as a whole was not addressed as the proposal would not impact upon this area or other migratory shorebird habitats elsewhere within Botany Bay (refer to Section 5.5 for further details on predicted Bay wide impacts on shorebird habitat).

5.3.2 Shorebird Habitat in Botany Bay

The importance of the Botany Bay Estuary for migratory shorebirds and their habitats has been significantly reduced in recent decades due to habitat loss and disturbance, relative to other NSW estuaries (pers. comm., Doug Watkins, Wetlands International). Although Botany Bay still has extensive shorebird habitats, these are chiefly confined to mangrove-fringed soft mudflats on the southern shores of the Bay between Taren Point and Bonna Point at Kurnell. These mudflats provide suitable habitat for Grey-tailed Tattlers, Whimbrel, Eastern Curlew and a few Terek Sandpipers and their numbers have remained relatively stable. One species, the Bar-tailed Godwit has been able to adapt to changes in conditions in the Bay and has also remained relatively stable in numbers (Avifauna Research Services 2003).

Shorebirds that used the feeding habitat at Runway Beach, the Pilots embayment, the entrance to the Mill Stream and Foreshore Beach, were displaced during the construction of the Parallel Runway, as were birds which used the roosting site at the sand stockpile area. After the construction of the Parallel Runway most of the shorebirds that returned to the northern portion of the Bay were concentrated in a much reduced area, restricted to Penrhyn Estuary and a small section of beach west of the Penrhyn Road boat ramp (Straw 1996).

Species such as most sandpipers and plovers that cannot utilise most of the habitats in the southern parts of the Bay are now virtually absent except for small populations at Penrhyn Estuary (Avifauna Research Services 2003).

Existing shorebird habitat in Botany Bay, as discussed by Straw (1996, 2003), is outlined below. Potential Bay wide impacts on remaining shorebird habitat elsewhere in Botany Bay as a result of the Port Botany Expansion is discussed in Section 5.5.

Penrhyn Estuary

Penrhyn Estuary is essentially the only habitat remaining for shorebirds formerly abundant in the northern part of the Bay. The estuary provides important feeding and roosting habitat for non-migratory shorebirds such as cormorants, pelicans and seagulls in addition to a number of migratory shorebirds listed under the TSC and EPBC Acts (refer to Section 5.3). Feeding habitat is restricted to the exposed mudflats that extend from the mouths of Floodvale and Springvale Drains to a narrow neck in the estuary (about 1.5 ha) and an area of sand flats along the southern shore of the Estuary (**Figure 6**). Penrhyn Estuary is now the most important site in Botany Bay for shorebird species such as the Red-necked Stint, Curlew Sandpiper, Red Knot, Pacific Golden Plover, Double-banded Plover and Sharp-tailed Sandpiper that are now sparse or absent from other parts of the bay.

Foreshore Beach

Foreshore Beach was created during dredging works by the Maritime Services Board and the creation of Foreshore Road replacing the former Botany Beach. This resulted in a loss of a large proportion of the intertidal flats that existed at the time. Wave action has eroded Foreshore Beach, steepening the profile and deepening the immediate foreshore and coupled with frequent disturbance from people and unleashed dogs that walk the beach has essentially precluded the use of the remaining beach as feeding habitat for shorebirds.

Sandringham to Rocky Point

The intertidal sand-flat area at this site provides an extensive feeding habitat for shorebirds. Shorebirds recorded feeding or roosting at this site include Bar-tailed Godwits, Grey-tailed Tattlers and small numbers of other shorebirds including Eastern Curlew, Masked Lapwing and Pied Oystercatcher. Birds feeding in this area often roost on the site during neap tides. Since 1992, a large number of shorebirds have been roosting at Sandringham Bay including up to 650 Bar-tailed Godwits, 62 Pied Oystercatchers, 70 Red-necked Stints and 17 Red Knots. The build up of numbers using this site has been due to the loss of other roost sites including a large proportion of roosting habitat at Towra Spit Island (Straw 1996).

The main impact on shorebirds in this area is the heavy use by fisherman, boating traffic from the local sailing club, bait collectors and bathers.

Shell Point to Taren Point

The shorebird community occurring in much of the area from Shell Point to Taren Point has been listed as an Endangered Ecological Community on Part 3 of Schedule 1 of the TSC Act. Some of the species that occur at Penrhyn Estuary also occur within this community but only in very small numbers. This area of muddy tidal flats and patches of mangroves is of most significance for the Grey-tailed Tattler, Terek Sandpiper, Whimbrel, Eastern Curlew, Bar-tailed Godwit and Pied Oystercatcher.

The shoreline of Shell Point is mainly mudflats with intermittent narrow patches of mangroves. There is a small sandy beach towards the east at Woodland Reserve Cove. Woodland Reserve Cove is an important feeding area for shorebirds such as Bar-tailed Godwits, Pied Oystercatchers, Grey-tailed Tattler and Eastern Curlew. The area provides a roost for these birds on neap tides.

The area to the west of Woodland Reserve Cove to Shell Point is one of the main feeding areas for Grey-tailed Tattler and is possibly the most important feeding area for Terek Sandpiper. Other species recorded in high numbers include Curlew Sandpiper, Eastern Curlew, Pied Oystercatcher, Bar-tailed Godwit, Red-necked Stint, Lesser Golden Plover, Ruddy Turnstone and Sharp-tailed Sandpiper. There have been occasional records of Red-capped Plover, Red Knot and Common Sandpiper.

Shorebirds utilising the area from Shell Point to Taren Point and Woollooware Bay roost on a privately owned jetty when it is not in use. The use of this roost site is a reflection of the lack of suitable roost sites remaining in this region of the Bay. A reduction in the number of shorebirds found near Shell Point would most likely be attributed to a lack of suitable roosting space and a change in feeding habitat.

Woollooware Bay

Woollooware Bay is predominantly used for oyster farming and almost all of the bay is included in the Towra Point Aquatic Reserve. The Bay is composed of seagrass beds, muddy and mud/sand substrate, mudflats and mangrove woodland. Woollooware Bay is utilised by long-billed wader species preferring mudflat feeding sites such as the Eastern Curlew, Whimbrel, Godwits, Grey-tailed Tattler, Greenshank and Marsh Sandpiper. The area is utilised as a roosting area for Eastern Curlew and Whimbrel.

Sand-Flats at Pelican Point

The intertidal sand shoal near Pelican Point is a heavily used feeding area by long billed shorebirds such as the Bar-tailed Godwit, Eastern Curlew and Whimbrel. This feeding site is particularly important as it is close to the largest roost site for godwits (Towra Spit Island) in Botany Bay. The area is relatively stable, being surrounded on three sides by oyster leases and does not seem to have been subject to sand movement.

Towra Spit Island

Towra Spit Island has, until recently, been the largest shorebird roosting site in Botany Bay for shorebirds. The area has been subject to erosion, which has seen major modifications to the landform. In 1990 the end of the spit was cut off forming an island. The numbers of some wader species have declined since the formation of the island, partly due to loss of feeding habitat for these species along Towra Point Nature Reserve and partly due to the loss of roosting space on Towra Spit Island on spring high tides. Continued erosion of the island has resulted in most species not roosting on Towra Spit Island. The formation of the island at Towra Point has provided a roosting site for shorebirds and a nesting site for the Little Tern.

Towra Spit Island is reportedly moving south and will come into contact with Towra Point mangroves. This is a concern as this will provide foxes access to the island. It is understood that a fox baiting program at Towra Point may assist in this regard (pers. comm., Geoff Ross).

Management of vegetation cover on the island is essential on an annual basis to provide suitable nesting habitat for Little Terns. This includes sparse vegetation to provide some shelter for young birds until they reach flying stage but prevent dense vegetation from forming that would deter Little Terns from nesting on the island. Lack of nesting resources during the 2001/02 season resulted in the birds abandoning the nesting site. Nesting was successful in 2002/03.

Towra Beach

At present, Eastern Curlew and Bar-tailed Godwit feed on seagrass beds on spring low tides at Towra Beach. Feeding area along Towra Beach, however, has greatly diminished from erosion since the mid 1970's as a result of past dredging activities associated with the construction of Port Botany, the oil wharf at Kurnell and the Parallel Runway at Sydney Airport. The area running east of Towra Point is rich in seagrass beds and provides an important feeding habitat for shorebirds.

Towra Point Saltmarsh

The saltmarshes at Towra Point Nature Reserve provide habitat for migratory shorebirds including Sharp-tailed Sandpiper and Pacific Golden Plover. The intertidal sandflats adjacent to the Nature Reserve provide an important feeding habitat for large numbers of shorebirds and Towra Spit provides one of the most important roost sites for these birds.

There has been a decline in the number of shorebirds at Towra Point Nature Reserve and the adjacent intertidal flats due to a loss of saltmarsh as a result of the invasion of mangroves. Tidal flats which were previously exposed on neap low tides off Towra Beach are now only exposed on the lowest spring tides and large areas are covered with sand eroded from Towra Beach and sand shoals migrating from Bonna Point.

Quibray and Weeney Bays

Quibray Bay, Weeney Bay and Bonna Point are important feeding areas for shorebirds including Bar-tailed Godwit, Grey-tailed Tattler, Black-fronted Plover, Black-winged Stilt, Eastern Curlew, Whimbrel, Great Knot, Ruddy Turnstone, Masked Lapwing and Sharp-tailed Sandpiper.

Quibray Bay is an important feeding and roosting area for shorebirds, providing a variety of habitats including mud and sand flats, beaches and mangroves. Wooden posts around the oyster leases on the north side of the entrance provide roosting sites for Eastern Curlew and Whimbrel as well as large numbers of seabirds.

The main threat to shorebirds in Quibray and Weeney Bays is the illegal use of the beach on the southern shore of the Bay by vehicles and horses.

Woolooware Shorebird Lagoon (H1 Lands)

The Woolooware Shorebird Lagoon on Woolooware Bay was a former sand quarry that has been partially enhanced by the NSW Roads and Traffic Authority for shorebird habitat (tidal mudflats) as compensation for the disturbance to the Eve Street Wetland at Arncliffe. However, the Eve Street Wetland has been restored as part of the Sydney Water Environmental restoration project funded by the Sydney Water Environmental Levy.

About 3 ha of intertidal mudflats have been created to provide feeding habitat for migratory species that may be displaced from Eve Street Wetlands. Species recorded at the site since construction include Bar-tailed Godwits, Red Knot, Ruddy Turnstone, Red-necked Stint, Sharp-tailed Sandpiper which feed at the site, Eastern Curlew that roost on the islands in the lake and Pied Oystercatchers, Black-fronted Dotterel, Black-winged Stilts and Masked Lapwings that nest on the islands in the lake.

Boat Harbour

Boat Harbour is an important habitat for Double-banded Plover, Red-necked Stint, Ruddy Turnstone, Lesser Sand Plover and Pacific Golden Plover. The area is exposed to disturbance from 4WD vehicles and dogs in addition to fishers and tenants of weekend cabins.

Barton Park Wetlands

A series of small wetlands situated approximately 1.5 km from the north western shores of Botany Bay, to the south of Cooks River, provide habitat for a high number of migratory and endemic shorebirds including Sharp-tailed Sandpiper, Curlew Sandpiper, Black-winged Stilt and Black-fronted Plover.

Eve Street Wetland has been restored by Sydney Water with the goal of providing intertidal habitat for shorebirds. Although it is the smallest of the three wetlands that comprise Barton Park Wetlands, it often

accommodates the highest number of shorebirds. The wetland is comprised of intertidal mudflat. The main threats to shorebirds is from disturbance from dogs and people at low tide.

Since the 1.2 hectare site was boxed in as a result of the construction of the M5 East Motorway, few Black-winged Stilts and no migratory shorebirds have utilised the site.

Spring Creek Wetland previously provided feeding habitat for Sharp-tailed Sandpiper, Curlew Sandpiper and Black-winged Stilt. The 1.5 hectare area has been subject to habitat restoration, including extensive planting of tall trees by Rockdale Council resulting in a total loss of shorebird habitat.

Riverine Park Wetland, a 1.8 hectare wetland, is used by a number of shorebirds including Sharp-tailed Sandpiper, Curlew Sandpiper, Black-winged Stilt and the Masked Lapwing.

Cooks River

Bar-tailed Godwit and Lesser Golden Plover use a section of the Cooks River adjacent to Tempe Recreation Reserve as feeding habitat at low tide. Limited mudflats exist along the lower reaches of the River, for feeding and roosting by shorebirds. Few shorebirds have been seen in this area in recent years.

Georges River

Areas of the Georges River are utilised as a feeding area by long billed shorebirds such as Bar-tailed Godwit and Eastern Curlew. Intertidal mudflats are extensive within the Georges River providing valuable feeding habitat for shorebirds, especially in the lower reaches of the river. A large proportion of intertidal mud flats have, however, been lost to foreshore development e.g. sports fields, housing and commercial development.

Botany Wetlands

Botany Wetlands, stretching from Gardeners Road to the Heliport at Mascot Airport, are comprised of a series of artificial lakes or ponds along the water course of the Mill Stream. The area has degraded as a wetland habitat over the past 20 years with heavy infestations of Water Primrose (*Ludwigia peruviana*) and other aquatic weeds. The wetlands provide roosting and feeding habitat for small numbers of Sharp-tailed Sandpiper and larger numbers of Latham's Snipe.

5.4 Impact of the Proposal on Shorebirds at Penrhyn Estuary

Potential impacts from the construction and operation of the Port Botany Expansion on the identified 23 shorebirds and one seabird species comprise disturbance to feeding and roosting from a change in lighting regime, , noise and vibration (human and machinery) from the construction and operation of the port (and associated infrastructure such as railway lines) and potential entry/exit psychological flyway barrier due to the enclosure of the Estuary. Disturbance issues are discussed below and are based on the author's

general knowledge of shorebirds in NSW estuaries, a report by Avifauna Research Services (2003) (refer to **Appendix G**) and from a desktop literature review of shorebird disturbance studies and other generalist bird studies (Paton et al 2000; Burger 1991; Goss-Custard and Verboven 1993; Smit and Visser 1993; Goss-Custard *et al* 1982; Goss-Custard 1980; Lawler 1996; Roberts and Evans 1993; Batten 1977; Straw 1996; Nelson 1994; Metcalfe and Furness 1984; West *et al* 2000).

5.4.1 Disturbance

There is little quantified and experimental assessment of the effects of disturbance to waterbirds and little understanding of the extent of such impacts. Disturbance is defined as a disruption to normal activity patterns.

Disturbances to shorebirds may vary in their intensity, frequency, duration, coverage and predictability. The susceptibility of birds to disturbance is likely to vary with age, season, weather, location and the degree of habituation to disturbance.

There are two potential consequences of sustained, localised disturbance to migratory shorebirds, the first being that these birds may have to shift to alternative, perhaps less favourable feeding grounds and secondly, may have their feeding rate reduced by having to devote time to vigilance and anti-predator behaviour. Disturbed shorebirds may spend less time foraging whilst increasing energy-expending behaviours such as fleeing (running, flying). It has also been suggested that migratory birds may be more prone to disturbance than non-migratory species as they are only present in a particular area for part of the year and so have little opportunity to become habituated to the disturbance.

Shorebirds prefer to forage in areas where prey density and prey availability are relatively high and where energy expenditure is low. Shorebird densities, therefore, tend to reach a maximum in the most preferred feeding areas. Where disturbances force birds to shift to alternative feeding areas, questions arise as to whether such areas are adequate, whether they can accommodate displaced individuals and what effect increased bird density has on intake rates and therefore bird fitness.

As bird density increases, average intake rates decline in many species as a result of increased competition and therefore, increased prey depletion. Where populations are limited by the quality and availability of habitat (Penrhyn Estuary and in Botany Bay Estuary in total), disturbance can have a negative impact on wader populations by affecting fitness, ability to fatten adequately during pre-migratory periods and increased mortality.

Some studies that have attempted to experimentally assess the impact of disturbance on waterbirds have predominantly used the bird's flight response as an index of disturbance whilst others have only crudely estimated alert distances. In such studies, a disturbance is introduced and the distance of the birds from the disturbance at the point of flight is measured. Buffer distances given for many shorebirds as part of past studies are in the order of 100-400 metres.

Many foraging migratory shorebirds are often disrupted from their typical behaviour well before a flight response is elicited with some birds shown to be alerted at distances on average 30-95% greater than

those at which they take flight. Following detection of a disturbance the bird may spend time assessing the degree of threat it is under and may balance the risk with the benefits of continued foraging or roosting. As discussed above, this may be particularly significant to migratory shorebirds during the pre-migratory period of fat accumulation (and post migratory period of recuperation and moulting) where an increase in food requirements during this period results in shorebirds trying to maximise their net rate of resource acquisition and thus invest more time in foraging at the expense of vigilance and anti-predator behaviour. This is particularly significant for shorebirds whose feeding times are regulated by tidal flow (and even more significant for small billed shorebirds such as plovers and stints where foraging areas are further limited by the amount of intertidal area not covered with water at low tide). Frequent and intense disturbance is likely to affect wader behaviour and reduce the time they spend foraging. Reductions in feeding may then affect the capacity of shorebirds to fatten at an adequate rate and therefore prolong the pre-migratory feeding period and departure delay. Such delays in migration departure from wintering grounds can seriously affect the breeding success of migratory birds, where individuals arriving late at the summer breeding grounds may be at a disadvantage in the competition for mates and territories.

Restriction of public access to Penrhyn Estuary associated with the proposal would minimise part of the human disturbance to shorebirds. Shorebirds are often seen at Penrhyn Estuary fleeing from roosting on the sandy point on the Penrhyn Road side of the channel to the sandy foothill of the dune on the opposite side of the channel due to disturbance from the use of the boat ramp, fisherman and pedestrians (pers. obs.).

The proposal contains a component to significantly enlarge and improve shorebird habitat at Penrhyn Estuary, which should assist in minimising disturbance to shorebirds from the expanded port activity. This is discussed in greater detail in Section 6.0 of this report.

5.4.2 Lighting

The Port Botany Expansion would result in an increase in the amount of ambient lighting at night over Penrhyn Estuary during both construction and operation of the new terminal. Light sources would include floodlights, building mounted lighting, quay cranes, straddles, rail and/or rubber tyred gantrys, vehicles, road lighting, and terminal lighting (Bassett 2002).

A change in lighting regime (predicted increase in ambient lighting at night) at Penrhyn Estuary may result in an increase in vigilant behaviour (area scans) at the expense of foraging as many shorebirds, particularly those that have been observed to forage nocturnally in “relatively dark” areas (such as sand plovers), may feel that they are more visible to potential predators (feral dogs, cats, foxes and birds of prey). Increased ambient lighting and flashes of light from railway lines may result in the displacement of the shorebirds to sub-optimal (less preferred) habitat elsewhere in the estuary/Bay. Safeguard measures to ameliorate lighting impacts on shorebirds are outlined in Section 6.1.1.

5.4.3 Noise

Noise associated with the construction of the new terminal would result from dredging operations, movement of people, machinery and trucks, construction of wharf/quay structures involving pile driving, transport and placement of materials, the construction of retaining walls, infilling and surfacing to form quayside surfaces and facilities. Noise associated with the operations of the new terminal would result from a variety of sources such as the loading and unloading of containers from trucks, trains and ships; movement of containers within the terminal; truck and train traffic; and from machinery used at the terminal including quay cranes, straddle carriers, forklifts and reach stackers.

Noise may have a significant impact on birds, especially sudden loud noises such as those from train whistles/horns. To a certain extent, birds appear to tolerate steady background or regularly emitted noise, more than sudden loud noises. Increased noise from port construction and operation may result in the displacement of the shorebirds to sub-optimal (less preferred) habitat elsewhere in the estuary/Bay. Safeguard measures to ameliorate noise impacts on shorebirds are outlined in Section 6.1.2.

5.4.4 Potential Entry/Exit Flyway Barrier

The Port Botany Expansion will result in partially enclosing Penrhyn Estuary with wharf structures, a rail line, stacked shipping containers and large cranes (refer to **Figure 2**). This may represent a psychological entry/exit flyway barrier into and out of the shorebird feeding and roosting habitat at the estuary. Despite their physical capabilities, shorebirds are very reluctant to enter an area that does not have an open aspect (mainly to enable them to have a clear view of potential predators and a clear line of sight to larger bodies of water). Based on both the observed current flyways of the shorebirds into and out of the estuary and on standard wader flyway behaviour, shorebirds currently utilising Penrhyn Estuary fly into the area either from the south over water or from the west by flying south around the runways and turning north east into the estuary over water. Based on casual recent and historical URS observations over several years at the site and on discussions with Geoff Ross (NPWS), Phil Straw (Avifauna Research) and local bird naturalists, shorebirds have not been observed flying over docks or runways to or from the Estuary (whereas other bird species such as gulls regularly do).

Discussions with Doug Watkins at Wetlands International (Environment Australia) and review of *Port Botany Expansion Penrhyn Estuary Shorebird Habitat Enhancement* (2003) indicate that Yatsu-Higato, a landlocked Ramsar wetland upstream of Tokyo Bay in Japan is essentially enclosed and surrounded by industry and residential development and by a freeway. The Estuary is, however, being used by a number of migratory shorebirds for part of their life cycle requirements. Shorebirds in Japan roost at the site and may also feed there at a later stage in a flood tide (that is, when the tide is coming in) when their primary feeding habitat (exposed mudflats elsewhere in Tokyo Bay) are flooded. Shorebirds fly over industrialised land because of the absence of any other suitable roost sites in the Bay (as a result of 80-90% of the Bay being reclaimed). This would suggest that shorebirds may fly into Penrhyn Estuary over the operational docks or negotiate along the 130 metre wide channel parallel to Foreshore Beach, particularly if they are forced to due to a lack of remaining suitable habitat in the Bay. The shorebirds

would not be expected to have any difficulty in negotiating over the proposed road and rail bridges across the channel.

5.4.5 Water Quality

An assessment of the impacts of a predicted reduction in tidal flushing and water quality on Penrhyn Estuary as a result of the proposal has been undertaken by Lawson and Treloar (May 2003a). Lawson and Treloar (2003a) note that potential impacts on Penrhyn Estuary include a small increase in siltation, small changes in temperature and dissolved oxygen and an increase in nutrients and faecal coliforms. Such predicted impacts may place pressures on Penrhyn Estuary in providing viable habitat for shorebirds, although direct and indirect impacts on shorebirds and their habitats at Penrhyn Estuary as a result of a reduction in tidal flushing and water quality is difficult to predict.

A range of monitoring programs are proposed at Penrhyn Estuary which will assist in assessing the impacts from construction and operation of the new terminal and associated facilities on shorebirds and their habitats. The monitoring will be undertaken during construction and operation of the facility and the results of which will be reviewed to make a final determination as to whether Penrhyn Estuary can continue to provide viable shorebird habitat or whether other compensatory shorebird habitat locations within Botany Bay need to be considered.

Proposed shorebird habitat monitoring during construction and operation is detailed in Section 6.0.

Other monitoring studies proposed are detailed in the relevant chapters and specialist reports in the EIS.

5.4.6 Feral Animals

The TSC and EPBC Acts provide for the identification and listing of Key Threatening Processes. These are processes that threaten or may threaten the survival, abundance or evolutionary development of a native species or ecological community.

Key Threatening Processes listed under both the TSC and EPBC Acts relevant to the study area and proposal comprise:

- Predation by the European Red Fox *Vulpes vulpes*; and
- Predation by Feral Cats *Felis catus*.

Predation by the European Red Fox, and Feral Cats have contributed to significant declines in the distribution and abundance of a suite of native vertebrate fauna throughout Australia, particularly among medium-sized ground-dwelling mammals, amphibians, birds and reptiles (NPWS 2001). Shorebirds may be vulnerable to predation from feral cats and foxes particularly when shorebirds are feeding in saltmarsh areas which support shrubs and mangroves which hinder their line of sight or on mudflats which support mangroves greater than 1 metre in height.

A number of measures are detailed in Section 6.1 which will act to minimise the likelihood of feral animal presence on the site during construction and operation of the Port Botany Expansion.

5.4.7 Creation of Additional Shorebird Habitat at Penrhyn Estuary

Enhancement of existing shorebird habitat at Penrhyn Estuary is a key component of the proposal which involves the creation of an additional 11 hectares of tidal flats and approximately five hectares of saltmarsh that will provide shorebird feeding habitat. The proposal will thus result in a significant net gain of shorebird habitat at the site. Details of the shorebird habitat enhancement proposed is discussed further in Section 6.0 and in **Appendix G**.

Habitat enhancement works at Penrhyn Estuary, which would include the use of earthworks machinery to level sand dunes, grade tidal flat surfaces and to infill deep areas of water, are likely to cause disturbance to shorebirds using the existing mudflats in the Estuary. As discussed in Section 6.1, to minimise these disturbances, works close to the feeding and roosting sites should be carried out during winter months when the majority of shorebirds have migrated to their northern hemisphere breeding and staging grounds.

5.5 Impact of the Proposal on Shorebird Habitat Elsewhere in Botany Bay

A review of the results of the hydrodynamic modelling undertaken by Lawson and Treloar (May 2003b) indicated that the impacts on Bay wide shoreline recession and progradation (sediment transport) will be negligible or immeasurable and may even be less than existing rates as a result of the proposal.

A brief discussion of predicted Bay wide impacts on shorebird habitat is provided below.

Silver Beach, Kurnell

There would be a minor change in wave conditions on Silver Beach but the change would be accommodated within the groyne fields on the beach. As a result, there would be no measurable impact on the beach.

Towra Beach

There would be a minor reduction in the shoreline recession rate on Towra Beach, however, such a reduction would be imperceptible. The erosion of this beach over time since the 1970s has resulted in a steeper beach profile with a corresponding suspected loss of shorebird feeding habitat.

Sandringham to Taren Point

No impacts between Sandringham and Taren Point are predicted. Shorebird feeding habitat in this area will not be affected.

Lady Robinsons Beach

No impacts on Lady Robinsons Beach are predicted. This area provides minimal shorebird feeding habitat.

6.1 Measures to Ameliorate the Potential Impacts on Flora and Fauna

6.1.1 Lighting

Avifauna Research (2003) recommended the following measures be adopted as part of the proposal to assist in minimising the impacts of a change in the light regime at Penrhyn Estuary on shorebird habitat:

- Moving lights such as spotlights and vehicle headlights (especially of vehicles shining headlights over Penrhyn Estuary while turning) should be screened by solid barriers, or more preferably, by native vegetation;
- Solid barriers along the edges of the port adjacent to the Estuary mudflats of sufficient height should be installed to obscure lights shining onto the Estuary. Where appropriate the barriers could be obscured with vegetation;
- Headlights from trucks turning onto the bridge between Foreshore Road and the new terminal are likely to have some disturbance effect on shorebirds in the vicinity of the bridge. Suitable barriers at either end of the bridge would reduce this impact. Barriers on the Foreshore Road end could be in the form of tall vegetation rather than constructed barriers to improve the aesthetics of the area.
- It is important to avoid the use of high mast lighting immediately adjacent to shorebird habitat as it would be virtually impossible to shield light from such installations (Bassett 2003).

Bassett (2003) also provided the following additional control measures to assist in eliminating and reducing lighting impacts on the general environment:

- Use high pressure sodium as the light source.
- General area and container storage area lighting to be provided by asymmetric floodlights installed with front glasses horizontal. Front glasses to have nil degrees tilt.
- Any floodlighting or other lighting from buildings or other structures to also be of asymmetric distribution and installed with the front glass horizontal.

Ensure that road based activities occur around the edge of the terminal, rather than operational areas with high mast lighting. This would help to provide a buffer zone to the high mast lighting. Lower poles with cut-off type road lighting luminaires and back-light spill shields would be required. The effect would be to provide greater control over light spill.

6.1.2 Noise

Avifauna Research (2003) notes that the proposed 4 m high noise barrier would assist in mitigating noise impacts on shorebirds within the study area. The barrier would be constructed along the eastern and northern edges of the new terminal as recommended by Wilkinson Murray (2003). Avifauna Research (2003) notes that the height of 4m barrier wall recommended by Wilkinson Murray (2003) would increase the boxing-in effect of the port construction on shorebirds and that a solid barrier of 2 m would have less of an impact, but may not meet Sydney Ports noise reduction objectives. Avifauna Research (2003) states that should a 4m barrier wall be required, the upper 2m of the barrier wall should be constructed from a translucent material to reduce the boxing-in effect, provided some form of pattern was printed onto the surface to make it visible to birds in flight and reduce the likelihood of birds flying into the barrier. The noise barrier would also act as a barrier to vehicle lights.

6.1.3 Enhancement of Existing Shorebird Habitat at Penrhyn Estuary

Whilst shorebirds could physically fly over the proposed port expansion facility, shorebirds typically need an open aspect for flying and a clear line of sight from their feeding and roosting grounds in order to feel safe from predators. The key issue, as discussed in Section 5.4 of this report, is whether the “boxing in” effect of the proposed port expansion will represent a significant psychological barrier to entry and exit for the shorebirds that regularly and occasionally use Penrhyn Estuary for feeding and roosting.

A concept design for the enhancement of existing shorebird habitat at Penrhyn Estuary has been proposed with the objective of creating significantly improved shorebird habitat so as to increase the likelihood of shorebirds using the area following the proposed port expansion works. The proposed shorebird habitat enhancement at Penrhyn Estuary is illustrated in **Figure 5a** and **5b**. A full, detailed description of the proposed shorebird habitat enhancement works is contained in *Port Botany Expansion Penrhyn Estuary Shorebird Habitat Enhancement* (Avifauna Research Services 2003) in **Appendix G**.

The proposed shorebird habitat enhancement comprises the removal/excision of the sand dune on the western side of Floodvale Drain. The dune sand would then be used to nourish/fill the mouth of the estuary to create additional intertidal sandflat habitat. The newly created sand flat would then be overlaid with at least 5 cm layer on finer sediment for invertebrate colonisation and shorebird feeding.

Existing shorebird habitat at Penrhyn Estuary is restricted to the exposed mudflats that extend from the mouths of Floodvale and Springvale Drains to a narrow neck in the Estuary (about 1.5 hectares) also an area of sand flats along the southern shore of the Estuary and narrow margins of the beaches to the south and north of the Estuary. The proposed enhancement works would significantly open up the area to shorebirds through the creation of additional intertidal sand and mudflats, saltmarsh habitat and seagrass habitat for shorebird feeding and roosting.

The specific disturbance buffer for shorebirds will vary from species to species depending on the nature and extent of the disturbance. At least 20 m would be factored into the design of the habitat enhancement, although shorebirds would obviously determine their own preferred feeding/roosting sites. In general, it should be noted that most species prefer large open spaces.

The other key to success of the proposed habitat enhancement is obtaining the optimal elevation profile for the reconfigured Estuary. Concept cross sections of the newly created tidal flats and saltmarsh are detailed in Avifauna Research (2003) provided as **Appendix G**, and are shown on **Figure 5b**.

Bridges over the channel should be kept as low as possible to reduce the boxing in effect of the site.

Construction Sequencing

To allow for optimal chances of success, the proposed habitat enhancement works should be carried out at the earliest possible time in the construction program so as to allow sufficient time for shorebirds to habituate to the newly-reconfigured Estuary and to allow for the colonisation of benthic fauna on the newly created tidal flats. According to Avifauna Research Services (2003) three to five years is the minimum period required for invertebrate establishment.

Habitat enhancement at Penrhyn Estuary should be carried out in stages. The first stage should comprise the removal/excision of the sand dunes to the north of the Estuary and the filling of deep water areas behind the new terminal at the mouth of the Estuary (refer to **Figure 6**). Works should be carried out between late March and early August to correspond with the period when most migratory shorebirds are on migration or at their northern hemisphere breeding grounds. Screening and/or temporary sand embankments could be used to shield noise and movement of heavy machinery. The upper reaches of the Estuary, including the existing mudflats, should be left relatively undisturbed, providing a feeding area for shorebirds (Avifauna Research 2003).

The next stage of shorebird habitat enhancement should include the application of a layer of fine particulate and organic material to enable the rapid colonisation of invertebrates at the site. Dredged material from Botany Bay that may be unsuitable for terminal reclamation may suit benthic organisms. Otherwise, soils may have to be manufactured to suit the site or sourced from other sites (Avifauna Research 2003).

Construction of culverts at Springvale and Floodvale Drains, and the stabilisation of the main channel through the Estuary should be undertaken in winter months also to avoid impacts on the majority of migratory birds that feed and roost in Penrhyn Estuary over summer.

The hydrodynamic feasibility of the proposed Estuary reconfiguration has been addressed by the hydrodynamic and coastal processes study undertaken by Lawson and Treloar (2003) the reader is referred to these reports for a discussion of this subject.

Saltmarsh Protection and Transplantation/Re-establishment

The proposed shorebird habitat enhancement works (dune earthworks) have the potential to significantly impact upon the saltmarsh recorded at Penrhyn Estuary without the implementation of adequate protection measures. Consequently, the following measures are proposed to assist in the retention, protection and re-establishment of saltmarsh following the proposed habitat enhancement works.

Prior to the proposed habitat enhancement works, saltmarsh and subsoil to a depth of 15 cm should be excavated and stored in a bunded area on the site for later transplanting or directly transplanted (preferred option). Seawater should be pumped into the bunded area on a monthly basis to inundate the saltmarsh with subsequent dewatering to the Bay. This is to ensure that soil salinity is not lost. The saltmarsh at Penrhyn Estuary would appear to be inundated by the tide infrequently (probably only at spring tides) and thus it will be important to maintain a monthly tidal inundation frequency.

Saltmarsh can be easily re-laid once suitable levels (1.8 m LAT) in the Estuary are created. It is proposed that the saltmarsh would be placed south of the proposed rail line and along the eastern edge of the Estuary as shown in **Figure 5a**.

As a precautionary measure against possible failure of saltmarsh storage during the proposed habitat enhancement works, saltmarsh seed provenance should be harvested during the next two fruiting seasons (summer) and subsequently stored for future use if required. Should areas of saltmarsh not survive transplanting during the proposed habitat enhancement works, seed provenance should be propagated for outplanting on the site. Saltmarsh seed should be harvested and propagated using appropriate techniques.

It would also be expected that once favourable conditions (i.e. levels) occur at Penrhyn Estuary following the proposed shorebird habitat enhancement works, the natural colonisation of saltmarsh at Penrhyn Estuary would be expected to occur via seed dispersed by the tide presumably from the saltmarsh colony at Towra Point. It should be noted that saltmarsh colonised Penrhyn Estuary following reconfiguration of the northern shoreline of Botany Bay in the late 1970s and that there is no reason not to expect this to happen again. This, however, should not preclude the need for saltmarsh protection and re-establishment proposed in the above discussion.

The detailed design and methodology associated with the saltmarsh excavation and transplanting will be addressed in the Vegetation Management Plan for the site should the Port Botany Expansion proceed.

Mangrove Removal and Control

The issue of mangrove proliferation at Penrhyn Estuary (and elsewhere in Botany Bay and in many other NSW estuaries) has been discussed in Section 4.3.2 of this report. The proliferation of mangroves at Penrhyn Estuary is presently reducing the availability of foraging habitat for shorebirds and without active control, will threaten the remainder of shorebird habitat at the site. Shorebirds will only forage amongst mangrove seedlings where the line of sight is not significantly impeded. Once the plants reach above one metre, the line of sight becomes affected and the shorebirds will no longer feel safe to forage. Consequently, as part of the shorebird habitat enhancement works, a two stage mangrove removal approach is proposed to control the mangroves at Penrhyn Estuary:

- manual removal of mangrove seedlings and juveniles below one metre in height (these are the plants that can be relatively easily pulled out by hand); and

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- for all plants that cannot be easily removed by manual means (juveniles and mature adults greater than one metre in height), stems should be cut as close to ground level as possible to reduce the chance of the plants resprouting via epicormic buds.

Follow up mangrove control on a quarterly basis would be undertaken for a period of at least two years to exhaust the soil seed bank for this species. Mangrove control should then be undertaken on a 6 monthly basis. This will ensure the maximum available habitat for shorebirds at the site.

A permit from NSW Fisheries for mangrove removal and on-going control will be required as part of the proposal. NSW Fisheries acknowledge the current mangrove issue in NSW and current Fisheries policy notes that where important shorebird habitat occurs, permits for mangrove removal would be considered.

A Vegetation Management Plan (VMP) detailing methodologies for mangrove removal and control would be prepared and would be incorporated as part of the Construction Environmental Management Plan (CEMP) for the proposal.

Visual Buffer

A visual buffer for shorebirds in Penrhyn Estuary would be created as part of the habitat enhancement works at Penrhyn Estuary. This buffer, consisting of native vegetation approximately 1-2m wide, would run along the southern and western side of the Estuary and along the rail line in the northern section of the Estuary.

Control of Public Access

The shorebird habitat at Penrhyn Estuary should be appropriately fenced to control public access and prevent feral and domestic animals from entering the site. Exclusion fencing should occur in association with the commencement of construction of the new terminal although access to/from the boat ramp in Penrhyn Estuary would still be required.

It is advantageous to have viewing platforms and interpretative facilities for the general public to educate people about the importance of undisturbed feeding and roosting sites for migratory shorebirds. A boardwalk and observation platform is proposed to be constructed by Sydney Ports Corporation.

Access to the Estuary via Foreshore Beach should be prohibited using an appropriate barrier, as well as signage to inform the public of the sensitive nature of the shorebird habitat. A suitable barrier may also be necessary to prevent boats and swimmers from entering the Estuary.

Control of Feral Animals

The following two measures are proposed to assist in the control of feral cats and foxes on the site, these being:

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- rubbish must be placed in bins which in turn must be appropriately covered at all times. Regular rubbish disposal is also essential; and
 - should shorebird monitoring during construction and operation of the Port Botany Expansion reveal feral cat and fox predation (on shorebirds) to be an ongoing issue, a 1080 fox baiting program should be initiated in consultation with NPWS and an expert shorebird ecologist.

A Feral Animal Management Plan (FAMP) should be prepared as part of the Construction and Operational EMP for the Port Botany Expansion. The FAMP should address fencing and the management of garbage, particularly in the habitat enhancement areas, and the viability of a baiting program to be initiated in conjunction with NPWS.

6.1.4 Management and Monitoring

The modification of Penrhyn Estuary associated with the proposal will require monitoring to assess the impacts of the construction and operation of the facility on shorebirds and to assess the degree of success of the reconfigured Estuary for shorebird habitat.

The monitoring program proposed would take into consideration the colonisation of benthic organisms, soil profiles and the diversity, abundance and behaviour of migratory shorebirds at Penrhyn Estuary. During the construction period monitoring should be carried out on a weekly basis from 1 August to 30 April each year (peak season) and at least monthly at other times. During the operational period and after all construction works are completed the monitoring should be carried out on a monthly basis for at least three years. Monitoring should include counts of birds and species composition as well as feeding observation to determine which species are using the site for roosting, whether the modified site is providing productive feeding habitat and determining whether there are any detrimental impacts. The regularity of the monitoring is required to cover species that may be moving through Botany Bay during the migration season.

The monitoring should be undertaken by expert shorebird ecologists such as the NSW Wader Study Group and Birds Australia whom already undertake regular monitoring of birds throughout Botany Bay.

Additional monitoring is proposed to be undertaken (during construction and operation period) by suitably qualified personnel in relation to water quality, hydrodynamics/coastal processes and contamination, which will have a bearing on the viability of shorebird habitat at Penrhyn Estuary.

Results of all the relevant monitoring studies (i.e. those studies having a bearing on shorebird habitat) will be used to make an overall “Go/No Go” decision in terms of continuing with the enhanced shorebird habitat concept at Penrhyn Estuary beyond the first stage of works. Should the monitoring studies show a poor or limited success in the ability of Penrhyn Estuary to provide viable shorebird habitat, alternative compensatory shorebird habitat locations elsewhere in Botany Bay would then be considered. This “Go/No Go” decision would be made by expert shorebird ecologists in consultation with NSW NPWS and would likely be made once sufficient monitoring data is available (expected to be within 2-3 years from commencement of construction).

Construction and establishment of the enhanced habitat at Penrhyn Estuary will be the responsibility of Sydney Ports Corporation but as the site becomes established it will be necessary for one or more authorities to take on the long-term management of the site with the commitment of the necessary resources. Responsibilities include securing the site from disturbance or damage, weed management of invasive species such as mangroves and pest control including potential bird hazard species and predators such as foxes cats and dogs.

Penrhyn Estuary provides feeding and roosting habitat for shorebirds, including a total of 23 migratory and non-migratory shorebird species and one seabird species listed under the TSC and/or EPBC Acts. These 24 species, considered as regular or occasional visitors to Penrhyn Estuary, may be significantly impacted upon as a result of the Port Botany Expansion if appropriate mitigation measures are not implemented.

Sydney Ports Corporation plan to carry out ameliorative measures to protect and enhance shorebirds and their habitat at Penrhyn Estuary by substantially enlarging the existing area of feeding and roosting habitat as well as securing the site from disturbance from people, feral animals and dogs and vehicles and shielding the Estuary as far as practicable from the impact of port operations. The objective of the habitat enhancement works is to, by enhancing existing habitat, continue the use of the Estuary by shorebirds for feeding and roosting following the proposed port expansion and to potentially increase bird numbers.

A range of shorebird and other monitoring studies are proposed which will assist in both the assessment of impacts on shorebirds and their habitats at Penrhyn Estuary and the success of the creation of enhanced shorebird habitat.

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The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared between April 2002 and March 2003 and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.



Plate 1 Scattered mangroves encroaching in the marsh zone.



Plate 2 Saltmarsh zone on the western side of the creek channel. Note *Sporobolus virginicus* grassland in the upper most marsh zone on the right hand side of the photo.



Plate 3 *Juncus kraussii* rush meadows on western side of creek channel.



Plate 4 Mangrove clumps in the lower intertidal and saltmarsh in the mid to upper intertidal.

Figures

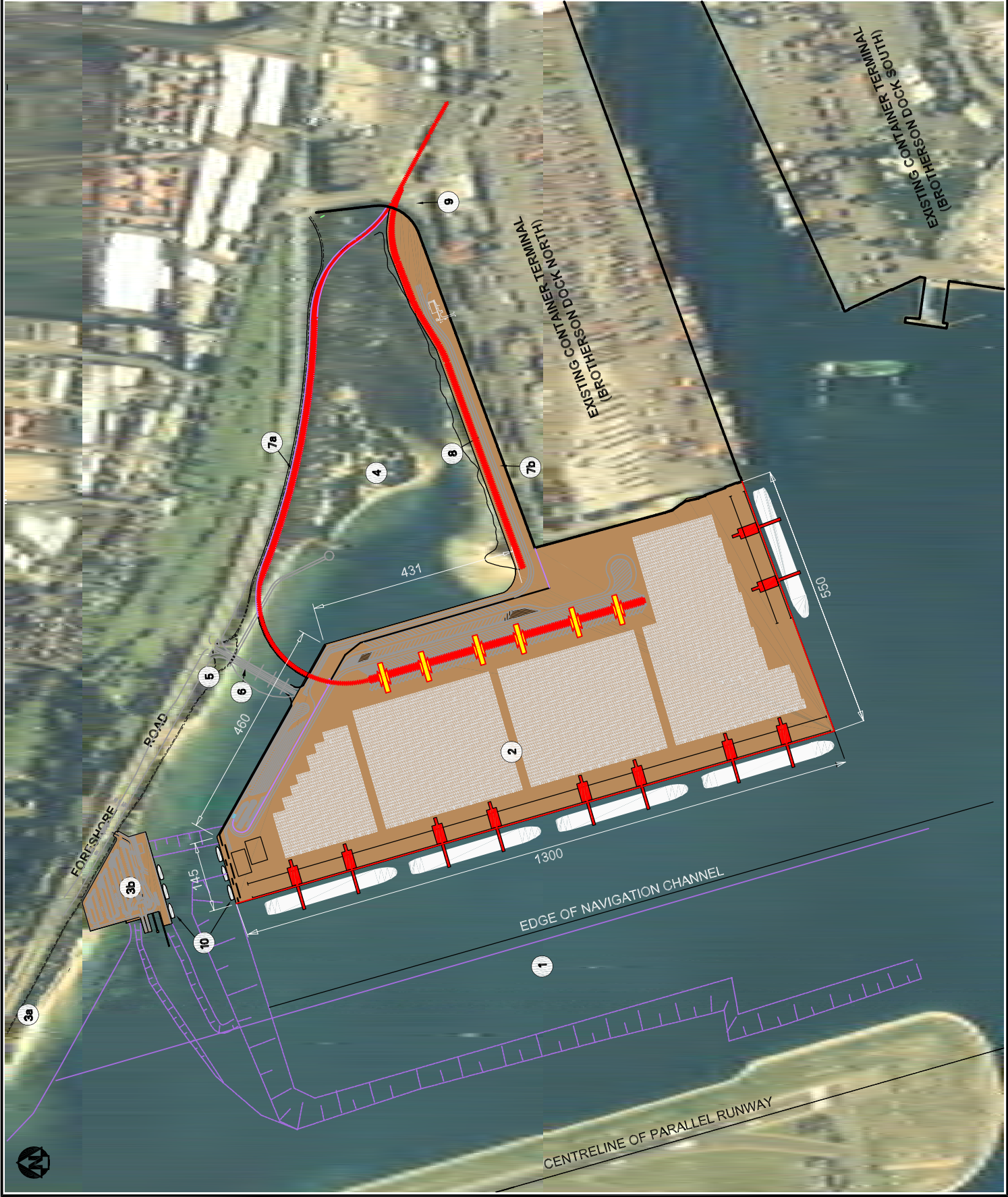


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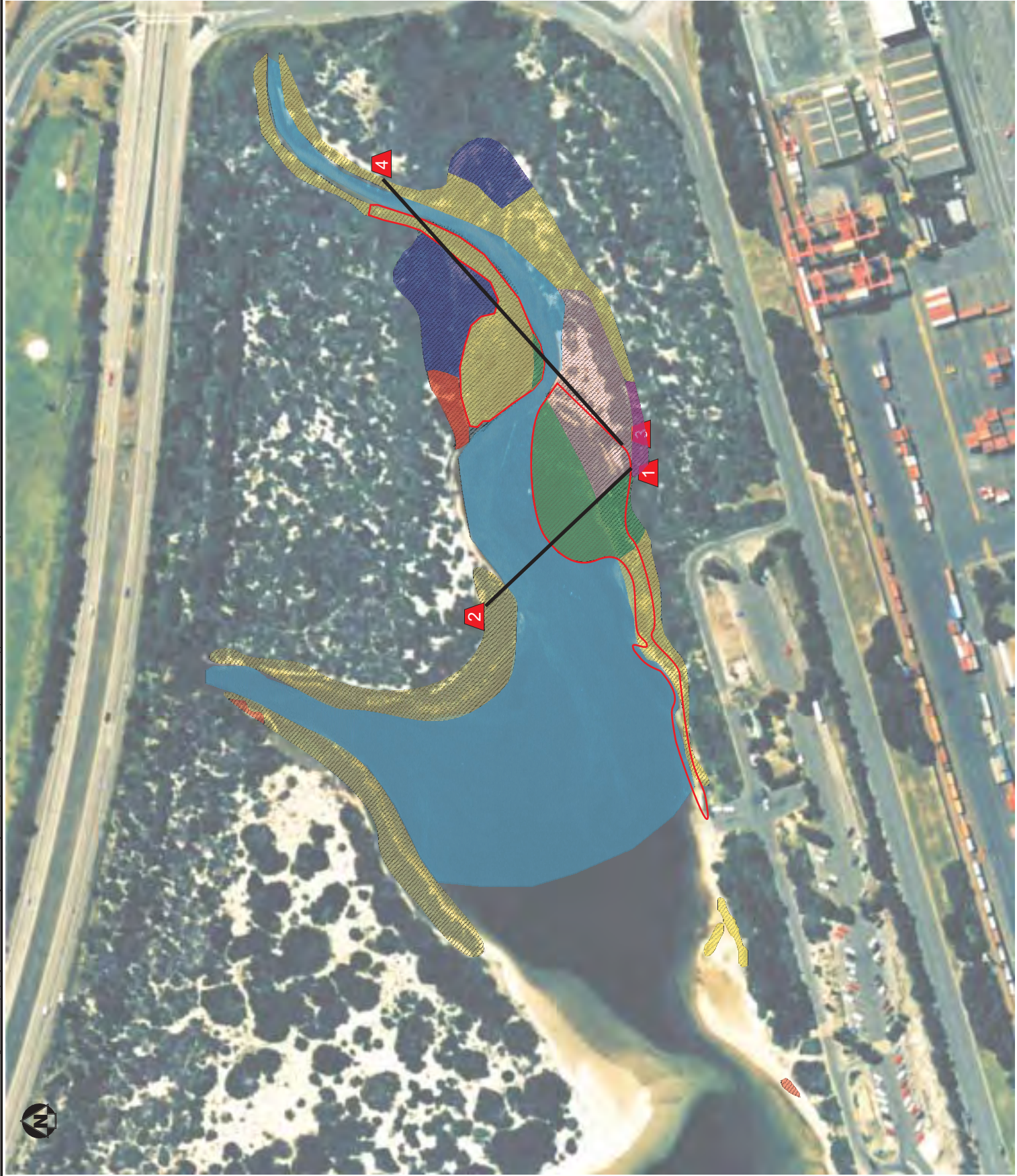
- LEGEND**
- ① Dredging of basin for ship berths & manoeuvring
 - ② New Terminal Area 63ha
 - ③ Beach and Picnic Park
 - ④ Boat Ramp & parking area
 - ⑤ Penryn Estuary
 - ⑥ Public access and beach along channel
 - ⑦ Terminal main entrance access and bridge
 - ⑧ Rail access to container terminal (with passing loop)
 - ⑨ Rail Sidings
 - ⑩ Inter-terminal access road
 - ⑪ Road over rail bridge
 - ⑫ Tug berths
 - NEW QUAY FACE
 - EXISTING SPC BOUNDARY
 - LIMIT OF DREDGING

CLIENT	SYDNEY PORTS CORPORATION
PROJECT	PORT BOTANY EXPANSION SIS BOTANY, N.S.W.
TITLE	PROPOSED PORT EXPANSION LAYOUT
FIGURE	2





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<div>0500metres</div>										
<div>PLANTED SHRUBLAND</div> <div>PLANTED SHRUBLAND<ul style="list-style-type: none"><i>Melaleuca armillaris</i><i>Atriplex semibaccata</i><i>Acetosa sagittata</i>*<i>Hydrocotyle bonariensis</i>*<i>Chrysanthemoides monilifera</i>* (Bitou Bush)<i>Leptospermum laevigatum</i><i>Banksia integrifolia</i><i>Spinifex sericeus</i><i>Acacia longifolia</i> var <i>sophorae</i></div> <div>* Introduced Species</div> <div>● 400m² flora survey plots</div>										
<div>AMG CO-ORDINATES</div> <table><tr><td></td><td>X</td><td>Y</td></tr><tr><td>1</td><td>333514.010</td><td>6241213.373</td></tr><tr><td>2</td><td>334312.061</td><td>6240727.562</td></tr></table>			X	Y	1	333514.010	6241213.373	2	334312.061	6240727.562
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CLIENT SYDNEY PORTS CORPORATION										
PROJECT PORT BOTANY EXPANSION SIS BOTANY N.S.W.										
TITLE DISTRIBUTION OF PLANTED SHRUBLAND										
	FIGURE 3									



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- SALT MARSH**
- Sarcocornia herbland
 - Juncus kraussii sedgeland
 - Sporobolus virginicus
 - Isoplepis nodosa sedgeland
 - Sarcocornia - Mangrove herbland/shrubland
 - Sarcocornia - Juncus herbland/sedgeland
 - MANGROVE**
 - MUDFLAT**
- FLORA SURVEY TRANSECTS**
- Sarcocornia australis
 - Sarcocornia quinqueflora
 - Isoplepis nodosa
 - Juncus kraussii
 - Sporobolus virginicus
 - Avicennia marina

AMG CO-ORDINATES	
X	Y
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2 334738.439	6240466.929
3 334825.030	6240405.023
4 334654.358	6240526.788

CLIENT
SYDNEY PORTS CORPORATION

PROJECT
**PORT BOTANY EXPANSION SIS
BOTANY N.S.W.**

TITLE
**VEGETATION COMMUNITIES OF
PENHRYN INLET**





Existing Shorebird Feeding Habitat at Penrhyn Estuary

Proposed Initial Stage of Intertidal Sand/Mudflats (approximate area)

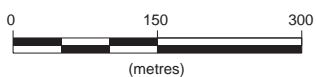
Source: Avifauna Research Services

CLIENT: **SYDNEY PORTS CORPORATION**

PROJECT: **PORT BOTANY EXPANSION SIS
BOTANY N.S.W.**

TITLE:

**Initial Stage of Penrhyn Estuary
Habitat Enhancement Works**



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