Summary of key outcomes:

The proposed Port Botany Expansion would cause changes to the terrestrial environment on the northern shoreline of Botany Bay between the Parallel Runway and the existing port.

An assessment of the likely impacts to threatened and migratory species from the proposal, in the form of an Eight Part Test, concluded that a Species Impact Statement (SIS) was required in respect of 23 shorebirds and one seabird that may be significantly affected by the proposal.

The SIS identified potential impacts from the proposal on these species as disturbance to feeding and roosting from a change in lighting regime, increased movement, noise from construction and operation of the port (and associated infrastructure such as railway lines) and potential flyway barriers due to the enclosure of Penrhyn Estuary.

To compensate for potential impacts to shorebirds, Sydney Ports Corporation would carry out measures to protect shorebirds and enhance their habitat at Penrhyn Estuary. These measures would entail substantially enlarging the existing area of feeding and roosting habitat as well as securing the site from disturbance from people, dogs and vehicles and shielding the estuary as far as practicable from the impact of port operations.

A range of shorebird and other monitoring studies are proposed which would assist in both the assessment of impacts on shorebirds and their habitats at Penrhyn Estuary and provide a means for gauging the success of the enhanced shorebird habitat.

In enhancing shorebird habitat in Penrhyn Estuary, 10.5 ha of planted shrubland from Penrhyn Estuary and approximately 1.0 ha of mangroves in Penrhyn Estuary would be removed and an additional 11 ha of intertidal flats and up to 5 ha of saltmarsh habitat, and up to 8 ha of seagrass habitat would be created.

The removal of vegetation and mangroves in Penrhyn Estuary is a trade-off to enhance a recognised important migratory shorebird habitat site in Botany Bay and should be viewed in this context.

20.1 Introduction

This chapter examines terrestrial flora and fauna and their habitats within the study area and the presence and likelihood of occurrence of threatened species, populations and ecological communities. The impacts of the proposed Port Botany Expansion on the terrestrial ecology in the study area and Botany Bay as a whole are assessed with emphasis on the impact of the proposal on migratory shorebirds. Mitigation measures are identified to ameliorate potential impacts on the terrestrial ecology of the study area.

The following chapter includes the findings of the *Port Botany Expansion Species Impact Statement* (URS 2003) which was prepared together with the *Penrhyn Estuary Shorebird Habitat Enhancement Report* (Avifauna Research Services 2003) (**Appendix O**).

20.2 The Study Area

The terrestrial ecology study area 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 Stevedores terminal (**Figure 20.1**). 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 were considered where appropriate.

20.3 Methodology

20.3.1 Literature Review

A search of the Atlas of NSW Wildlife (administered by NSW NPWS) and the EPBC Act online database (administered by EA) was undertaken to identify all terrestrial flora and fauna species recorded within a 10 km radius of the site.

Interpretation of past and present aerial photographs was undertaken to define the location of key site features likely to influence flora and fauna presence, such as natural or man made attributes, habitat and vegetation community distribution and disturbance through time.

The results of previous ecological assessments such as the *Proposed Third Runway Sydney (Kingsford Smith) Airport Draft EIS* (Kinhill 1990), *Botany Bay City Council State of the Environment Report* (2000) and the *Patrick Port Botany Container Terminal Upgrade EIS* (PPK 2002) were reviewed to determine the likely presence of flora and fauna species and their habitats.

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) were undertaken. Desktop literature searches and reviews of shorebird disturbance studies in Australia and overseas were also undertaken.

0 500m

Terrestrial Ecology Study Area **Figure 20.1**

Study Area

20.3.2 Field Survey

Site visits were conducted in April 2002 to verify the types and condition of flora habitats present and to help determine the likelihood of the presence of particular species or groups of species. Three locations at the site were inspected: Penrhyn Estuary; Foreshore Beach; and the section of the Mill Stream downstream of Foreshore Road.

A total of two 400 m^2 plots and two linear transects approximately (100 m in length) were undertaken to inventory plant taxa and communities within the study area. The two plots were situated within the planted shrubland along Foreshore Beach (**Figure 20.2**). Given the homogeneity of the vegetation along the Beach the methodology employed was considered to be standard industry practice.

The two linear transects were undertaken at spring low tide in the mid to upper reaches of Penrhyn Estuary across the upper and lower intertidal zones (**Figure 20.3**) to target saltmarsh. 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.

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

A Low, Moderate and High ranking system was used to assess the conservation value of plant communities recorded within the study area.

No field surveys for fauna were undertaken, or considered to be required as part of this assessment as it was considered that there was sufficient existing information available to make an assessment of the impacts of the proposal on fauna. However, a site inspection of the study area was undertaken on 16 and 27 May 2002 to assess the existing shorebird habitats at Penrhyn Estuary and to develop shorebird habitat enhancement options. Shorebird habitat areas elsewhere in the Botany Bay locality were also assessed.

20.3.3 Eight Part Test and Species Impact Statement

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 23 shorebird and 1 seabird species listed under the TSC Act and/or the Commonwealth EPBC Act. In accordance with section 78A(8)(b) of the EP&A Act, an SIS was prepared to accompany the development application for the proposed Port Botany Expansion.

The SIS was prepared in accordance with Division 2 of Part 6 of the TSC Act, which requires NSW NPWS Director-General requirements on 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 O**.

As the NSW assessment process had been accredited for this project (refer to **Chapter 9** *Statutory Planning*), an SIS under the EP&A Act would satisfy the assessment requirements of the Commonwealth under the EPBC Act.

0 500m

Distribution of Planted Shrubland **Figure 20.2**

Planted Shrubland

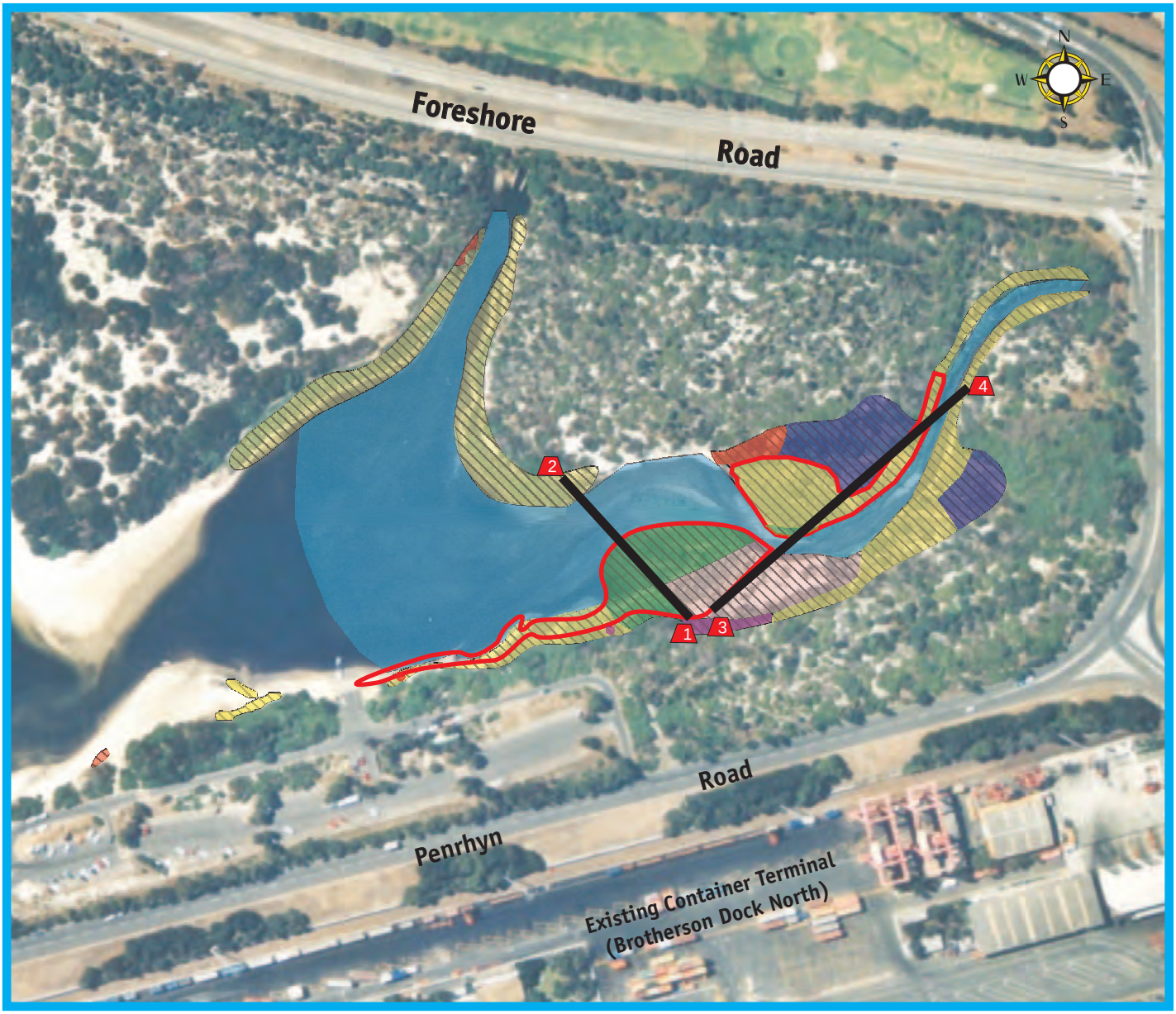
PLANTED SHRUBLAND

Melaleuca armillaris
Atriplex semibaccata
*Acetosa sagittata**
*Hydrocotyle bonariensis**
*Chrysanthemoides monilifera** (Bitou Bush)
Leptospermum laevigatum
Banksia integrifolia
Spinifex sericeus
Acacia longifolia var sophorae

AMG CO-ORDINATES

	X	Y
1	333514.010	6241213.373
2	334312.061	6240727.562

400m² flora survey



0 100m

Vegetation Communities of Penrhyn Estuary **Figure 20.3**

- SALTMARSH
- *Suaeda* - *Sarcocornia* herbland
- *Juncus kraussii* sedgeland
- *Sporobolus virginicus*
- *Isolepis nodosa* sedgeland
- *Suaeda* - *Sarcocornia* - Mangrove herbland/shrubland
- *Suaeda* - *Sarcocornia* - *Juncus* herbland/sedgeland
- MANGROVE
- MUDFLAT
- FLORA SURVEY TRANSECTS

SALTMARSH

Suaeda australis
Sarcocornia quinqueflora
Isolepis nodosa
Juncus kraussii
Sporobolus virginicus

MANGROVE

Avicennia marina

AMG CO-ORDINATES

	X	Y
1	334815.954	6240400.107
2	334738.439	6240466.929
3	334825.030	6240405.023
4	334654.358	6240526.788

International treaties such as the JAMBA, CAMBA and the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals) were considered as outlined in **Chapter 9** *Statutory Planning*.

20.4 Existing Environment - Flora

20.4.1 Vegetation Communities

A total of three vegetation communities were identified during field surveys in the study area. These include:

- Planted Shrubland

  This shrubland community occurs on marine sands and was recorded in the hind dunes along Foreshore Beach, the Mill Stream and Penrhyn Estuary (**Figure 20.2**). This community is dominated by *Banksia integrifolia* to approximately 7 m in height, a sparse to moderately dense and wind-pruned shrub stratum to 4 m in height, and a sparse groundcover to 0.5 m in height comprising herbs and grasses. Foredune vegetation comprising grasses and herbs to 30 cm in height is also included in this plant community, occurring along Foreshore Beach and Penrhyn Estuary above the high water mark.

- *Sarcocornia quinqueflora* / *Suaeda australis* - Saltmarsh

  This saltmarsh community, covering approximately 1.15 ha, occurs on marine sands as well as alluvial deposits (muds) as a narrow fringe above the mangroves in the mid to upper intertidal zone of Penrhyn Estuary on both the eastern and western sides of the channels entering the Estuary. This community comprises a patchy herbland to 0.5 m in height dominated by *Sarcocornia quinqueflora* and *Suaeda australis* and a dense rush meadow on the western side of the creek channel comprised of *Juncus krausii* and *Isolepis nodosa* to 1 m in height (**Figure 20.3**). The rush meadow occupied most of the saltmarsh area. Scattered grey mangrove seedlings and shrubs to 1 m in height were recorded in the marsh zone. Small grassland patches were also recorded in the upper marsh zone on both sides of the creek channels.

- *Avicennia marina* – Grey Mangrove

  This grey mangrove community is generally confined to the lower intertidal zone on both sides of the eastern channel entering the Estuary and was also frequently recorded encroaching into the saltmarsh zone. This community receives daily tidal inundation and varies in structure from low shrubland of scattered seedlings (frequently recorded in the marsh zone) to dense pockets of mature shrubs 2-3 m in height. Scattered grey mangrove seedlings and shrubs to one metre in height were often recorded in the marsh zone.

The distribution of these vegetation communities is shown in **Figures 20.2** and **20.3**.

20.4.2 Floristics of the Study Area

It is evident from the site inspection that floristic species diversity in the study area is low due to the disturbed nature of the site. This is particularly true for the planted shrubland community along Foreshore Beach and the Mill Stream. Although there are access tracks to Foreshore Beach, this community is disturbed by humans walking through and using the areas of shrubland. Rubbish is dumped in this area and

there are problems with erosion. In some places there are heavy infestations of the exotic shrub Bitou Bush (*Chrysanthemoides monilifera*). A floristic species list has been compiled for the study area and is presented in **Appendix O**.

20.4.3 Conservation Significance

Vegetation Communities

The Eastern Suburbs Banksia Scrub in the Sydney Basin Bioregion (ESBS) is listed as an endangered ecological community under both the TSC Act and the EPBC Act. While 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 NSW Scientific Committee Final Determination (2002) for this plant community. Additionally, the shrubland was planted in the 1970's and Foreshore Beach is not a remnant dune, but was formed from dredged material during previous development of Sydney Airport and the existing port. 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 remnant is not considered any further in this report as it would not be affected by the proposal.

The planted shrubland community that occurs along the hind dunes of Foreshore Beach, along the Mill Stream and along Penrhyn Road foreshore is of low to moderate conservation value. While this community was planted, 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 Estuary foreshore.

The saltmarsh community at Penrhyn Estuary is of high conservation value. This plant community colonised Penrhyn Estuary following reshaping of the northern foreshore of Botany Bay in the late 1970's. It 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-1990's. Saltmarsh is of high ecological significance to fish and migratory shorebirds.

The mangrove community at Penrhyn Estuary is of low to moderate conservation value. The present landward encroachment of mangroves into the mid/upper tidal marsh zone at Penrhyn Estuary would reduce the amount of saltmarsh area on the site over time. 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 intertidal areas would eventually be to the detriment of the saltmarsh at Penrhyn Estuary unless active mangrove removal and control is carried out.

Flora Species

Based on NSW NPWS and EPBC database searches, thirteen species of threatened flora listed under the TSC and/or EPBC Act have been recorded from the site or the vicinity. The status and habitat details of these species are described in **Table 20.1**.

Table 20.1 Significant Flora Species Recorded in the Vicinity of the Study Area

SPECIES	CONSERVATION STATUS*	HABITAT REQUIREMENTS	LIKELIHOOD OF OCCURRENCE AND COMMENTS
Acacia bynoeana Bynoe's Wattle	E[1] V[2]	Heath and woodland on sandy soils	**Low -** Habitat not present within study area. No recent records of the species in the vicinity of the study area.
Acacia gordonii	E[1, 2]	Dry heath in eucalypt woodland, usually in shallow sandy soil amongst sandstone outcrops	**Low -** Habitat not present within study area. No recent records of the species in the vicinity of the study area.
Acacia terminalis subsp. *Terminalis*	E[1, 2]	Scrub and dry sclerophyll woodland on sandy soil	**Low -** 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.
Acacia pubescens Downy Wattle	V[1, 2]	Open forest on clay soils	**Low -** Habitat not present within study area.
Eucalyptus pulverulenta Silver-leaved Mountain Gum	V [1, 2]	Mallee	**Low -** Low likelihood of occurrence. Habitat not present within study area.
Melaleuca deanei	V [1]	Heath and woodland on ridges and upper slopes on Hawkesbury Sandstone, often in *E. piperita – A. costata* association	**Low -** Habitat not present within study area. No recent records of the species in the vicinity of the study area.
Syzgium paniculatum Magenta Lilly Pilly	V [1, 2]	Coastal rainforest	**Low -** Habitat not present within study area. 1977 record of the species at Towra Point.
Caladenia tessellata 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 -**Habitat not present within study area. No recent records of the species in the vicinity of the study area.
Tetratheca juncea	V [1]	Ridgetops on southeast to southwest 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 *E. capitellata, A. costata-C. gummifera* (Payne 1998)	**Low -** Species not recorded within study area during present study. This species is considered regionally extinct in Sydney.
Cryptostylis hunteriana Leafless Tongue-orchid	V[1, 2]	Sandstone soils	**Low -** Species occurs from the Ku-ring-gai area and recently from near Campbelltown.
Prostanthera densa Villous Mintbush	V[1, 2]	Heath and sea coasts on sandstone	**Low**. - Occurs from Cronulla south to the Royal National Park.
Pterostylis sp Botany Bay Bearded Greenhood	E[1, 2]	Coastal scrub	**Low -** No recent records of the species in the vicinity of the study area.
Thesium australe Austral Toadflax	V[1, 2]	Grasslands, grassy woodlands or sub-alpine grassy heathlands	**Low -** 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.

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, and are therefore not considered further in this assessment.

20.5 Existing Environment – Fauna

As discussed in Section 20.3.2, no field surveys for fauna were undertaken, or considered to be required, as previous surveys and assessments conducted in the area were sufficient for determining the existing environment.

Desktop studies were undertaken to determine the likelihood of threatened species, populations and communities that exist within the study area and to assess shorebird habitat within the study area and elsewhere in Botany Bay.

20.5.1 Conservation Significance

Threatened Fauna Communities

The Taren Point Shorebird Community is listed as an endangered ecological community under 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 Community 1998).

The assemblage of shorebird species that make up the Taren Point Shorebird Community have been addressed individually in this assessment. 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 20.7.4 for further details on predicted Bay-wide impacts on shorebird habitat).

Threatened Fauna Species

Eighty-six species of terrestrial fauna listed as having conservation significance under the TSC and/or EPBC Act have been previously recorded in the vicinity of the study area or have been predicted to occur within the study area. The status and habitat details of these species are summarised in **Table 20.2** and described in detail in **Appendix O**.

Table 20.2 Significant Fauna Species Recorded in the Vicinity of the Study Area

SPECIES	CONSERVATION STATUS *	HABITAT REQUIREMENTS	LIKELIHOOD OF OCCURRENCE AND COMMENTS
Threatened Fauna			
Frogs			
Crinia tinnula Wallum Froglet	V[1]	Confined to acid, paperbark swamps of the 'wallum' country	**Low** Suitable habitat not present in study area.
Heleioporus australiacus Giant Burrowing Frog	V[1, 2]	Burrows in banks of small creeks	**Low** Suitable habitat not present in study area.
Litoria aurea 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.
Litoria littlejohni 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			
Actitis hypoleucos 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.
Anseranas semipalmata 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.
Arenaria interpres 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.
Botaurus poiciloptilus 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.
Burhinus grallarius 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.

SPECIES	CONSERVATION STATUS *	HABITAT REQUIREMENTS	LIKELIHOOD OF OCCURRENCE AND COMMENTS
Cacatua leadbeateri Major Mitchell's Cockatoo	V[1]	Mallee, mulga, Murray Pine and casuarina associations	**Low** Suitable habitat not present in study area.
Calamanthus fuliginosus Striated Fieldwren	V[1]	Saltmarsh where there are sedges and reeds present	**Low** No recent records in the area.
Calidris acuminata 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).
Calidris alba 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 (Penrhyn Estuary).during rough weather for shelter and feeding.
Calidris canutus 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 Woolooware 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.
Calidris ferruginea 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).
Calidris ruficollis 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.
Calidris tenuirostris 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.

SPECIES	CONSERVATION STATUS *	HABITAT REQUIREMENTS	LIKELIHOOD OF OCCURRENCE AND COMMENTS
Calyptorhynchus lathami 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.
Charadrius bicinctus 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 fishermen, 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).
Charadrius leschenaultii 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 one or two individuals are recorded in the Bay on an occasional basis (this is significant given the NSW estimated population for this species is only 80 birds with the majority occurring in the Clarence and Richmond estuaries).
Charadrius mongolus 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.
Dasyornis brachypterus 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.
Diomedea amsterdamensis Amsterdam Albatross	E[2], M,	Oceanic and coastal seas	**Low** Suitable habitat not present in study area.
Diomedea antipodensis Antipodean Albatross	V[2], M,	Oceanic and coastal seas	**Low** Suitable habitat not present in study area.
Diomedea dabbena Tristan Albatross	E[2], M	Oceanic and coastal seas	**Low** Suitable habitat not present in study area.
Diomedea exulans Wandering Albatross	E[1, 2], M	Oceanic and coastal seas	**Low** Suitable habitat not present in study area. No recent records in the area.
Diomedea gibsoni Gibson's Albatross	V[1, 2], M	Oceanic and coastal seas	**Low** Suitable habitat not present in study area.
Gallinago hardwickii Latham's Snipe	M, J, C	Wet grasslands; open, wooded swamps	**Low** Suitable habitat not present in study area.
Gygis alba White Tern	V[1]	Oceanic and breeds on islands	**Low** Suitable habitat not present in study area. No recent records in the area.
Haematopus fuliginosus Sooty Oystercatcher	V[1]	Rocky coasts within 50 m of the shoreline. Breeds on islands	**Low** Suitable habitat not present in study area.

SPECIES	CONSERVATION STATUS *	HABITAT REQUIREMENTS	LIKELIHOOD OF OCCURRENCE AND COMMENTS
Haematopus longirostris 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 Penrhyn Estuary where it feeds on intertidal sandflats. Presently five or six pairs nest at Woolooware 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.
Haliaeetus leucogaster 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.
Hirundapus caudacutus 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.
Lathamus discolor 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.
Limicola falcinellus 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-1970's (northern shoreline). This species may occasionally feed and roost at Penrhyn Estuary.
Limosa lapponica 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.
Limosa limosa 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 (one or two 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.
Macronectes giganteus Southern Giant-Petrel	E[1, 2], M	Oceans and bays	**Low** Suitable habitat not present in study area. No recent records in the area.
Macronectes halli Northern Giant-Petrel	V[2], M, P	Oceans and bays	**Low** Suitable habitat not present in study area.
Monarcha melanopsis Black-faced Monarch	M	Forests	**Low** Suitable habitat not present in study area.
Myiagra cyanoleuca Satin Flycatcher	M	Tall and medium open forests	**Low** Suitable habitat not present in study area.
Neochmia ruficauda 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.

SPECIES	CONSERVATION STATUS *	HABITAT REQUIREMENTS	LIKELIHOOD OF OCCURRENCE AND COMMENTS
Ninox strenua Powerful Owl	V[1]	Tall open forests	**Low** Suitable habitat not present in study area.
Numenius madagascariensis 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 Woolooware, 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.
Numenius phaepus 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 Woolooware, Weeney and Stinkpot Bays. This species may occasionally feed at Penrhyn Estuary.
Oxyura australis 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.
Pandion haliaetus 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.
Phipidura rufifrons Rufous Fantail	M	Wet forests, occasionally more open forests	**Low** Suitable habitat not present in study area.
Pluvialis fulva Pacific Golden Plover	M, J, C	Occurs mainly on estuarine sand and mudflats and nearby saltmarsh and short, moist 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 six 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-1980's. 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.
Pluvialis squatarola 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.

SPECIES	CONSERVATION STATUS *	HABITAT REQUIREMENTS	LIKELIHOOD OF OCCURRENCE AND COMMENTS
Polytelis swainsonii Superb Parrot	V[1, 2]	Riverine and floodplain open forest and woodlands, particularly River Red Gum	**Low** Suitable habitat not present in study area.
Procelsterna cerulea Grey Ternlet	V[1]	Oceanic and breeds on islands	**Low** Suitable habitat not present in study area. No recent records in the area.
Pterodroma leucoptera leucoptera Gould's Petrel	E[1, 2], M	Oceanic	**Low** Suitable habitat not present in study area.
Pterodroma neglecta neglecta Kermadec Petrel (western)	V[1, 2]	Oceanic	**Low** Suitable habitat not present in study area. No recent records in the area.
Pterodroma nigripennis Black-winged Petrel	V[1]	Oceanic	**Low** Suitable habitat not present in study area. No recent records in the area.
Pterodroma solandri Providence Petrel	V[1]	Oceanic	**Low** Suitable habitat not present in study area. No recent records in the area.
Ptilinopus superbus Superb Fruit-dove	V[1]	Rainforest, but will feed in adjacent mangroves or eucalypt forest	**Low** Suitable habitat not present in study area.
Puffinus assimilis Little Shearwater	V[1]	Oceanic and breeds on islands	**Low** Suitable habitat not present in study area. No recent records in the area.
Puffinus carneipes 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.
Rostratula benghalensis Painted Snipe	M, C	Marsh with moderate cover	**Low** Suitable habitat not present in study area.
Stagonopleura guttata 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.
Sterna albifrons 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 and had a successful breeding season.
Sterna fuscata Sooty Tern	V[1]	Oceanic and breeds on islands	**Low** Suitable habitat not present in study area. No recent records in the area.
Thalassarche bulleri Buller's Albatross	V[2], M, P	Oceanic and coastal seas	**Low** Suitable habitat not present in study area.
Thalassarche cauta Shy Albatross	V[1, 2], M	Oceanic and coastal seas	**Low** Suitable habitat not present in study area. No recent records in the area.
Thalassarche impavida Campbell Albatross	V[2], M	Oceanic and coastal seas	**Low** Suitable habitat not present in study area.

SPECIES	CONSERVATION STATUS *	HABITAT REQUIREMENTS	LIKELIHOOD OF OCCURRENCE AND COMMENTS
Thalassarche melanophris Black-browned Albatross	V[1] M	Oceanic and coastal seas	**Low** Suitable habitat not present in study area. No recent records in the area.
Thalassarche salvini Salvin's Albatross	V[2], M	Oceanic and coastal seas	**Low** Suitable habitat not present in study area.
Thalassarche steadi White-capped Albatross	V[2], M	Oceanic and coastal seas	**Low** Suitable habitat not present in study area.
Tringa brevipes 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 has 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.
Tringa nebularia Common Greenshank	M, J, C	Occur in all types of wetlands. Usually found beside shallow 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 Woolooware Bay and used to favour the pond at the Woolooware Shorebird lagoon site (H1 site). May be an occasional visitor to Penrhyn Estuary.
Tringa stagnatilis 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.
Tyto novaehollandiae Masked Owl	V[1, 2]	Forests, woodlands and caves	**Low** Suitable habitat not present in study area. No recent records in the area.
Xanthomyza phrygia Regent Honeyeater	E[1, 2], M	Woodland and open forest. Uncommon, nomadic	**Low** Suitable habitat not present in study area.
Xenus cinereus 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			
Chalinolobus dwyeri 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.

SPECIES	CONSERVATION STATUS *	HABITAT REQUIREMENTS	LIKELIHOOD OF OCCURRENCE AND COMMENTS
Dasyurus maculatus Spotted-tail Quoll	V[1, 2]	Rainforest, open forest, woodland, coastal heathland and inland riparian forest	**Low** Suitable habitat not present in study area.
Dasyurus viverrinus 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.
Miniopterus schreibersii Common Bentwing-bat	V [1]	Forages in tall open eucalypt forests, dry sclerophyll forest, woodland, wet sclerophyll forest, rainforest, *Melaleuca* swamps and over grasslands and roost in caves and mines	**Low** May forage in Botany Bay whilst in transit between foraging and roosting sites.
Myotis adversus *Large-footed Myotis*	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.
Petrogale penicillata 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.
Potorous tridactylus 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.
Pteropus poliocephalus Grey Headed Flying Fox	V [1, 2]	Canopy feeding frugivore, blossom eater and nectarivore of rainforests, open forests, woodland, *Melaleuca* swamps and *Banksia* woodlands. Roosts in rainforest patches, Melaleuca 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.
Saccolaimus flaviventris Yellow-bellied Sheathtail-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			
Hoplocephalus bungaroides 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			
Perameles nasuta Long-nosed Bandicoot	P	A variety of habitats from rainforest to wet and dry woodlands to heathland	**Low** 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. 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 Stevedores 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.

** Conservation Status is as follows:*
E = Endangered
V = Vulnerable
where 1 = listing under TSC Act 1995
2 = listing EPBC Act 1999 Act.
M = Listed as Migratory under EPBC Act *P = Protected under NSW National Parks and Wildlife Act 1974*
J = Listed under JAMBA agreement *C = Listed under CAMBA agreement.*

Of the 86 listed species, 23 shorebirds and one seabird are considered to have a moderate to high likelihood of occurrence and therefore may be impacted as a result of the proposed Port Botany Expansion. These species were considered as regular or occasional visitors to Penrhyn Estuary. Of these 24 species, 23 are listed as migratory under the EPBC Act and eight are listed either as Vulnerable or Endangered under the *TSC Act.*

The study area does not represent suitable habitat for the remaining species which are consequently considered to have a low likelihood of occurrence and are not considered further in this assessment.

20.5.2 Eight Part Tests

The 23 shorebird and one seabird species listed under the TSC and/or EPBC Act considered as regular or occasional visitors to Penrhyn Estuary were assessed under Section 5A of the EP&A Act. The Section 5A assessments (Eight Part Tests) concluded that the proposal may significantly impact upon the life cycle requirements of the 23 shorebirds and one seabird that regularly or occasionally use Penrhyn Estuary for feeding and roosting if not appropriately mitigated.

A full Section 5A assessment and ecological descriptions of the 23 shorebird and one seabird species are provided in **Appendix O**.

20.5.3 Species Impact Statement

An SIS was prepared following the completion of the Eight Part Tests to assess the likely impacts on the 23 shorebird and one seabird species due to the Port Botany Expansion. This was done in accordance with the specifications of the Director-General of NPWS.

The SIS concluded that in order to compensate for potential impacts to migratory shorebirds, listed as Threatened under the TSC Act and/or international agreements resulting from the proposed Port Botany Expansion, ameliorative measures to protect and enhance shorebirds and their habitat at Penrhyn Estuary would need to be carried out. This would involve substantially enlarging the existing area of feeding and roosting habitat as well as securing the site from disturbance from people, dogs and vehicles and shielding the estuary as far as practicable from the impact of port operations. The proposed habitat enhancement of Penrhyn Estuary is detailed further in Section 20.9.1.

20.5.4 Shorebird Habitat

The importance of Botany Bay for migratory shorebirds has been significantly reduced in recent decades due to habitat loss and habitat disturbance (relative to other NSW estuaries). 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 in these locations have remained relatively stable. One species, the Bar-tailed Godwit has been able to adapt to changes in conditions in the Bay and their overall numbers have remained relatively stable.

Shorebirds that once used feeding habitat at Runway Beach, the Pilots Embayment, the entrance to the Mill Stream and Foreshore Beach, were displaced as a result of the construction of the Parallel Runway. 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).

Shorebird habitat within the study area is described below.

- *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 and migratory shorebirds listed under the TSC and EPBC Acts. 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 20.3** and **Figure 20.6**). 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. While the Estuary provides an important ecological habitat for migratory shorebirds, water quality within the Estuary is poor due to historical contamination from industrial land uses in the surrounding catchment.

- *Foreshore Beach* - Foreshore Beach was created during dredging works for Sydney Airport and Port Botany in the 1970's, 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.
- *The Mill Stream* - Saltmarsh, mud flat and sand flat habitats at the mouth of the Mill Stream that previously provided valuable feeding and roosting habitats for shorebirds were lost during the construction of the Parallel Runway. The Mill Stream does not, at present, provide feeding or roosting habitat for shorebirds (Straw 1996).

20.6 Assessment of Impacts on Flora

20.6.1 Planted Shrubland

The proposal would result in the direct removal of approximately 0.6 ha (out of a total of approximately 12 ha) of planted shrubland behind Foreshore Beach 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 20.9.1, would result in the removal of approximately an additional 10.5 ha of planted shrubland at Penrhyn Estuary (out of a total of approximately 15 ha).

The loss of planted shrubland community, whilst it possesses some local conservation value, is not considered to be significant in a local or regional sense.

Along Foreshore Beach, much of the existing vegetation would be retained and enhanced, and where removal is required for the construction of infrastructure, the area would be revegetated with local native species as described in **Chapter 7** *Public Recreation and Ecological Plan*.

Approximately 4.5 ha of the planted shrubland within Penrhyn Estuary would 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.

20.6.2 Mangroves

Under the proposed port expansion, the small stand of mangroves (approximately 1.0 ha) 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:

- it would be a 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 did not occur on the northern shores of the Bay, but have colonised (via dispersed seed) in the favourable environmental conditions (sediment accumulation and nutrient input) of the newly formed estuary (formed from the construction of Port Botany); 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.

The removal of mangroves would require a permit from NSW Fisheries under the FM Act. Further details of the removal and long term control of mangroves at the site are described in Section 20.9.1.

20.6.3 Saltmarsh

Saltmarsh habitat of up to 5 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 of approximately 4%, based on West *et al.* (1985) in the total area of this habitat within Botany Bay, and would 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 are described in Section 20.8.1.

20.7 Assessment of Impacts on Fauna

Potential impacts from the proposal on the identified 23 shorebird and one seabird species would include 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); as well as the potential entry/exit psychological flyway barrier due to the enclosure of the Estuary.

20.7.1 Disturbance

Disturbance, for the purposes of this assessment, 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 is little quantified and experimental assessment of the effects of disturbance on shorebirds and little understanding of the extent of such impacts.

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.

Frequent and intense disturbance is likely to affect shorebird 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 result in departure delay. Such delays 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.

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 m.

Public Access

The restriction of public access to Penrhyn Estuary would minimise part of the human disturbance element 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, fishermen and pedestrians.

Lighting

The Port Botany Expansion would result in an increase in the amount of ambient lighting at night over Penrhyn Estuary from various sources, including building mounted lighting, quay cranes, straddle carriers, rail mounted gantries, vehicles, road lighting, and terminal lighting.

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 or vehicles may result in the displacement of the shorebirds to habitat elsewhere in the Estuary or Bay. Safeguard measures to ameliorate lighting impacts on shorebirds are outlined in Section 20.9.2.

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 20.8.3.

20.7.2 Potential Entry/Exit Flyway Barrier

The Port Botany Expansion would result in partially enclosing Penrhyn Estuary with wharf structures, a rail line, stacked shipping containers and large cranes. This may represent a psychological entry/exit flyway barrier into and out of the shorebird feeding and roosting habitat at Penrhyn 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 Penrhyn 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 northeast into the estuary over water.

Research into international examples of similar environments indicate that Yatsu-Higato, a 40 ha Ramsar wetland upstream of Tokyo Bay in Japan is essentially enclosed and surrounded by industry and residential development and traversed by a freeway. This wetland is being used by a number of migratory shorebirds for part of their life cycle requirements. The shorebirds 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. Yatsu-Higato is connected to Tokyo Bay by two channels 20 m and 50 m wide. This would suggest that shorebirds would fly into Penrhyn Estuary over the operational docks or negotiate their way along the 130 m wide channel parallel to Foreshore Beach provided the area of the Estuary was sufficiently large to provide an open aspect.

20.7.3 Water Quality

An assessment of the impacts of a predicted reduction in tidal flushing and water quality in Penrhyn Estuary as a result of the Port Botany Expansion is presented in **Chapter 16** *Hydrology and Water Quality*. Predicted 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 would assist in assessing the impacts from construction and operation of the new terminal and associated facilities on shorebirds and their habitats. The monitoring would be undertaken during construction and operation of the Port Botany Expansion and the results would be reviewed to make a final determination as to whether Penrhyn Estuary can continue to provide viable shorebird habitat, or whether compensatory habitat elsewhere in Botany Bay needs to be considered.

Proposed shorebird habitat monitoring during construction and operation is detailed in **Section 20.8.5**.

20.7.4 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 the Port Botany Expansion 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.

Mitigation measures detailed in Section 20.8.1 would act to minimise the likelihood of feral animal presence on the site during construction and operation of the Port Botany Expansion.

20.7.5 Creation of Additional Shorebird Habitat at Penrhyn Estuary

Enhancement of existing shorebird habitat at Penrhyn Estuary is a key component of the Port Botany Expansion. The enhancement would involve the creation of an additional 11 hectares of tidal flats and up to five hectares of additional saltmarsh habitat to provide shorebird feeding habitat. The proposal would thus result in a significant net gain of shorebird habitat at the site. Details of the shorebird habitat enhancement are discussed further in Section 20.8.1.

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 20.8.1, to minimise these disturbances, works close to the shorebird feeding and roosting sites would be carried out during winter months when the majority of shorebirds have migrated to their northern hemisphere breeding and staging grounds.

20.7.6 Shorebird Habitat Elsewhere in Botany Bay

A review of the results of the hydrodynamic modelling undertaken by Lawson and Treloar (2003) indicated that the impacts on Bay-wide shoreline recession and progradation (sediment transport) will be negligible or immeasurable.

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

Silver Beach

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.

Sandringham to Taren Point

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

Lady Robinsons Beach

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

20.8 Mitigation Measures

20.8.1 Lighting

The following measures would be adopted 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) would be screened by vegetation or a solid barrier; and
- high mast lighting would be designed to focus illumination on the terminal and prevent light spill over the Estuary.

20.8.2 Noise

A 4 m high noise barrier would be constructed along the northeastern and northern edge of the new terminal as outlined in **Chapter 22** *Noise*. This barrier would mitigate noise impacts on shorebirds within the study area. To reduce the boxing-in effect of the port construction, the upper 2 m of the barrier would be constructed from a translucent material. Some form of pattern would be printed on the surface to make it visible to birds in flight and to reduce the likelihood of birds flying into the barrier. The noise barrier would also act as a barrier to vehicle lights. The wall would be set back as far as possible from the edge of the Estuary to minimise the boxing-in effect.

20.8.3 Structures

To mitigate the “boxing-in effect” on shorebirds, structures would be set back from the edge of the new terminal where it adjoins Penrhyn Estuary. The proposed buildings would be a maximum of three storeys and would be located on the northwestern corner of the new terminal, so would be less of a flyway barrier to shorebirds than if located closer to the Estuary. Furthermore, container stacks would be set back at least 150 m from the edge of the Estuary.

20.8.4 Habitat Enhancement

Habitat enhancement works are proposed for Penrhyn Estuary as part of the Port Botany Expansion. Habitat enhancement of Penrhyn Estuary would significantly improve shorebird habitat so as to provide for the continued use of the Estuary by shorebirds and potentially increase the number of shorebirds using the area following the proposed port expansion works. The proposed shorebird habitat enhancement is illustrated in

Figure 20.4. Conceptual cross sections of the proposed Estuary are shown in **Figure 20.5**. A detailed description of the proposed shorebird habitat enhancement works is contained in **Appendix O**.

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 contour the Estuary to create additional intertidal sandflat habitat. The newly created sand flats would then be overlain with at least a 5 cm layer of finer sediment for invertebrate colonisation and shorebird feeding.

The proposed enhancement works would significantly open up the area to shorebirds through the creation of an additional 11 ha of intertidal sand and mud flats, up to 5 ha of saltmarsh habitat and up to 8 ha of seagrass habitat.

Construction Sequencing

The proposed habitat enhancement works would 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 likely to be required for invertebrate establishment.

Habitat enhancement at Penrhyn Estuary would be carried out in stages. The first stage would 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 (**Figure 20.6**). Works would 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 during other times. The upper reaches of the Estuary, including the existing mudflats, would be left relatively undisturbed, to ensure that a feeding area for shorebirds is always accessible (**Figure 20.6**).

The next stage of shorebird habitat enhancement would 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 or imported from other sources.

Construction of culverts at Springvale and Floodvale Drains, and the stabilisation of the main channel through the Estuary should also be undertaken in winter months to minimise impacts on migratory birds.

Saltmarsh Protection and Transplantation/Re-establishment

The following measures would be implemented 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 to be transplanted (approximately 0.35 ha) and subsoil to be relocated would be directly transferred to the new locations. If this is not feasible the saltmarsh and soil would be stored for later transplanting;
- saltmarsh seed provenance would be harvested and propagated for planting within the Estuary. This would expand the area of saltmarsh and would provide a means of compensation should the saltmarsh not survive the above transplanting process; and
- additional saltmarsh would be planted once suitable levels in the Estuary are created for this habitat.

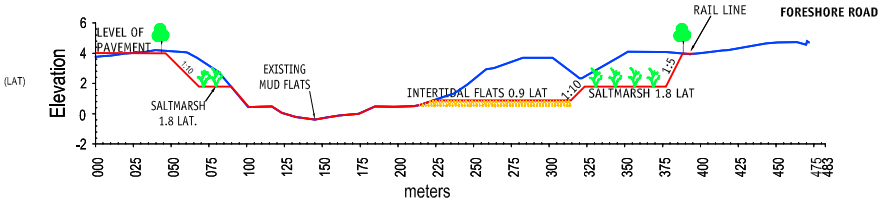
0 300m

- Proposed Intertidal Sand/Mud Flats (area approx. 11ha)
- Existing Mudflats To Be Retained (area approx. 1.5ha)
- Proposed Saltmarsh Habitat (area approx. 5ha including approx. 0.6ha of existing mangroves to be removed)
- Existing Saltmarsh To Be Transplanted into Proposed Saltmarsh Habitat (area approx. 0.35ha)
- Existing Saltmarsh To Be Retained (Area approx. 1ha)
- Existing Mangroves To Be Removed & Replaced With Saltmarsh Habitat
- Proposed Seagrass Habitat (area approx. 8ha)
- Potential Opportunity For Sediment/litter Traps (subject to detailed assessment on drain hydraulics)
- Proposed Preferential Flow Channel
- Proposed Preferred Noise Wall Location (approx. 4m High)
- Landscaped Buffer Strip

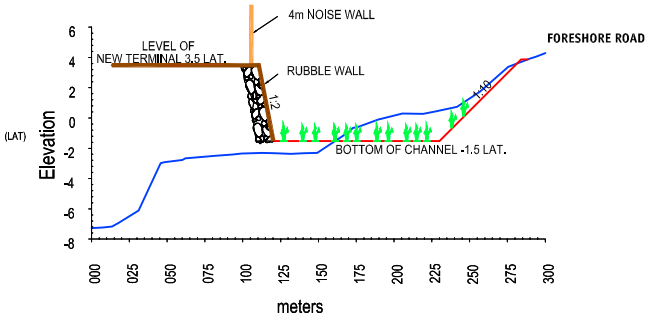
Penrhyn Estuary Proposed Habitat Enhancement Plan

Figure 20.4

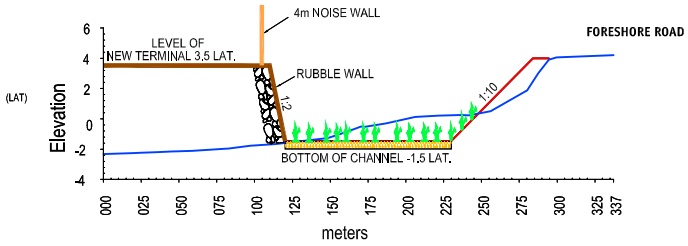
LINE 1



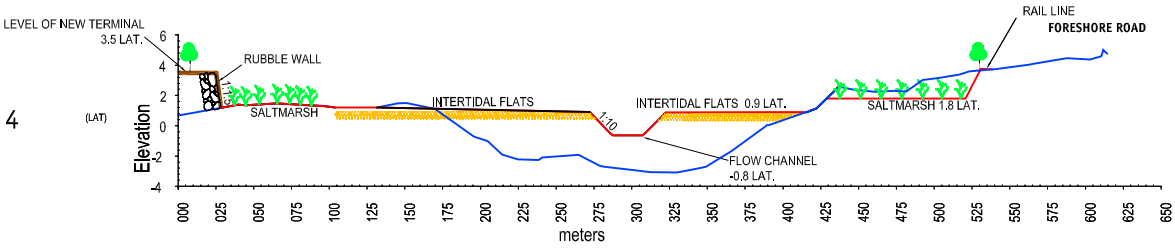
LINE 2



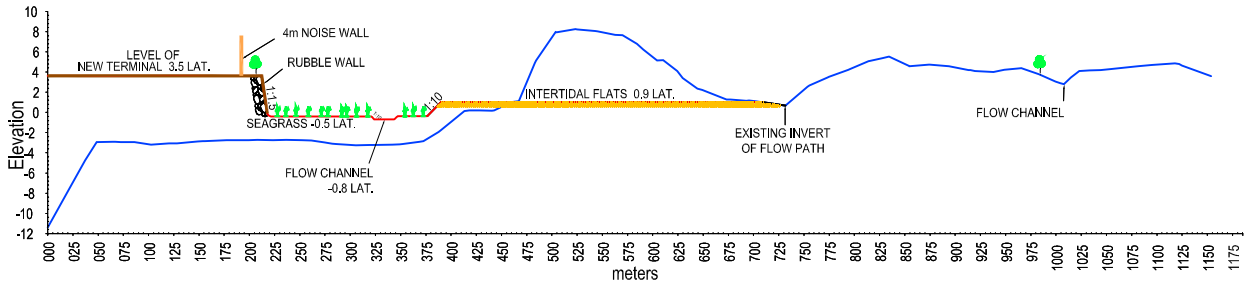
LINE 3



LINE 4



LINE 5



Vertical Exaggeration = 10x

All areas and measurements are approximations

Natural Surface

Proposed Development

Penrhyn Estuary Proposed Habitat Enhancement Cross Sections

Figure 20.5

Source: Avifauna Research and Services 2003

0 300m

Existing Shorebird Feeding Habitat at Penrhyn Estuary

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

Initial Stage of Penrhyn Estuary Habitat Enhancement Works

Figure 20.6

A Vegetation Management Plan (VMP) detailing methodologies for saltmarsh excavation, storage, propagation and transplantation would be prepared and would be incorporated as part of the Construction and Operational EMPs for the project.

Mangrove Removal and Control

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 1 m in height (these are the plants that can be relatively easily pulled out by hand); and
- for all plants that cannot be easily removed by manual means (juveniles and mature adults greater than 1 m in height), stems would be cut as close to ground level as possible to reduce the chance of the plants resprouting via epicormic buds. In areas of contaminated sediment, mangroves would also be cut in this fashion to minimise any disturbance of the sub-strata.

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 would then be undertaken on a 6 monthly basis or as required. This would help prevent re-colonisation of mangroves which would outcompete habitat for shorebirds.

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

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 1-2 m 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 would be appropriately fenced to control public access and prevent feral and domestic animals from entering the Estuary. Exclusion fencing would be constructed in association with the commencement of construction of the new terminal. Access to/from the boat ramp in Penrhyn Estuary would be maintained until a replacement boat ramp was available.

Interpretative signage would be erected to educate visitors about the importance of undisturbed feeding and roosting sites for migratory shorebirds. A boardwalk and observation platform would be constructed adjacent to the existing Government Jetty remains.

Access to the Estuary via Foreshore Beach would be restricted using an appropriate barrier. A suitable barrier would also be erected to prevent boats and swimmers from entering the Estuary.

Control of Feral Animals

The following two measures would assist in the control of feral animals at Penrhyn Estuary, these include:

- ensure rubbish is placed in appropriately covered bins at all times. Ensure rubbish is regularly disposed; 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) would be prepared as part of the Construction and Operational EMP for the Port Botany Expansion. The FAMP would 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.

20.9 Management and Monitoring

The modification of Penrhyn Estuary associated with the proposal would 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 of the diversity, abundance and behaviour of migratory shorebirds at Penrhyn Estuary would 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, this monitoring would be carried out on a monthly basis for at least three years. Monitoring of shorebirds would 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 shorebird monitoring is required to cover species that may be moving through Botany Bay during the migration season.

Results of all the relevant monitoring studies (i.e. those studies having a bearing on shorebird habitat) would be used to make an overall 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 designs or compensatory shorebird habitat locations elsewhere in Botany Bay would then be considered. This 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 two to three years from commencement of construction).

Construction and establishment of the enhanced habitat at Penrhyn Estuary would be the responsibility of Sydney Ports Corporation but as the site becomes established it would be necessary for one or more authorities to participate in the long term management of the site. 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.

20.10 Conclusion

The proposed Port Botany Expansion would result in changes to the terrestrial environment on the northern side of Botany Bay between the Parallel Runway and Penrhyn Road.

An assessment of the likely impacts to threatened species from the proposal, in the form of an Eight Part Test, concluded that a SIS was required for the proposal in respect of 23 shorebird and one seabird species that could be significantly affected by the proposal.

Key impacts from the proposal on the 23 shorebird and one seabird species considered as regular or occasional visitors to Penrhyn Estuary could include disturbance to feeding and roosting from a change in lighting regime, increased movement, noise from construction and operation of the port (and associated infrastructure such as railway lines) and potential entry/exit flyway barriers due to the enclosure of Penrhyn Estuary.

To compensate for potential impacts to these shorebirds as a result of the proposed Port Botany Expansion, Sydney Ports Corporation would carry out measures to protect shorebirds and enhance their habitat at Penrhyn Estuary. These measures would entail substantially enlarging the existing area of feeding and roosting habitat as well as securing the site from disturbance from people, dogs and vehicles and shielding the Estuary as far as practicable from the impact of port operations.

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

In enhancing shorebird habitat in Penrhyn Estuary, approximately 10.5 ha of planted shrubland and approximately 1.0 ha of mangroves in Penrhyn Estuary would be removed and an additional 11 ha of intertidal flats, up to 5 ha of saltmarsh habitat and up to 8 ha of seagrass habitat would be created.

The removal of vegetation and mangroves in Penrhyn Estuary is a trade-off to enhance a recognised important migratory shorebird habitat site in Botany Bay and should be viewed in this context.