



Warriewood Wetland

Plan of Management

Prepared under the Local Government Act, 1993

Prepared by:



PITTWATER COUNCIL

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Abbreviations

ABBREVIATION	DESCRIPTION
ASS	Acid sulphate soils
CAP	Draft Sydney Metropolitan Catchment Action Plan
CMA	Catchment Management Authority
DECCWW	Department of Environment, Climate Change and Water
EEC	Endangered Ecological Community
ELA	Eco Logical Australia Pty Ltd
KTP	Key threatening process
LGA	Local Government Area
NPWS	National Parks and Wildlife Service
PoMs	Plans of management
RTA	Roads and Traffic Authority
WSUD	Water Sensitive Urban Design

Executive Summary

Warriewood Wetland covers approximately 26 ha in Warriewood (Pittwater LGA) and is in close proximity to Narrabeen Lagoon. The Wetland is of regional conservation significance (DECC 2008) and is highly valued by the local community. The subject area provides opportunities for recreation and there is habitat for a number of native flora and fauna species and endangered vegetation communities. Overall, however, the wetlands are in a degraded condition with numerous environmental and hydrological challenges.

Warriewood Wetland is public land owned by Pittwater Council. Currently, the entire site is zoned 7a: Environment Protection "A". As stated in the Pittwater Local Environment Plan 1993, the objectives of this zone are to:

- Identify areas having significant natural, cultural and heritage conservation values
- Ensure that the ecology and environmental qualities of land within the zone are enhanced and protected from adverse impact arising from development of land in the vicinity

This plan presents a detailed vegetation management program. Other high priority actions include controlling weeds and pollutants at the source, community education, boardwalk maintenance and installation of signage.

1 Introduction

1.1 CONTEXT

Pittwater Council is reviewing and updating the Warriewood Wetland Plan of Management (Water Resources Consulting Services 1997) with the support of the NSW Government's Catchment Action New South Wales Program (funding allocated by Sydney Metropolitan CMA). The preparation of the updated plan will contribute to achieving several state, catchment and local targets. Relevant state and catchment targets are:

- *By 2015 there is an improvement in the condition of important wetlands, and the extent of those wetlands is maintained.* (NSW State Plan - Wetland Target E4.8)
- *By 2016 there is an improvement in the condition and extent of wetlands.* (Sydney Metropolitan Catchment Management Authority Catchment Action Plan May 2009 - Wetland Target CTW2)

Eco Logical Australia was contracted to prepare the new Plan of Management for Warriewood Wetland for Pittwater Council, with Council direction and consultation with the community and interest groups. The Plan identifies works and actions for long-term sustainable management of the wetland. It builds on two key documents recently prepared by/for Council:

- *Pittwater Natural Areas (Draft) Plan of Management* (Pittwater Council Dec 2009)
- *Warriewood Wetland Plan of Management* (Water Resources Consulting Services 1997)

1.2 STUDY AREA

Warriewood Wetland is the largest remaining sand plain wetland in northern Sydney (DECC 2008). The wetland covers approximately 26 ha in Warriewood (Pittwater LGA) and is in the Narrabeen Lagoon Catchment. The wetland is a freshwater system and is recognised as having regional conservation significance.

The study area supports a number of vegetation communities listed as endangered under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and provides habitat for many fauna species including several listed under state and federal legislation. The wetland is connected via remnant vegetation to the Ingleside Escarpment and together these areas form one of the most important habitat areas in the greater Sydney region (DECC 2008).

Warriewood Wetland is predominantly fringed by residential areas and the Warriewood Square Shopping Centre. The areas to the north and west of the wetland have been progressively developed into residential estates over the last ten years in line with the Warriewood Valley Urban Land Release Planning Strategy. Development of these areas is continuing.

The wetland is fed by three creeks (Narrabeen, Fern and Mullet Creeks) and discharges into Narrabeen Lagoon. Rehabilitation and water quality monitoring of these creeks has occurred as a component of the Land Release Planning Strategy, as have works within the wetland (e.g. wooden boardwalks) to improve access. The site and surrounding area are depicted in **Figure 1**.

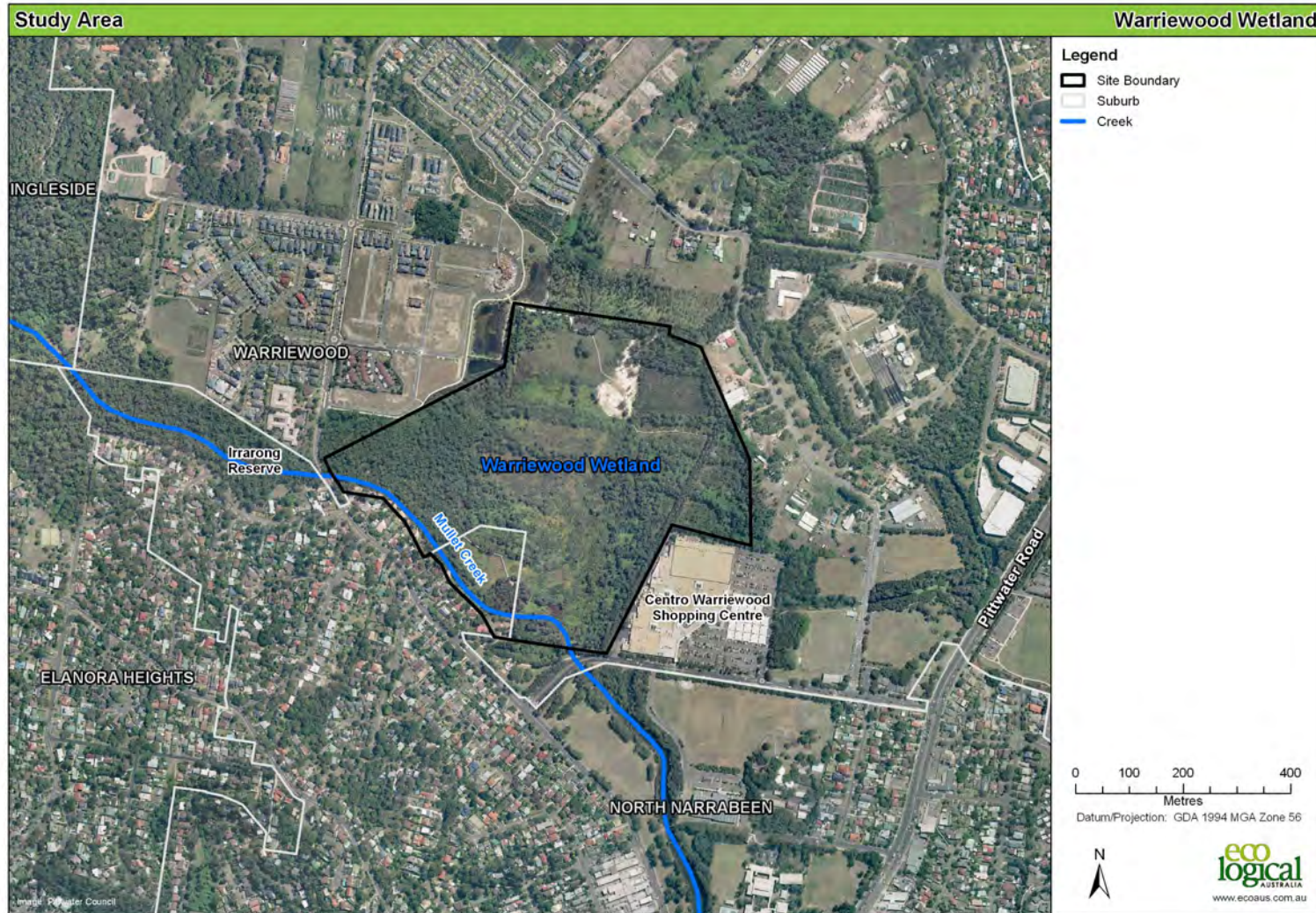


Figure 1: Study location

1.3 PROJECT NEED AND OBJECTIVES

Warriewood Wetland is of regional conservation significance (DECC 2008) and is highly valued by the local community. The area provides opportunities for passive recreation and there is habitat for a number of native flora and fauna species and sensitive vegetation communities. Since development commenced, the wetland has suffered degradation, with both environmental and hydrological challenges. These challenges and the need to resolve them for the benefit of the local community and the broader environment, has led to the need for a detailed plan of management to guide the conservation and management of Warriewood Wetland into the future.

The existing PoM for Warriewood Wetland (NSW Department of Public Works and Services 1998) is over a decade old and precedes the Warriewood Land Release. It therefore requires review and updating. This update reflects recent works undertaken within the wetland and the surrounding catchment, and changes within the local, state and federal legislation and policy environment.

Pittwater Council has recently prepared a Pittwater Natural Areas (Draft) Plan of Management (Dec 2009). Part 1 (Generic Management Issues) is an overarching document that sets out the directions for future planning and management of open space in Pittwater LGA. The aim of this overarching Plan is to ensure that the natural area reserves of the Pittwater area retain their environmental, recreational, scenic, cultural and social values by addressing key management issues such as conservation, access and public safety.

This PoM for Warriewood Wetland has been developed to fulfil the above overarching aim. More specifically it provides:

- A description of environmental areas and values
- A description of the management issues
- A list of prioritised works and activities including:
 - Measures to manage threats to biodiversity values
 - Measures to address the issue of surrounding land uses encroaching into the wetlands
 - Identification of recreation areas, values and appropriate future recreation options
 - Activities and management actions aiming to engage the local community

1.4 CONSULTATION

1.4.1 Previous community consultation

The previous Plan of Management was developed by Water Resources Consulting Services (1997) in consultation with the community. Over 100 residents attended a public meeting to discuss the plan, which was also publically exhibited. The final PoM had broad community support.

A total of 74 residents participated in the consultation process undertaken in 2007 during the development of rehabilitation plans for creeks in Pittwater LGA, including Mullet Creek (Hyder Consulting 2008). Key findings from the community survey and consultation process are listed below. While the consultation process focused on the whole of Mullet Creek, the findings below are relevant to the reaches of the creek that are within Warriewood Wetland.

- The community places a high level of importance on the Mullet Creek system in terms of their lifestyle and business.
- Key values identified by the community for Mullet Creek include wildlife and habitat diversity, aesthetically pleasing landscapes and use of the catchment for recreational purposes.

- Walking is by far the most common community interaction/usage in the Mullet Creek system.
- A significant proportion of survey respondents view Mullet Creek system as 'unhealthy' or 'very unhealthy'.
- Key issues impacting on creek health identified by the community in Mullet Creek include: weeds, lack of flow, illegal dumping and rubbish, siltation and sedimentation, unstable banks, declining wildlife and flooding.
- Key root causes of the issues impacting on creek health include: lack of management, weed invasion, increased nutrient loads in stormwater, urbanisation, land clearing, obstructions to flow, opening and closing of Narrabeen lagoon, lack of signage, industrial discharges, introduced species, lack of compliance and poor engineering and planning.
- Common management actions identified by the community to address root causes of problems in Mullet Creek include: education, weed removal and native revegetation programs, in-creek engineering works, review of licence conditions for all water users, installation of silt traps and detention basins, compliance monitoring and signage.

1.4.2 Community consultation

A range of stakeholders were consulted during the preparation of this Plan of Management. Representation was sought from local government, special interest groups, residents and the broader community. Stakeholders were invited to comment on proposed management strategies and actions through public exhibition of the draft PoM and during a public meeting. Feedback from stakeholders was used to guide preparation of the PoM, particularly identifying the actions and their priorities. Stakeholders are supportive of the PoM and no formal submissions were made during the public exhibition period.

2 Relevant legislation

Legislation and policy that has been taken into consideration in the development of this Plan of Management is listed below. Please refer to the *Pittwater Natural Areas Draft Plan of Management* (Part 1): Generic Management Issues (Pittwater Council 2009) for a full explanation of the legislation/policy and its applicability to this PoM.

- *Local Government Act 1993*
- *Environmental Planning and Assessment Act 1979*
- *Threatened Species Conservation Act 1995*
- *Fisheries Management Act 1994*
- *Protection of Environment Operations Act 1997*
- *Environmental Protection and Biodiversity Conservation Act 1999 (Commonwealth)*
- *State Environment Planning Policies for Infrastructure, Bushland in Urban Areas (SEPP 19), Koala Habitat Protection (SEPP 44), Coastal Protection (SEPP 71)*
- *Pittwater Local Environment Plan 1993*

There are a number of other plans that relate to this PoM. These include:

- *Warriewood Wetland Plan of Management 1997*: Developed to guide Council's management of the land in accordance with relevant legislation and was prepared for the conservation of the wetlands within the context of the entire catchment.
- *Warriewood Valley Urban Land Release Water Management Specification 2001*: Developed to ensure that the development of the Warriewood Valley is carried out in an ecologically sustainable manner within the realm of the water environment.
- *Warriewood Valley Urban Land Release Planning Strategy 1995*: Guides rezoning and development of land within the valley.
- *Narrabeen Lagoon Estuary Management Plan 2002*: Aims to achieve long-term sustainable management of the lagoon.
- *Management Plan for Threatened Flora and Fauna 2000*: Provides detailed information about the threatened species and communities known to occur in Pittwater LGA (as of 2000). Management and threat abatement measures consistent with the TSC Act are provided.
- *Habitat and Wildlife Corridors Conservation Strategy 1995*: Classifies remnant bushland in Pittwater LGA according to its habitat and wildlife corridor values. Recommendations for protection and enhancement of these areas are presented.
- Additional strategies and plans developed by Sydney Metropolitan CMA including: *Sydney Metropolitan CMA Catchment Action Plan*, *A Wetland Prioritisation Technique*, *Rapid Fauna Habitat Assessment* and *Waterways Health Strategy*.

3 Council and community activities

3.1 VISION

The overarching vision for the management of natural areas in Pittwater LGA is set out in the *Pittwater Natural Areas Draft Plan of Management* (Pittwater Council 2009) and states that:

Pittwater's natural areas contribute to the green landscape character of the locality and are valued for their cultural, educational, scientific, economic, environmental and recreational opportunities.

This has been adopted as the overall vision for Warriewood Wetland. More specifically, the 1997 *Warriewood Wetland Plan of Management* (Water Resources Consulting Services) presents the goals for management of the wetlands as:

- Conserve the native flora and fauna
- Improve water and sediment quality
- Provide appropriate opportunities for environmental education and passive recreation
- Rehabilitate degraded areas

The management strategies and actions in this Plan of Management have been designed to work towards achieving these management goals for Warriewood Wetland.

3.2 MANAGEMENT PRINCIPLES

A set of management principles have been developed by Pittwater Council to ensure natural areas are managed according to best practice. These principles are designed to foster the protection, conservation and enhancement of natural areas and include:

- Minimise negative impacts on the natural environment.
- Continue to review management practices to keep up-to-date with best practices.
- Integrate a well-connected network of natural area reserves with:
 - A dominance of the urban forest
 - Maximisation of wildlife corridors
 - Integration of activity nodes in neighbouring parklands.
- Provide a diverse range of recreational, economic and social opportunities in reserves where appropriate, while conserving the natural environment and its ecosystems.

The management strategies and actions in this Plan of Management for Warriewood Wetland have been prepared in accordance with the above principles.

3.3 COUNCIL MANAGEMENT

Warriewood Wetland is public land owned by Pittwater Council. The entire site is zoned 7a: Environment Protection "A". As stated in the Pittwater Local Environment Plan 1993, the objectives of this zone are to:

- Identify areas having significant natural, cultural and heritage conservation values
- Ensure that the ecology and environmental qualities of land within the zone are enhanced and protected from adverse impact arising from development of land in the vicinity

Current management of the Warriewood Wetland is primarily in the form of weed control, with some baiting of pest animal species. Weed control in the wetlands has been undertaken within areas that are within reach of the boardwalks and paths. Since 1996, *Ludwigia peruviana* and *Salvinia molesta* control has been undertaken. 2,4-D herbicide has been applied to treat approximately one quarter of the *Ludwigia* infestation, however treatment is ongoing due to the extent and threat of this species. Use of the *Salvinia* weevil as a biological control was trialled in 2007, however was not followed up until 2009. Initial results indicate that the wetland may not be optimal for use of the weevil due to the shading of many areas.

In addition to current management works being performed in the wetland, there have been several projects undertaken recently using developer contributions associated with Warriewood Valley Urban Land Release developments (Pittwater Council 2010a). These include:

- The boardwalk through Warriewood Wetland and along Mullet Creek to the waterfall via Irrawong Road. This is part of a network of walking tracks being developed, which will enable people to experience and learn about Pittwater's natural diverse vegetation of coastal dunes, wetlands, swamp forest, Eucalypt and Angophora forest and headland.
- The creeks throughout the Warriewood Valley are undergoing a major transformation with the progressive restoration of creek line corridors.
- A total of 12,000 trees will eventually be planted in the Valley.

3.4 COMMUNITY ACTIVITIES

Warriewood Wetland is currently well used by the local community. There is a network of boardwalks throughout the wetland that provide interpretive material about the natural values of the wetlands. The most commonly undertaken activities within the wetlands include walking and bird watching from the boardwalk. The remainder of the wetland is not visited often due to difficult access.

A small Bushcare group is active within the Swamp Mahogany Forest in the western section of Warriewood Wetland. Bushcare activities are generally associated with easily accessible, more elevated, drier sections of the wetland.



Boardwalk through Warriewood Wetland

4 Resource overview and site features

4.1 VALUES STATEMENT

The values of Warriewood Wetland include:

- Biodiversity including endangered ecological communities
- Habitat and wildlife corridor provision
- Recreation
- Aesthetic / visual amenity
- Ecosystem services such as flood mitigation and sediment and nutrient filtering

Warriewood Wetland has significant biodiversity values and there is evidence of a decline in these values over the previous decade. The wetland constitutes the largest remaining sandplain wetland in the northern Sydney region and is made up almost entirely of endangered ecological communities (EECs). The wetland (and adjacent Irrawong Reserve) supports the largest stand of Swamp Mahogany (*Eucalyptus robusta*) in the Sydney Metropolitan CMA (DECC 2008).

The wetland also provides very important habitat for a number of threatened species and migratory birds. It forms the lowland end of a significant biodiversity corridor running from the Ingleside Escarpment through Irrawong Reserve to the Warriewood Wetland. This corridor has been identified as having some of the highest fauna values in the Sydney Metropolitan CMA (DECC 2008).

There is some evidence of declines in the biodiversity of the wetlands when current data is compared to that gathered during the development of the first Plan of Management for the wetland in the mid-1990s. In particular, the aquatic weed *Ludwigia peruviana* was identified as occurring in the southern area of the wetland (and spreading) and *Salvinia molesta* was identified as a lesser problem. In 2010, these species are found throughout the majority of the wetland and are posing a major threat to the system. The dominant native freshwater species appear to be gradually moving towards a *Typha orientalis* mono-culture, particularly in the northern central areas of the wetlands where sediment from urban development inputs are the greatest.

In addition to the biodiversity values of the wetland, the area has a great significance to the local residents of the Warriewood Valley. The walking trails through the wetland are heavily trafficked, there is a dedicated local Bushcare group and the Pittwater Coastal Environment Centre regularly undertakes educational and recreational activities with the community in the wetlands.

4.2 SITE HISTORY

Warriewood Wetland is a highly modified ecosystem that is vastly different from its original natural state. Little is known about the condition of the wetland at the time of European settlement, however it is thought that the wetland area was more extensive. From the mid-1800s to the 1960s, agricultural activities including grazing and market gardening led to significant alterations in water quality and vegetation. During this time the water levels in the wetland were heavily influenced by Narrabeen Lagoon.

During the 1950-70s, a number of drains and creek diversions altered the hydrology of Warriewood Wetland. Modifications to Mullet, Fern and Narrabeen Creeks included the creation of drains, dredging and diversions, while drainage channels and windrows were constructed in the northern regions of the wetland. In the late 1970s, a weir and causeway were constructed across Mullet Creek to a height of 1.3 m AHD. These modifications have reduced the influence of Narrabeen Lagoon on the wetlands.

In the late 1970's, the NSW Government agreed to let developers build a shopping centre on part of the site on the condition that Warringah Council would purchase the remainder of the site for retention as a natural area. Dispute over what constituted a fair price for the area continued until 1996, when, following an eighteen year-long battle by conservationists, the matter was resolved in an out of court settlement which resulted in the purchase of the land by Pittwater Council for \$4.5 million.

Approximately 110 ha of land in the Warriewood Valley were approved in 1997 for release for urban development according to the Warriewood Valley Urban Land Release Planning Strategy. The Valley is divided into a number of sectors for development. This development has been on-going since the late 1980s on a sector-by-sector basis.

Warriewood Wetland is immediately adjacent to Sectors 12 and 15 and Buffer Area 3 (**Figure 2**). Status of development in these areas is proceeding as follows (Pittwater Council 2010b):

- Sector 12: Mixed residential development currently underway
- Sector 15: No approved Master Plan for this sector submitted to date
- Buffer Area 3: Development application (DA) lodged for 600 dwellings (apartments). This DA is currently being assessed as a Major Project under Part 3a of the EP&A Act

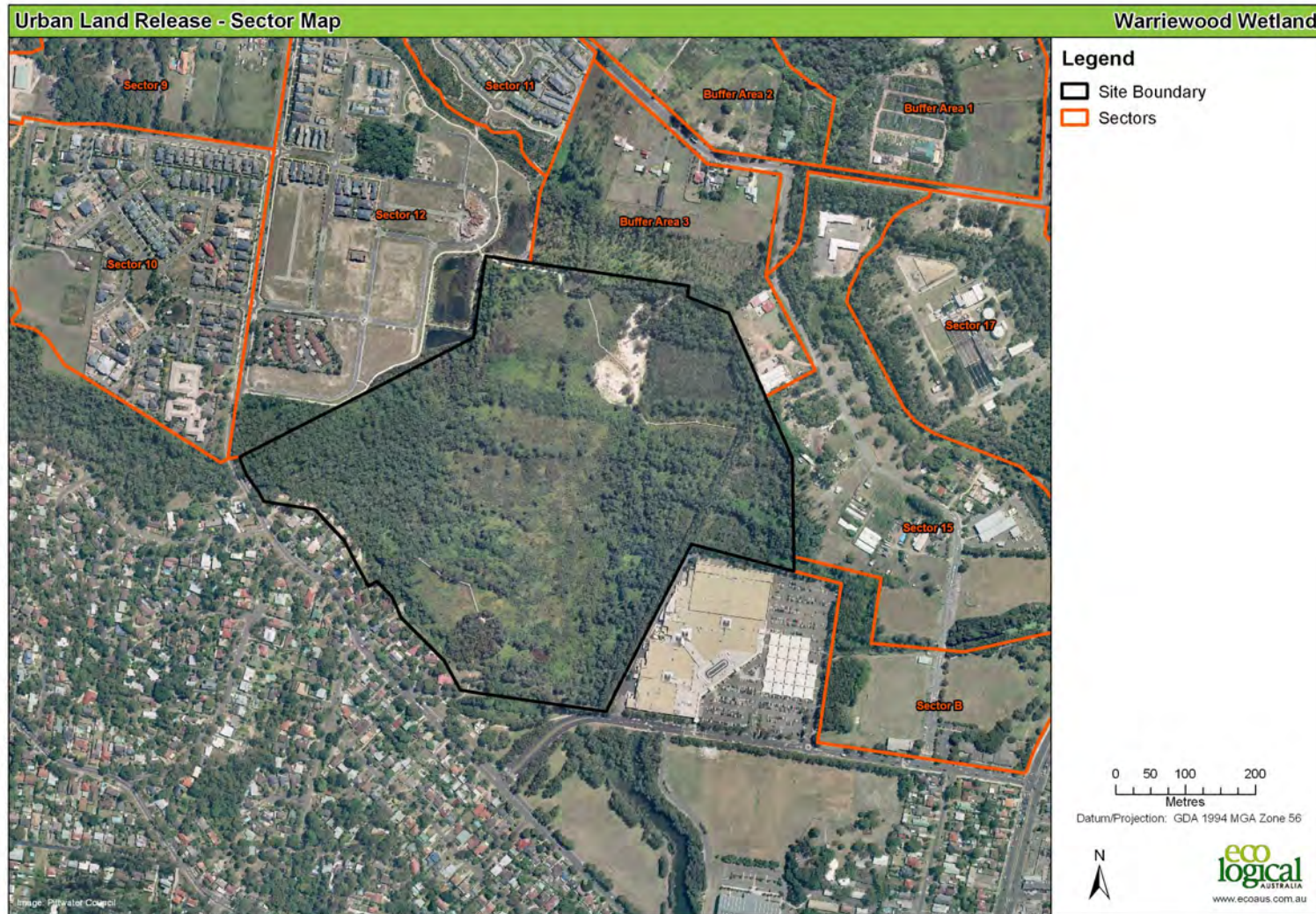


Figure 2: Warriewood Valley Urban Land Release Sector Map

4.3 TOPOGRAPHY, GEOLOGY & SOILS

4.3.1 Topography

Warriewood Wetland is situated in a natural depression between the base of the Elanora Escarpment and the Warriewood Sand Plain. The wetlands are made up of a series of vegetation communities ranging from floodplain forests to reed/sedge dominant patches and open water. Freshwater inflows originate from Mullet, Fern and Narrabeen Creeks and the wetlands discharge into Narrabeen Lagoon via Mullet Creek. The wetland is separated from the saline waters of Narrabeen Lagoon by a weir with a height of 1.3 m AHD.

4.3.2 Geology and soils

Warriewood Wetland is the largest remaining sandplain wetland in the northern Sydney region. Approximately 6,000 years ago, the wetlands were flooded during sea level rise and were rapidly filled with sand under relatively wet conditions. There is pollen evidence that indicates a freshwater swamp developed in the area at least 1,500 years ago (Dodson 1995 in Water Resources Consulting Services 1997).

The wetlands are underlain by Quaternary unconsolidated sand, silt and clay with varying amounts of organic matter. Within the wetland, soils are swampy with poor drainage. The Mullet Creek floodplain has been subject to extensive sedimentation as a result of erosion of the Hawkesbury Sandstone in the upper catchment. Loose organic matter overlies clean sand found in the majority of the wetland areas. This was thought to have accumulated following the construction of the weir and associated decline in flushing from Narrabeen Lagoon (Water Resources Consulting Services 1997).

4.3.3 Contaminated soils

Potential acid sulphate soils (ASS) are natural soils that form in seawater or brackish water environments. They generally occur in low lying and flat locations which are often flood prone or swampy, and are common in every estuary and estuarine floodplain in NSW.

Land that may contain potential acid sulphate soils has been identified from maps provided by the former NSW Department of Land and Water Conservation. These maps, known as Acid Sulfate Soils Planning Maps, establish five classes of land based on the probability of acid sulfate soils being present (Class 1 being the most likely and Class 5 being the least likely). The majority of Warriewood Wetland is identified as Class 2 (**Figure 3**).

Acid sulphate soils contain iron sulphides that are stable and do not cause a problem when waterlogged. However when exposed to air, after drainage or excavation, the soils rapidly form sulphuric acid. This acid can leak into the surrounding area acidifying wetlands, creeks, estuaries and bays, causing severe environmental damage. It can affect industries such as fishing and tourism, and can impact on public and private infrastructure by causing serious damage to steel and concrete structures such as the foundations (footings) of a building.

As an identified Class 2 area, field assessment of ASS is required prior to any action which may disturb soils in Warriewood Wetland. If ASS are found in potentially affected areas, an ASS management plan will need to be prepared in accordance with the NSW ASS Manual.

There is an old illegal dumping area in the northern section of the wetland (**Figure 3**) which has been capped and remediated. The nature of this site means a no-dig policy is enforced.

4.3.4 Erosion and sedimentation

Erosion is limited within Warriewood Wetland, however the area is a significant sink for sediments eroded from upstream in the catchment. The Mullet Creek floodplain has been subject to extensive

sedimentation as a result of erosion of the Hawkesbury Sandstone in the upper catchment (Pittwater Council 1996). Watercourses transport sediments downstream and into the wetlands, where they are deposited due to the low flow velocities through the wetlands.

During the field investigation in February 2010, significant accumulation of sediment was observed in the northern central parts of the wetlands (immediately west of the landfill site, see **Figure 3**). In this region, growth of vegetation such as *Typha* sp. has exacerbated the rate of accumulation due to its sediment trapping abilities.

There is significant potential for increased upstream erosion and further sedimentation within the wetlands from the Warriewood Valley Urban Land Release developments. Strict sediment and erosion control measures are required for all development within the area as per the Warriewood Valley Urban Land Release Water Management Specification (Pittwater Council 2001).

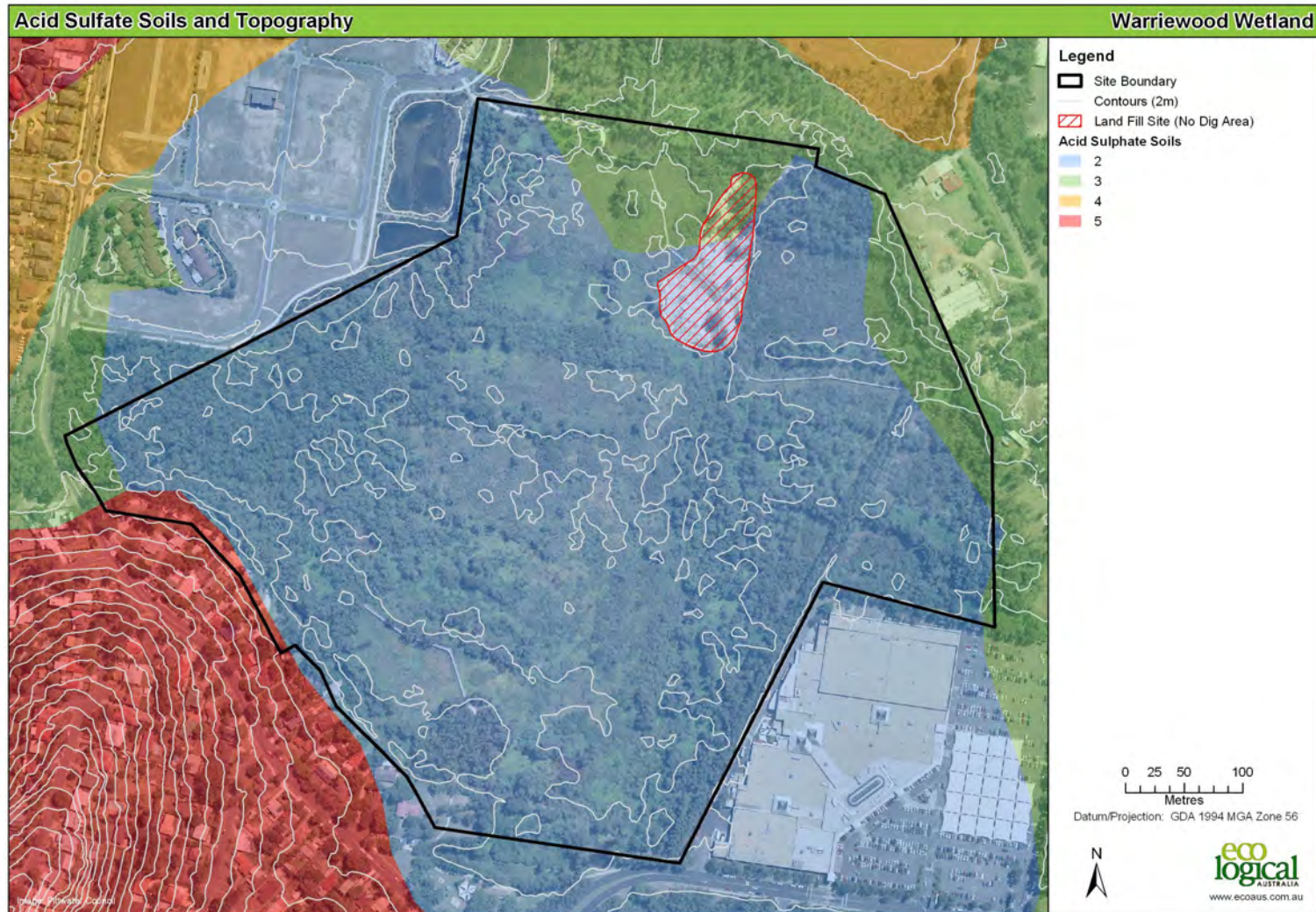


Figure 3: Topography, ASS and contaminated sites

4.4 WATER QUALITY AND FLOW

4.4.1 Water quality

An extensive program of water quality monitoring has been undertaken in the Warriewood Valley since 2000 as a condition of development associated with the Warriewood Valley Urban Land Release. Monitoring sites are situated both within the wetlands and in the three creeks that flow into the wetlands.

Overall, the key issues for water quality in the Warriewood Valley are (Cardno Lawson Treloar 2009):

- Elevated nutrient concentrations (nitrogen and phosphorus) during both wet and dry conditions. These levels have been attributed to land use within the Valley potentially including the upstream land uses and previous market gardens in the area.
- An approximate 60% reduction in nitrogen concentrations within Narrabeen Creek between 1999 and 2008. This has been attributed to land release activities including sewage infrastructure upgrades, installation of water sensitive design features and creek rehabilitation works.
- Elevated faecal coliform levels during wet weather events. This is attributed to the presence of septic systems within the catchment and potential sewer overflows.
- Depleted levels of dissolved oxygen, particularly during dry weather conditions.
- Periodic blue-green algae blooms in Narrabeen Creek.

The water quality monitoring program ceased in December 2008. This program was funded by developer contributions. However, recent changes to legislation regarding how developer contributions are allowed to be spent have resulted in a cessation of funding for this program.

4.4.2 Surface and groundwater flow

Mullet Creek is the primary surface water input to Warriewood Wetland (Manly Hydraulics Laboratory 1998). This waterway flows along the south-western boundary of the wetlands, resulting in high flows associated with heavy rainfall bypassing the majority of the wetland area. Fern Creek provides a lesser input from the north of the catchment and other minor drains enter from developed areas around the wetlands.

Surface water inputs from Narrabeen Creek may have been significant in the past but are now apparently limited to flood events which cause infrequent overbank flow into the north-east of the wetlands. Also, extensive urban development in the catchment has increased impervious surface areas leading to accelerated runoff rates which have changed the nature of surface flows and flood events in the lower catchment. These impacts have been mitigated on-site by conditions set out in the Warriewood Valley Water Management Specification.

Groundwater movements are generally low and this is not a major source of flow within the Warriewood Wetland (Manly Hydraulics Laboratory 1998). Groundwater flows in a south-south-westerly direction across the wetland towards Mullet Creek. There is a noticeable lag in flow, with groundwater contributing water to the wetlands for a considerable time after high rainfall events. Groundwater is generally fresh, although may have high nutrient loads.

4.4.3 Hydrological Modifications

The natural hydrology of Warriewood Wetland has been highly disrupted, with the majority of changes undertaken prior to Council acquisition of the wetland in the mid-1990s. The following modifications have been made to the wetland which impact on the hydrological regime (Water Resources Consulting Services 1997):

- Sewer rising main along the western edge of Warriewood Square, crossing the wetland and Boondah Rd, and associated culverts.
- Rubble causeway built during the construction of the rising main which represents a barrier between freshwater in the wetland and saline or brackish water from Narrabeen Lagoon.
- Culverts built under Jacksons Road which carry flows from the wetland to Mullet Creek.
- Past dredging and widening of Mullet Creek between the causeway and Pittwater Road.
- Piping of Narrabeen Creek under Warriewood Square, with the outlet of the culverts downstream of the causeway.
- A weir downstream of Jacksons Road on Mullet Creek.

There is currently no tidal influence of Narrabeen Lagoon on Warriewood Wetland due to the modifications to Mullet Creek, namely the weir downstream of Jacksons Rd. This structure is a fixed crest weir that creates a weir pool upstream and stabilises water levels in the upstream wetland area (Nichols & McGirr 2005).

4.4.4 Sea level rise

Mean sea level along the NSW coast is predicted to rise 40 cm by 2050 and 90 cm by 2100 (NSW Government Draft Sea Level Rise Policy Statement 2009). There is no modelling available regarding the potential influence of sea level rise on Warriewood Wetland. However, given the low-lying nature of the wetlands there is the potential for sea level rise to impact these wetlands in the future.

4.5 PLANT COMMUNITIES

4.5.1 Vegetation communities

The distribution of vegetation communities within Warriewood Wetland was mapped in the mid-1990s for the development of the original Plan of Management (Water Resources Consulting Services 1997). The following vegetation communities were identified (Winning 1994, see **Figure 4**):

- *Eucalyptus robusta* Swamp Sclerophyll Forest/woodland
- *Eucalyptus robusta* – *Casuarina glauca* Swamp Sclerophyll Forest/woodland
- *Casuarina glauca* Swamp Sclerophyll Forest/woodland
- *Casuarina glauca* – *Melaleuca ericifolia* Swamp Sclerophyll Forest/woodland
- *Melaleuca ericifolia* Swamp Sclerophyll Scrub
- *Melaleuca ericifolia* – *Ludwigia peruviana* Swamp Sclerophyll Scrub
- Herbaceous Swamp Complex
- Herbaceous Swamp Complex – *Ludwigia peruviana*
- *Lantana camara*

Eco Logical Australia remapped the vegetation within the wetlands in February 2010. The original vegetation types were used in order to identify change in the wetland over time. The changes in vegetation over time are mapped in **Figure 4** and described below.

- *Ludwigia peruviana* (*Ludwigia*) has expanded in distribution and is currently found in all areas of the wetland. *Salvinia molesta* (*Salvinia*) also occurs throughout the wetland, and may potentially be a greater risk to the vegetation communities than *L. peruviana* (in contrast to *L. peruviana* as the top priority for control in the 1990s).
- The dominant native freshwater wetland species appear to be gradually moving towards a *Typha orientalis* (Broad-leaf Cumbungi) and *Phragmites australis* (Common Reed) monoculture, particularly in the northern areas of the wetlands where sediment inputs are the greatest. These species appear to be replacing a diversity of other native species including *Isachne globosa* (Swamp Millet) and *Persicaria strigosa* (Spotted Knotweed). Not only does

this result in an overall decrease in diversity, but also a change to the habitat structure of the community.

- The area of Swamp Sclerophyll Forest (EEC) appears to have declined marginally within the wetland. In 1994, it was noted that the age structure of this community was skewed towards adult trees and that there was little recruitment into the forest. This trend was also observed in 2010, however some areas were observed with a mixed age class.
- Expansion of Swamp Oak Floodplain Forest and in particular the *Melaleuca ericifolia* dominated form of the community. This community appears to be expanding into areas that were previously cleared (or semi-cleared) and areas that were unidentified vegetation communities in 1994.

A description of the biophysical and floristic characteristics of the each vegetation community is provided in **Appendix A**.

Endangered Ecological Communities

The majority of vegetation within Warriewood Wetland correspond to Endangered Ecological Communities (EECs) listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act). These are listed in **Table 1** along with the corresponding vegetation types. The location of all EECs in Warriewood Wetland is mapped in **Figure 5**.

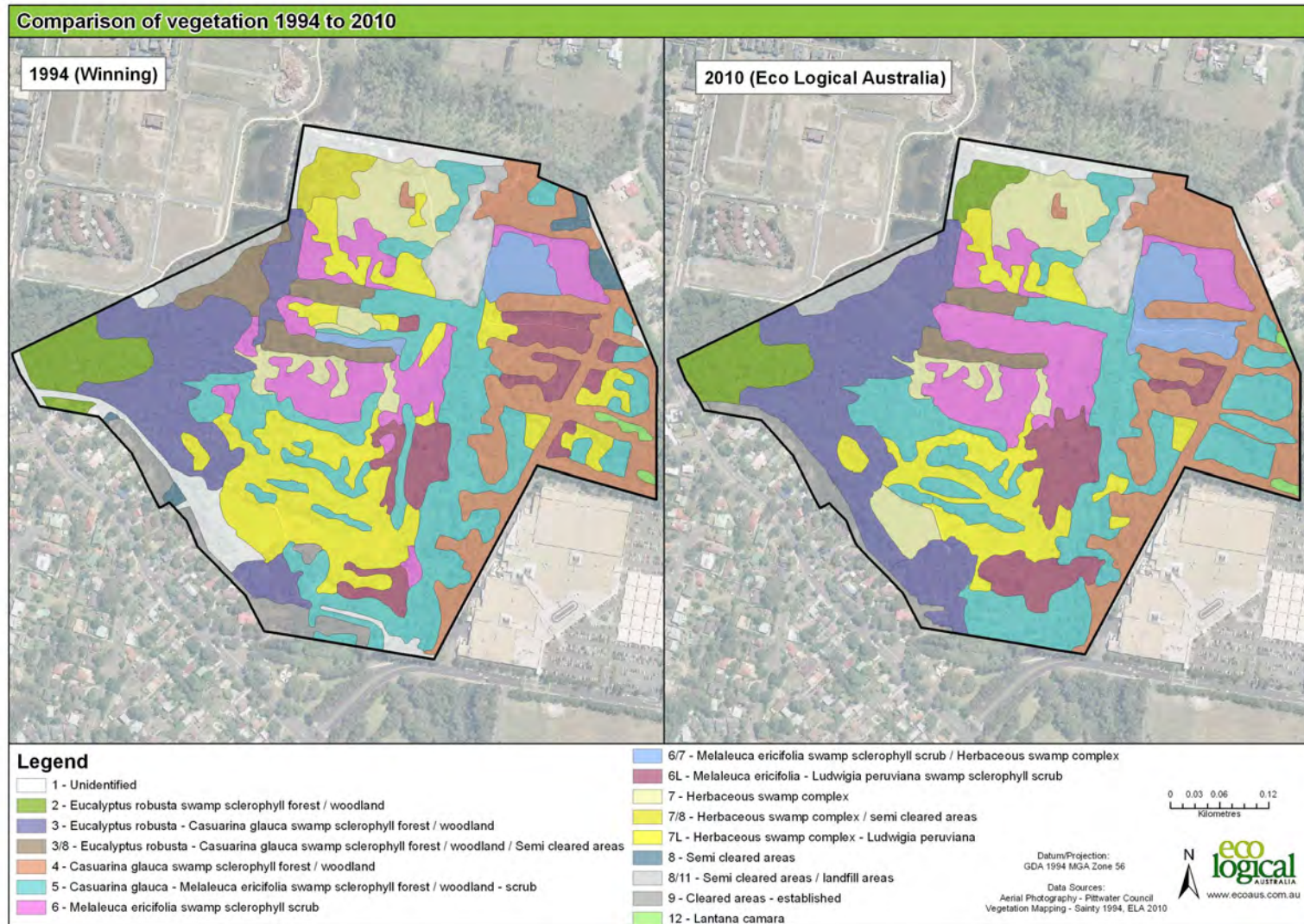


Figure 4: Vegetation communities in 1994 and 2010

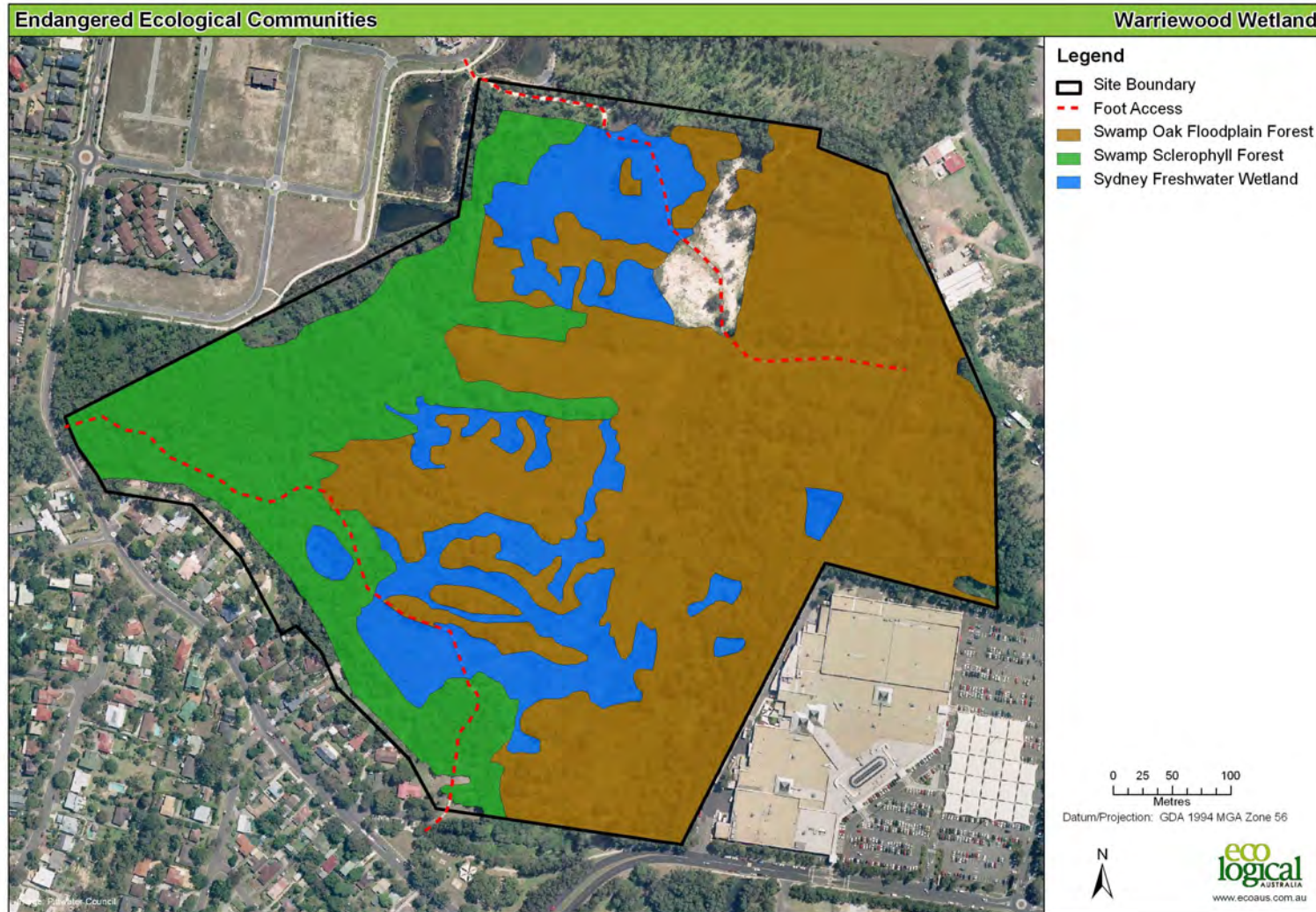


Figure 5: Endangered Ecological Communities (ELA vegetation mapping 2010)

Table 1: Endangered Ecological Communities and corresponding vegetation types

ENDANGERED ECOLOGICAL COMMUNITY	CORRESPONDING VEGETATION TYPES
Swamp Sclerophyll Forest on Coastal Floodplains	<ul style="list-style-type: none"> • <i>Eucalyptus robusta</i> swamp sclerophyll forest/woodland • <i>Eucalyptus robusta</i> – <i>Casuarina glauca</i> swamp sclerophyll forest/woodland
Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions	<ul style="list-style-type: none"> • <i>Casuarina glauca</i> swamp sclerophyll forest/woodland • <i>Casuarina glauca</i> – <i>Melaleuca ericifolia</i> swamp sclerophyll forest/woodland • <i>Melaleuca ericifolia</i> swamp sclerophyll scrub • <i>Melaleuca ericifolia</i> – <i>Ludwigia peruviana</i> swamp sclerophyll scrub
Sydney Freshwater Wetlands in the Sydney Basin bioregion	<ul style="list-style-type: none"> • Herbaceous swamp complex • Herbaceous swamp complex – <i>Ludwigia peruviana</i>

EECs face a very high risk of extinction in NSW in the near future (DECC 2005). Threats to these wetland communities include (DECC 2005a,b,c):

- Activation of acid sulfate soils
- Anthropogenic climate change
- Changes in water quality, particularly increased nutrients and sedimentation
- Continuing fragmentation and degradation
- Dumping of landfill, rubbish and garden refuse
- Flood mitigation and drainage works
- Habitat degradation resulting from altered hydrology/nutrient levels, weed invasion, off-road vehicles, illegal waste dumping and sand extraction
- Habitat loss and fragmentation due to clearing and filling associated with urban development
- Inappropriate fire regimes
- Land clearing
- Land-filling and earthworks associated with urban and industrial development
- Management of water and tidal flows
- Native fauna is threatened by predation, particularly by *Gambusia* and cane toads
- Pollution and eutrophication from urban and agricultural runoff
- Rubbish dumping
- Weed invasion

Strategies required to recover EECs have been identified by DECCW in the Priority Action Statement (2005). Possible actions for the EECs at Warriewood Wetland are listed in **Table 2**. Not all actions may be relevant or feasible at Warriewood Wetland. All management recommendations put forward in this PoM are consistent with the stated recovery actions.

Table 2: Relevant recovery Actions for EECs found at Warriewood Wetland (DECC 2005a,b,c).

RECOVERY ACTION	SWAMP SCLEROPHYLL FOREST	SWAMP OAK FLOODPLAIN FOREST	SYDNEY FRESHWATER WETLANDS
Undertake weed control as required using removal methods that will not damage the community.	✓	✓	✓
Protect and actively manage wetlands through conservation mechanisms such as covenanting and the preparation/implementation of site-specific vegetation management plans.	✓	✓	✓
Improve vegetative connectivity within and between remnants through revegetation / regeneration programs and provide vegetative buffers around these remnants.		✓	✓
Ensure that the fire sensitivity of the community is considered when planning hazard reduction and asset management burning.	✓	✓	
Promote public involvement in restoration activities.		✓	
Install storm water control mechanisms to prevent off-site impacts from adjacent development.			✓
Restore natural drainage conditions.			✓
Control access to remnants by installing fencing and signage and rationalising informal tracks through the community.			✓

Vegetated Buffer

In total, approximately 25% of the wetland's edge has some form of vegetation outside the zoned site boundary that acts as a buffer. The majority of the wetland is directly adjacent to residential areas or the Warriewood Shopping Centre.

The buffering capacity of the small pockets of vegetation adjacent to the wetland is limited. There is a patch of Swamp Mahogany – Swamp Oak Forest in the western corner of the site, which extends along the edge of the adjacent urban development (Figure 8, zones 1 and 3). The vegetation in zone 1 extends into Irrawong Reserve and forms the lower end of the corridor up to the Ingleside Escarpment. The vegetation in Zone 3 presents a buffer to the adjacent development, however this bushland is highly disturbed, contains many weeds and is very narrow in parts. Bush-regeneration is required in order to improve the buffering capacity of this vegetation. There is a currently vegetated buffer along the northern boundary of the site, immediately adjacent to "Buffer Area 3" of the Warriewood Valley Urban Release. This area is currently proposed for development, and there is a concept plan to retain the vegetation immediately adjacent to the wetland.

4.5.2 Threatened and protected flora

No threatened flora species have been recorded at or within the immediate vicinity (i.e. 1 km) of Warriewood Wetland. Ten species of significance within the northern Sydney region and an additional two species identified as being of significance in the Pittwater LGA were identified at Warriewood Wetland (**Appendix B**).

Eucalyptus robusta (Swamp Mahogany) occurs in significant numbers in Warriewood Wetland, as the dominant tree species of the Swamp Sclerophyll Forest EEC. This species is also listed as a Protected Species under the *NSW National Parks and Wildlife Act* and as a major feed tree for Koalas under SEPP 44 (Koala Habitat Protection). This species is also an important winter flowering food source for a number of birds, including listed threatened/migratory species. These factors highlight the importance of protecting Swamp Mahogany trees within Warriewood Wetland and the wider creek system.



Swamp mahogany (*E. robusta*) forest

4.5.3 Weeds

Weed infestations occur throughout Warriewood Wetland and its drainage lines. Weeds that were recorded by ELA on 9-10th February 2010 are listed in **Table 3**. There are seventeen noxious weeds and four weeds of national significance.

Weeds have been a persistent problem at Warriewood Wetland and in the neighbouring Irrawong Reserve (Water Resources Consulting Services 1997). Of particular concern are the aquatic weed species *Salvinia molesta* and *Ludwigia peruviana*, while *Erythrina crista-galli* (Coral Tree) also requires management action. Warriewood Wetland is identified as an area of 'dense infestation' for *Salvinia* in the *Regional Weed Management Plan: Control of Aquatic Weeds in the Sydney West-Blue Mountains and Sydney North Regions* (Sydney Weeds Committee 2006).

Previous Ludwigia control in Warriewood Wetland has been deemed successful. The Sydney-wide *Regional Ludwigia Management Plan (2003-2008)* states that the largest infestation of Ludwigia in northern Sydney occurred in Warriewood Wetland, which were 'highly infested' with this weed. According to this Plan, works undertaken since 1998 have:

... resulted in near eradication in the initial work areas, where previously impenetrable Ludwigia infestations have been replaced by natural regenerating wetland species and open water.

The current condition of the wetland is not consistent with this assessment. During the development of this plan, Ludwigia infestations were observed and mapped throughout the wetland and identified this species as a significant threat to the biodiversity values of the wetland (**Figure 4**). This highlights the critical need for continual management of aquatic weeds (both Ludwigia and Salvinia) to ensure that success of previous works is not compromised by lack of ongoing management.

Garden and aquarium escapees and dumping of green waste are a likely source of weed invasion into Warriewood Wetland. The seriousness of this threat has recently been recognised by the Australian Government. 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants' was listed on the EPBC Act as a key threatening process (KTP) in January 2010 (Commonwealth of Australia 2010). General threat abatement measures for this KTP are provided by DEWHA (Commonwealth of Australia 2010), and specific actions to be undertaken at Warriewood Wetland are detailed in Section 6.

The NSW *Noxious Weeds Act 1993* specifies the duties of landholders, including Councils, for control of noxious weeds.

Table 3: Weed species in Warriewood Wetland

COMMON NAME	SPECIES	STATUS IN PITTWATER LGA	WoNS
African Olive	<i>Olea europaea subsp. cuspidata</i>	Noxious - Class 4	
Arum Lily	<i>Zantedeschia aethiopica</i>		
Balloon Vine	<i>Cardiospermum grandiflorum</i>	Environmental	
Banana	<i>Musa sp.</i>		
Beach Pennywort	<i>Hydrocotyle bonariensis</i>	Environmental	
Black Thistle	<i>Cirsium vulgare</i>		
Blackberry	<i>Rubus fruticosus sp. Agg</i>	Noxious - Class 4	Yes
Blackberry Nightshade	<i>Solanum nigrum</i>		
Black-eyed Susan	<i>Thunbergia alata</i>		
Blue Morning Glory	<i>Ipomoea indica</i>	Noxious - Class 4	
Box Elder	<i>Acer negundo</i>		
Buffalo Grass	<i>Stenotaphrum secundatum</i>		
Camphor-laurel	<i>Cinnamomum camphora</i>	Environmental	
Cape Ivy	<i>Delairea odorata</i>	Environmental	
Cassia	<i>Senna pendula var. glabrata</i>	Environmental	
Castor Oil Plant	<i>Ricinus communis</i>	Noxious - Class 4	
Catsear, False Dandelion	<i>Hypochaeris radicata</i>		
Coast Morning Glory	<i>Ipomoea cairica</i>	Noxious - Class 4	
Cockspur Coral Tree	<i>Erythrina crista-galli</i>	Environmental	
Common Sow-thistle	<i>Sonchus oleraceus</i>		
Coral Tree	<i>Erythrina x sykesii</i>		
Couch	<i>Cynodon dactylon</i>		
Creeping Buttercup	<i>Ranunculus repens</i>		
Crofton Weed	<i>Ageratina adenophora</i>	Environmental	

COMMON NAME	SPECIES	STATUS IN PITTWATER LGA	WoNS
Fennel	<i>Foeniculum vulgare</i>		
Flaxleaf Fleabane	<i>Conyza bonariensis</i>	Environmental	
Formosan Lily	<i>Lilium formosanum</i>	Environmental	
Fruit-salad Plant	<i>Monstera deliciosa</i>		
Green Cestrum	<i>Cestrum parqui</i>	Noxious - Class 3	
Indian Shot	<i>Canna indica</i>		
Inkweed	<i>Phytolacca octandra</i>	Environmental	
Isolepis	<i>Isolepis prolifera</i>		
Ivy	<i>Hedera helix</i>		
Japanese Honeysuckle	<i>Lonicera japonica</i>	Environmental	
Kikuyu	<i>Pennisetum clandestinum</i>		
Lantana	<i>Lantana camara</i>	Noxious - Class 4/5	Yes
Ludwigia	<i>Ludwigia peruviana</i>	Noxious - Class 3	
Madeira Vine	<i>Anredera cordifolia</i>	Noxious - Class 4	
Mallow	<i>Malva sp.</i>		
Mickey Mouse Plant	<i>Ochna serrulata</i>	Noxious - Class 4	
Montbretia	<i>Crococsmia x crocosmiiflora</i>	Environmental	
Moth Vine	<i>Araujia sericifera</i>	Noxious - Class 4	
Narrow-leaved Carpet Grass	<i>Axonopus fissifolius</i>		
New Zealand Cabbage Tree	<i>Cordyline australis</i>		
Noogoora Burr	<i>Xanthium occidentale</i>		
Onion Weed	<i>Nothoscordum borbonicum</i>		
Paddy's Lucerne	<i>Sida rhombifolia</i>		
Pampas Grass	<i>Cortaderia selloana</i>	Noxious - Class 3	
Panic Veldgrass	<i>Ehrharta erecta</i>	Environmental	
Papyrus	<i>Cyperus papyrus</i>		
Parrot's Feather	<i>Myriophyllum aquaticum</i>		
Pimpernel	<i>Anagallis arvensis</i>		
Popcorn Senna	<i>Senna didymobotrya</i>		
Poplar	<i>Populus sp.</i>		
Purpletop	<i>Verbena bonariensis</i>		
Rose	<i>Rosa sp.</i>		
Salvinia	<i>Salvinia molesta</i>	Noxious - Class 2	Yes
Slender Pigeon Grass	<i>Setaria gracilis</i>		
Small-Leaved Privet	<i>Ligustrum sinense</i>	Noxious - Class 4	
Spider Plant	<i>Chlorophytum comosum</i>		
Spiny Rush	<i>Juncus acutus</i>		
Stinking Roger	<i>Tagetes minuta</i>		
Tall Fleabane	<i>Conyza sumatrensis</i>	Environmental	
Taro	<i>Colocasia esculenta</i>		
Thickhead	<i>Crassocephalum crepidioides</i>		
Turkey Rhubarb	<i>Acetosa sagittata</i>	Noxious - Class 4	
Vasey Grass	<i>Paspalum urvillei</i>		
Wall Pellitory	<i>Parietaria judaica</i>	Noxious - Class 4	
Wandering Jew	<i>Tradescantia fluminensis</i>	Environmental	
Water-plantain	<i>Alisma plantago-aquatica</i>		
Wild Tobacco	<i>Solanum mauritianum</i>		
Willow	<i>Salix sp.</i>	Noxious - Class 5	Yes
Yellow Ginger	<i>Hedychium gardnerianum</i>	Environmental	

Noxious Weed Class Requirements: 3 - The plant must be fully and continuously suppressed and destroyed

4- The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed

5 - The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with

4.6 LOCAL FAUNA

Warriewood Wetland supports a large number of native animals including birds, mammals (including bats) and aquatic species. The biodiversity corridor from the Ingleside Escarpment to Warriewood Wetland provides habitat for 207 terrestrial species (recorded during the last decade), including: 166 birds, 20 mammals, 15 reptile and 5 frogs (DECC 2008). The wetland areas provide essential habitat for a large number of these species, including several that are listed under state and federal environmental legislation (see below).

The northern beaches from Manly to Palm Beach are one of the last strongholds for bandicoots in the Sydney region. Significant populations of Long-nosed Bandicoots (*Perameles nasuta*) still exist in the Pittwater area, and are often sighted at Warriewood Wetland. On-going threats to this species includes habitat removal and fragmentation (particularly from development), predation by domestic pets and feral animals and road casualties (Pittwater Council 2010c).

The native fish community within Warriewood wetland has not been extensively surveyed. The presence of Striped Gudgeon was recorded in the wetland by Winning (1989, 1995, quoted in Water Resources Consulting Services 1997). In recent investigations for the development of this PoM, only the highly invasive *Gambusia holbrooki* was observed in the wetland. Sea mullet and eels are known from Mullet Creek below the Jackson Rd weir.

A complete list of fauna observed in the vicinity of Warriewood Wetland is provided in **Appendix C**. It is based on NSW Wildlife Atlas data records, species observed during field investigation for the development of this plan and fauna lists in the previous Plan of Management (Water Resources Consulting Services 1997).

4.6.1 Threatened and migratory fauna

Several threatened and migratory fauna species listed under state and Commonwealth legislation have been recorded within Warriewood Wetland. Additionally, a search of the NSW Wildlife Atlas in January 2010 found records of six fauna species listed as threatened on the *NSW Threatened Species Conservation Act* within 1 km of Warriewood Wetland. These species are listed in Table 4 below.

Threats to these species include (but are not limited to):

- Loss, fragmentation and removal of habitat, including hollow-bearing and feed or nesting trees
- Competition and predation from introduced species e.g. foxes, dogs, cats
- Disturbance to roosting and nesting sites
- Inappropriate fire regimes impacting habitat and prey availability
- Road kill

Actions required to recover these species include (but are not limited to):

- Maintain, enhance and protect existing habitat
- Identify and protect key feeding, roosting and nesting sites/trees
- Maintain and enhance wildlife corridors
- Minimise disturbance to nesting and roosting sites
- Control introduced species e.g. foxes, dogs, cats
- Employ appropriate fire management regimes

Table 4: Threatened and migratory flora known to occur within or close to Warriewood Wetland

COMMON NAME	SCIENTIFIC NAME	TSC ACT STATUS	EPBC ACT STATUS
Regent Honeyeater	<i>Xanthomyza phrygia</i>	endangered	endangered
Swift Parrot	<i>Lathamus discolor</i>	endangered	endangered
Spotted-tailed Quoll	<i>Dasyurus maculatus</i>	vulnerable	endangered
Grey-headed Flying Fox	<i>Pteropus poliocephalus</i>	vulnerable	vulnerable
Osprey	<i>Pandion haliaetus</i>	vulnerable	migratory
Barking Owl	<i>Ninox connivens</i>	vulnerable	
Black Bittern	<i>Ixobrychus flavicollis</i>	vulnerable	
Eastern Bentwing Bat	<i>Miniopterus schreibersii oceanensis</i>	vulnerable	
Large-footed Myotis	<i>Myotis macropus</i>	vulnerable	
Powerful Owl	<i>Ninox strenua</i>	vulnerable	
Koala	<i>Phascolarctos cinereus</i>	vulnerable species and an endangered population in Pittwater LGA	
Black-faced Monarch	<i>Monarcha melanopsis</i>	-	migratory
Clamorous Reed Warbler	<i>Acrocephalus stentoreus</i>	-	migratory
Japanese/Latham's Snipe	<i>Gallinago hardwickii</i>	-	migratory
Rufous Fantail	<i>Rhipidura rufifrons</i>	-	migratory
White Egret	<i>Ardea alba</i>	-	migratory
White-throated Needletail	<i>Hirundapus caudacutus</i>	-	migratory

4.6.2 Pest species

Introduced fauna species observed in the study area are listed in **Table 5**.

Table 5: Introduced fauna

SCIENTIFIC NAME	COMMON NAME
<i>Acridotheres tristis</i>	Indian Myna
<i>Anas platyrhynchos</i>	Mallard Duck
<i>Canis familiaris</i>	Dog
<i>Carduelis carduelis</i>	European Goldfinch
<i>Columba livia</i>	Feral Pigeon
<i>Felis catus</i>	Cat
<i>Gambusia holbrooki</i>	Plague Minnow, Mosquito Fish
<i>Mus domesticus</i>	Mouse
<i>Oryctolagus cuniculus</i>	Rabbit
<i>Passer domesticus</i>	House Sparrow
<i>Rattus rattus</i>	Black Rat
<i>Streptopelia chinensis</i>	Spotted Turtle dove
<i>Sternus vulgaris</i>	Common Starling
<i>Vulpes vulpes</i>	Fox

Feral animals are considered to present a threat to native flora and fauna. Foxes have been observed within 1 km of Warriewood Wetland and rabbits are known to occur both in the capped area, dry areas around Katoa Close and around the wetland edges. Rabbits are also present in adjacent private properties within the Shearwater Estate. Control of these animals has been trialled; however, there

have been some difficulties with native species such as bandicoots taking/investigating baits. At the time of plan preparation, rabbits are baited using carrot baits in Katoa Close only.

Domestic dogs and cats that escape from yards or dogs that walk unleashed in the wetland area are also a threat to native fauna.

Warriewood Wetland is currently inhabited by the pest fish species *Gambusia holbrooki* (Plague Minnow, Mosquito Fish). The negative impact of this species on natives, particularly fish and frogs, has led to the NSW Scientific Committee identifying 'Predation by the Plague Minnow (*Gambusia holbrooki*)' as a key threatening process under the TSC Act and a corresponding threat abatement plan has been developed by DECCW (NPWS 2003). The level of infestation and threat to native species from *Gambusia* in Warriewood Wetland is currently unquantified.

4.6.3 Fish Passage

Fish passage is currently blocked between Warriewood Wetland and downstream areas of Narrabeen Lagoon by the fixed crest weir downstream of Jackson Rd. While the weir blocks fish passage, its removal is likely to endanger the wetlands, which are currently a fully freshwater system with permanent water bodies. NSW DPI's investigation into fish passage in urban catchments suggested that an alternative to weir removal would be to install a fishway. This would be a significant undertaking and further investigation of the potential remediation options was recommended (Nichols & McGirr 2005).

4.7 HABITAT AND CONNECTIVITY

As discussed above, Warriewood Wetland is part of a significant habitat corridor that takes in the Ingleside Escarpment, Irrawong Reserve and the wetlands. This corridor has been identified as having some of the highest fauna values in the Sydney Metropolitan CMA (DECC 2008). Pittwater Council has mapped key habitat corridors throughout the LGA and Warriewood Wetland has been identified as a major habitat area.

The wetland contains a number of habitat elements that are utilised by a variety of animals, including threatened and migratory species. Drier wetlands areas e.g. Swamp Mahogany and Swamp Oak Forests contain fallen timber, dead and hollow-bearing trees. In particular, the Swamp Mahogany (*Eucalyptus robusta*) forest is a vegetation community which is considered as a regionally significant seasonal feeding ground for birds, bat and possibly arboreal animals (Water Resources Consulting Services 1997).

Areas of the wetland that contain water include creeks with instream vegetation and snags and areas of open water are currently inhabited by several water bird species including ducks and moorhens. Further, the creeks and drainage lines entering the wetland are also important as access points for some species of birds, bats, frogs, reptiles and small mammals.

4.8 INFRASTRUCTURE

4.8.1 Stormwater

There is an extensive stormwater drainage network associated with developed areas surrounding Warriewood Wetland. Within the wetlands, stormwater infrastructure is restricted to pipes running through Mullet Creek.

Stormwater detention and water quality improvement ponds have been built adjacent to the northern boundary of the wetland as controls for the Warriewood Valley Urban Development. These basins provide habitat for aquatic and bird species (open water and fringing aquatic vegetation), as well as fulfilling a water quality and sediment trapping role.

4.8.2 Sewer overflows and GPTs

Elevated faecal coliform levels have been recorded in the wetland and creeks of Warriewood Valley during wet weather events. This is attributed to the presence of septic systems within the catchment and potential sewer overflows (Cardno Lawson Treloar 2009).

Gross pollutant traps (GPTs) are located primarily along the piped stormwater system in urban areas adjacent to Warriewood Wetland. One GPT is located on Fern Creek where it enters the wetland and there are two GPTs in Mullet Creek downstream of the wetland. Overall, these devices appear to be working well in preventing gross pollutants entering the wetland. Minimal litter was observed in the wetlands in February 2010, when field surveys were undertaken after a period of heavy rain.

4.8.3 Recreation

Recreational activities in Warriewood Wetland include walking/running, dog walking (although these are prohibited in the wetlands), cycling, and bird watching. These activities are restricted to the boardwalk and walking trails throughout the wetland, and the trails from a well-used connection from surrounding residential areas to the Warriewood Shopping Centre. There is no access to the middle of the wetland, including most of the open water sections.

4.8.4 Encroachments

The south-western side of the wetland is directly adjacent to residential housing, and encroachments and waste dumping are problematic. Landscaping waste (e.g. grass clippings) were observed in the wetland areas directly adjacent to the Warriewood Shopping Centre. There is significant dumping of hard rubbish from the property on the north-eastern side of the wetland (**Figure 6**).

4.9 VISUAL AND LANDSCAPE CHARACTER

Landscapes within the study area include:

- Residential – predominantly single dwellings with established gardens
- Bushland – native vegetation
- Wetland area – reeds, small areas of open water, water birds

Views across the wetland are available from the boardwalk. An example is provided below.



Views of wetland from boardwalk

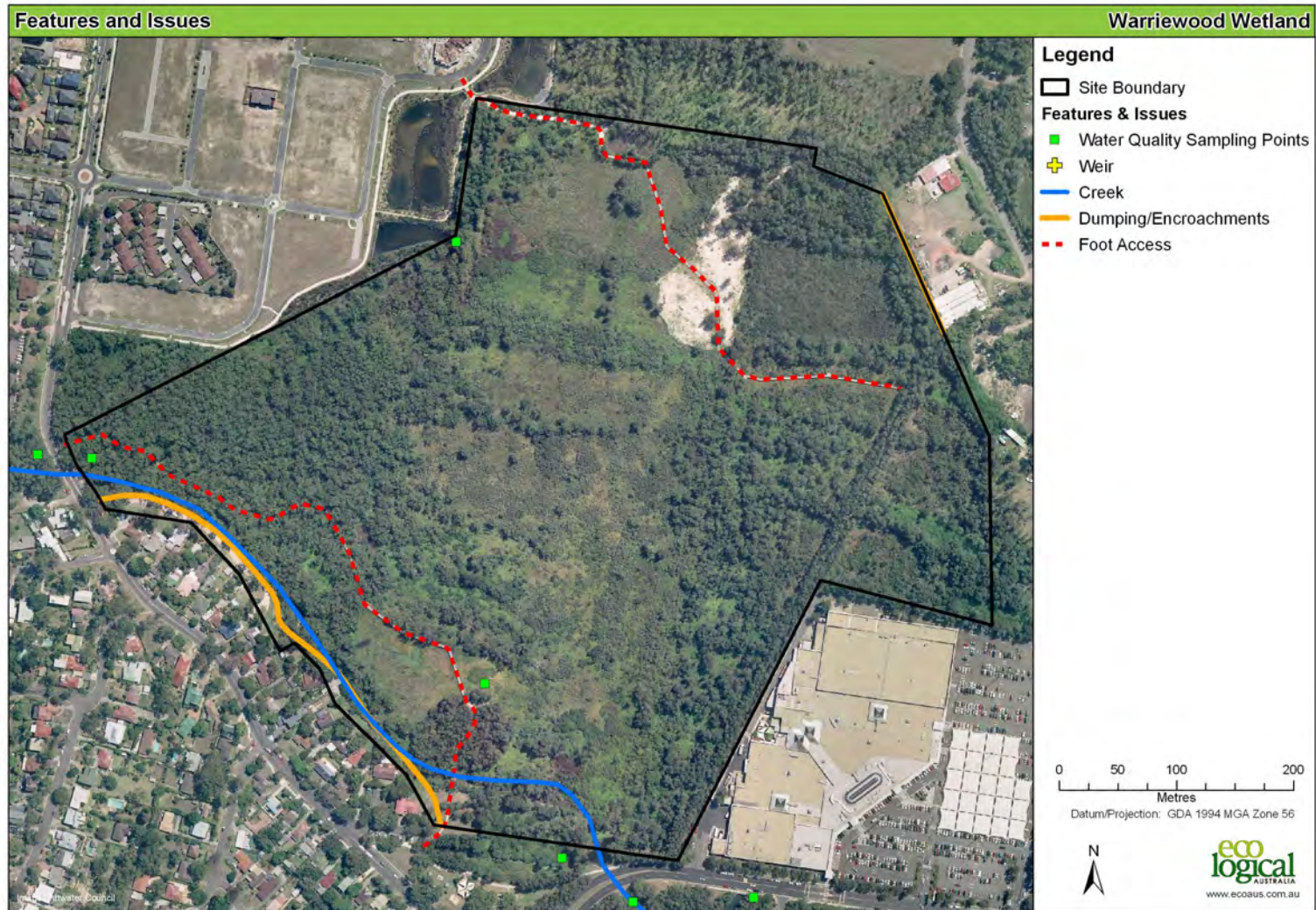


Figure 6: Features of the study area



Dumped rubbish from adjoining properties



Encroachment from adjoining properties

5 Management issues

The following table summarises the main issues relevant to management of Warriewood Wetland. The issues have been grouped according to the management themes identified in the *Pittwater Natural Areas Draft Plan of Management* (Part 1). Objectives and actions relating to each of the issues below are presented in Section 6 (see cross reference to specific actions in far right column).

Table 6: Management issues for Warriewood Wetland (grouped by themes identified in Pittwater Natural Areas Draft Plan of Management Part 1, 2009)

MANAGEMENT THEME	ISSUE	ACTIONS – CROSS REFERENCE TO TABLES 7-11
5.1 Sustainability	<p>Climate change and sea level rise (SLR): risk to wetland from climate change and sea level rise unknown. Council's commitment to management is critical to success of programs.</p> <p>Water Sensitive Urban Design for infill developments and implementation of Warriewood Valley Water Management Specification for Warriewood Valley Urban Land Release.</p> <p>Endangered Ecological Communities (EECs): management to ensure long-term viability of these vegetation communities and their associated fauna.</p>	1, 5, 7, 12
5.2 Research, Education and Community Training and Participation	<p>Engage community to encourage best practise management of properties adjoining wetland, including landscaping with appropriate native species.</p> <p>Encourage community participation through Council coordinated activities e.g. Bushcare, tours and talks, monitoring activities.</p> <p>Promote awareness of biodiversity through interpretive signage and provision of educational information.</p>	2, 18 – 23
5.3 Encroachments	<p>Encroachments along urban interface e.g. children's play equipment, driveways.</p> <p>Dumping of "hard rubbish" and green waste e.g. lawn clippings.</p> <p>Stormwater and urban runoff bringing litter into creek and wetland areas.</p>	6, 11, 12, 18

MANAGEMENT THEME	ISSUE	ACTIONS – CROSS REFERENCE TO TABLES 7-11
5.4 View Conservation and Management	Visual amenity is reduced by weeds and poor water quality. Views of wetland throughout from boardwalks.	1, 14 – 16
5.7 Water Catchment 5.7.1 Stormwater and Surface Runoff	Water quality issues associated with elevated nutrient levels. Potential for increased urban runoff (including pollution and sediment) from surrounding urban development.	3, 9, 11 – 13
5.7.2 Soil Erosion and Sedimentation	Potential erosion associated with surrounding urban development. Evidence of sediment build-up in wetland, particularly within northern areas (immediately west of old fill site). This appears to be impacting vegetation communities. Unknown sediment condition e.g. source of landfill, acid sulphate soils posed potential risk during works.	11 – 13
5.7.3 Flooding	Wetland and surrounding area at high risk of flooding. Wetland acts as significant stormwater reservoir and play important flood mitigation role. Upstream works (e.g. weed removal, channel improvements, vegetation planting) must not decrease hydraulic roughness as this will increase flood risk. Flooding can occur from catchment rainfall or from backing up of high water levels in Narrabeen Lagoon. Backwater flooding may cause saltwater intrusion	11 – 13
5.8 Geotechnical Risk Management	Unknown sediment condition e.g. source of landfill, acid sulphate soils. High risk of acid sulphate soils (entire wetland mapped as Class 2)	12
5.9 Biodiversity	Biodiversity is currently at risk from weed invasion and introduced species. Identified as a major habitat area and part of the Ingleside-Warriewood Habitat Corridor.	1, 10
5.9.1 Plant Communities	Three Endangered Ecological Communities covering ~90% of the study area. Significant weed invasion e.g. <i>Ludwigia</i> , <i>Salvinia</i> and <i>Erythrina crista-galli</i> (Cockspur Coral Tree) Age structure in Swamp Sclerophyll Forest skewed towards adult plants with little recruitment. Apparent decline in area of Swamp Sclerophyll Forest. Potential change in dominant native freshwater wetland species leading to overall reduction in diversity and	1

MANAGEMENT THEME	ISSUE	ACTIONS – CROSS REFERENCE TO TABLES 7-11
	change in habitat structure.	
5.9.2 Bushland Restoration	Current restoration (Bushcare) works in Swamp Sclerophyll Forest community in south west of study area. Significant opportunities for restoration including establishing Bushcare groups. On-going upstream creek rehabilitation associated with surrounding urban development.	1, 18 – 23
5.9.3 Weed Management	Weed invasion is serious threat to biodiversity values and extensive management required. Aquatic weeds include <i>Ludwigia peruviana</i> , <i>Salvinia molesta</i> . Control of Ludwigia requires persistent and on-going commitment. Terrestrial weeds include <i>Lantana</i> sp. and <i>Erythrina crista-galli</i> (Cockspur Coral Tree) Very limited access to majority of wetland for weed control (i.e. wet areas away from boardwalk). Weed inputs from garden escapes and dumping, washed down from upstream.	1
5.9.4 Local Fauna	Threatened and migratory species recorded on site. Significant bird diversity. Lack of open water for water birds. Site forms habitat corridor up to Ingleside Escarpment. Fish passage is blocked by weir downstream of Jackson Rd.	1, 4, 7, 10
5.9.5 Introduced Animals	Introduced animals (e.g. rabbits, foxes, Gambusia) present threat to native species. Rabbit control currently occurs at Katoa Close. Illegal dog walking (including off-leash) in wetland.	8
5.10 Fire Management	Fire management for biodiversity and asset management may be required. Recommended fire interval for forested wetlands (i.e. Swamp Oak Floodplain Forest and Swamp Sclerophyll Forest) is 10-35 years and no fire is recommended in Sydney Freshwater Wetlands. The Asset Protection Zone (APZ) for forested wetlands on gently sloping land is 15m.	1

MANAGEMENT THEME	ISSUE	ACTIONS – CROSS REFERENCE TO TABLES 7-11
5.11 Recreational Uses	Main recreational uses are walking and bird watching. Bike riding and dog walking are prohibited in wetland but occur regularly.	14 – 17
5.13 Walking Tracks, Vehicle Access and Parking	Boardwalks are very well used and provide off-street connection from residential areas to Warriewood Shopping Centre. Access to boardwalks from new development areas is limited. On and off-street parking options. Dumping rubbish off boardwalk (e.g. shopping trolleys).	14 – 18
5.15.Risk Management and Public Safety	Potential risks from encroachments and illegal structures. Risk from inappropriate use of boardwalk (e.g. too narrow for bike riding) Risk from damage to boardwalk. Potential risks from chemical weed/pest management to people and domestic animals. Need to ensure capping of old fill site is maintained.	1, 16

6 Objectives and actions

6.1 KEY DIRECTIONS OF COUNCIL

This Plan of Management has been developed to be consistent with the management directions of Pittwater Council's Strategic Plan.

A key direction for Pittwater Council is valuing and caring for the natural environment. This involves the need to be a model community that leads the way towards sustainable living by reducing ecological footprints, protecting and enhancing the bush, beaches and waterways as well as achieving long-term sustainability of biodiversity. The key strategies include:

- Supporting viable and thriving biodiversity and sustainable ecosystems.
- Sustainably managing our areas of urban forest, bushland and waterways.
- Providing a diverse range of accessible recreational opportunities for a broad range of ages, abilities and interests inspired by bush, beach and water.

6.2 ACTIONS

In recognition of the degraded state of Warriewood Wetland and its upper catchment, this Plan of Management proposes that rehabilitation be implemented progressively over the next ten years. Actions to address the above key directions are presented in **Table 7 to Table 11** according to the following management themes:

- Biodiversity
- Water
- Recreation
- Community Learning
- Financial Management

Each action is prioritised and has performance measures and responsibilities allocated, which are discussed below. All location-specific actions are marked on Figure 7.

6.3 PRIORITIES

Priorities have been allocated as follows:

- High priority – to be completed within two years
- Medium priority – to be completed within the next five years
- Low priority – to be completed

It is easier and more effective to prevent degradation than to restore ecosystems that become degraded. Therefore highest priority is given to maintaining or improving areas that are in the best ecological condition.



Figure 7: Location-specific management actions (numbers correspond to management actions in Tables 7-11)

6.4 BIODIVERSITY MANAGEMENT ACTIONS

Note that all actions marked with # have specific recommendations and/or additional information following this table. Location specific actions are marked on Figure 7.

Table 7: Biodiversity management actions for Warriewood Wetland

NO.	ACTION	PRIORITY	PERFORMANCE MEASURES RESPONSIBILITY
BIODIVERSITY: On-ground works			
1#	Implement vegetation management program (see detailed information below). Ensure on-going commitment to follow up works before major control programs are commenced.	High	Improved condition of vegetation and habitat.
2	Plant indigenous native vegetation in areas surrounding wetland. Focus on plantings in near-by housing developments' open space/residential areas and existing residences adjacent to wetland (Warriewood Landscape Masterplan requires residents to plant native species if within 50 m of wetland).	Medium	Increase proportion of native vegetation.
3	Consider need to remove any substantial build-up of dead weed biomass from wetland to ensure nutrient build-up is minimised. Ensure disposal is appropriate and that weed collection does not negatively impact wetland.	Low	Excess weed biomass removed appropriately if necessary.
4	Create and maintain areas of open water in wetland as water bird habitat and to reduce weed infestation impacts on water quality (esp dissolved oxygen).	Low	Open water areas.
BIODIVERSITY: Monitoring and review			
5	Monitor wetlands for changes associated with climate change e.g. shift in species distribution, arrival of new species. Determine timeframes and thresholds for climate change mitigation actions.	High	Management actions developed if necessary.
6	Improve enforcement of green waste and hard rubbish dumping in wetland areas.	High	Illegal dumping of waste reduced.

NO.	ACTION	PRIORITY	PERFORMANCE MEASURES RESPONSIBILITY
7	Continue fauna monitoring programs and expand to include community involvement (see also community engagement below). Key focus on bird species (especially threatened and migratory species) and other regionally significant species.	Medium	As above
8	Monitor pest animal populations and control where necessary. Investigate Gambusia control options and their feasibility.	Medium	Reduced pest numbers. Gambusia control as required.
BIODIVERSITY: Catchment-wide actions			
9	Control weeds in upper catchment.	High	Reduced inputs of weeds from upstream.
10	Maintain links to Irrawong Reserve and Ingleside Escarpment through best practise vegetation management, in order to protect biodiversity corridor values.	High	Habitat linkage maintained.
11	Give further consideration to options for restoring fish passage by undertaking a cost-benefit study for remediating fish passage at all barriers. This would include determining the quality and extent of fish habitat upstream of the barriers, and the benefits of establishing a healthy native fish community in the wetland which may help to control Gambusia and mosquito populations in the wetland. NSW I&I (Fisheries) should be engaged in this process.	Medium	Decision made regarding actions to restore fish passage.

6.5 VEGETATION MANAGEMENT

Vegetation management zones have been identified for Warriewood Wetland (**Figure 8**). Information regarding the management of each zone is provided below and information regarding control methods of weed species found in the wetlands is provided in **Appendix D**. Zones with previous successful vegetation management works and high resilience should be prioritised. There are also a number of wetland-wide priorities for vegetation management. These include:

- Extend *Ludwigia* control to include new and more inaccessible major infestations in the following areas to protect more intact, high conservation vegetation:
 - Southern quarter of zone 6
 - Western half of zone 9
 - Northern section of zone 11
 - Establish permanent but discreet access points to assist with *Ludwigia* control and monitoring in the above zones from the following locations (see also **Figure 9**)
- Establish permanent but discreet access points to assist with *Ludwigia* control and monitoring in the above zones from the following locations:
 - Windrow (zone 4) in the west
 - Sandstone capped area (zone 7) in the east
 - Elevated Swamp Oak stands in zone 9
- Continue the use of amphibious vehicles for weed control and investigate improved access options. Do not use amphibious vehicles in more intact native vegetation areas e.g. zone 9
- Expand current trial of *Salvinia* weevil (*Cyrtobagous salviniae*) throughout appropriate locations (open, sunny, less dense *Salvinia* infestations) in the wetland. Continue liaising with experts at NSW Industry and Investment regarding this treatment. Note that biological control will be ineffective by itself and must be used as part of an integrated control process.
- Target *Erythrina crista-galli* (Cockspur Coral) Tree infestations in zone 2 and elsewhere in the wetland
- Maintain the work already achieved with existing *Ludwigia* control sites
- Ensure the areas worked as a part of the bush-regeneration program in zones 1 and 12 do not become weed infested.
- Retain stands of *Lantana* in the short-term as fauna habitat, and barriers to access and other weeds.

Zone 1: Swamp Mahogany Forest

Objective: Maintain and extend current bush regeneration program to include the small block in the north-western corner of the wetlands.

Description: This is probably the best example of *Eucalyptus robusta* (Swamp Mahogany) forest remaining in northern Sydney. The most serious weeds in this zone are *Ipomoea indica* (Morning Glory) and *Erythrina crista-galli* (Cockspur Coral Tree) which require constant management. In comparison with most of the other wetland areas this zone has reasonable access for weed control, particularly during prolonged dry periods.

Resilience: High. The zone has been under a program of bush-regeneration for a number of years.

Strategy:

- Target weedy vines and Cockspur Coral Trees

- Extend weed control towards weedy wet edges of zone 2
- Staged removal of lantana, particularly near boardwalk, Mullet Creek and urban edges to minimise disturbance to fauna habitat
- Link bush regeneration program with restoration work in Irrawong Reserve
- Consider pile burns to stimulate natural regeneration

Zone 2: Swamp Mahogany and Swamp Oak Forest

Objective: Control Cockspur Coral Trees and Ludwigia throughout the zone. Enhance and maintain a protective buffer to zone 5.

Description: The canopy is intact, but much of understorey, especially in wet areas is weedy. In the wetter areas there are scattered *Ludwigia peruviana* (Ludwigia) outbreaks and many Cockspur Coral Tree seedlings including some very large individuals. As with all other zones, *Salvinia molesta* (Salvinia) is distributed throughout all wet areas as scattered clumps under the canopy.

Resilience: Moderate

Strategy:

- Target Cockspur Coral Tree and Ludwigia outbreaks as a high priority initially focusing on the boundary with zone 5
- Gradually extend bush regeneration program from zone 1 into this zone – this should occur over a period of many years due to the wet conditions and degree of weed invasion
- Consider pile burns in Swamp Mahogany areas during dry periods to stimulate regeneration

Management Issues: Due to wet swampy conditions access to this area is difficult to manage. Permanent but discreet access for weed control and monitoring should be established from the windrow (zone 4). Floating planks (see above) are an option. Dry weather periods should be exploited.

Zone 3: Edges of new urban development areas to the north-west

Objective: Control weeds in landscaped areas and other edge effects while maintaining a physical vegetated buffer

Description: Combination of fill batter and disturbed bushland impacted by edge effects. There are a range of weeds invading landscaped areas due to reduced maintenance. Bush-regeneration works on the slope extending eastwards from the Garden St/Water Gum Dr intersection are being overtaken by weed regrowth.

Resilience: Nil on landscaped areas and fill batter to moderate in bushland extending off Water Gum Dr.

Strategy:

- Eradicate weeds from landscaped edges
- Revegetate gaps with plants propagated from local stock, monitor invasive potential of existing *Melaleuca quinquinervia* (Broadleaved Paperbark) plantings. Ensure no more of this species is planted
- Eradicate *Juncus acutus* (only one individual observed) from water quality pond areas as a high priority
- Ensure an effective maintenance program on landscaped areas is implemented
- Extend bush regeneration program in zone 1 to include the slope

Zone 4: Elevated east-west windrow

Objective: Eradicate weeds and develop as informal access to monitor and control weeds into wetland core (zone 5).

Description: Windrow created in early 1960s which has been colonised by Swamp Mahogany and *Casuarina glauca* (Swamp Oak) with an understorey of Lantana, *Imperata cylindrica* (Blady Grass) and *Pteridium esculentum* (Bracken). Traversing the windrow is relatively easy as it is elevated and dry and it affords reasonable views to core areas of wetland. There appears to be a *Ludwigia* infestation on the southern face of the windrow which is threatening zone 5.

Resilience: Moderate

Strategy: Control weeds including possible *Ludwigia* outbreak on southern face.

Management Issues: Difficult to access this zone as zone 2 has to be traversed to reach this area.

Zone 5: Wetland core: Paperbark Swamp Scrub

Objective: Protect relatively intact condition of the zone. Regularly monitor for and control outbreaks of *Ludwigia* and open areas of *Salvinia*.

Description: Dense growth of *Melaleuca ericifolia* (Heath-leaved Paperbark) with *Casuarina glauca* (Swamp Oak) in higher areas. Understorey includes a mixture of *Phragmites australis* (Common Reed), Swamp Millet (*Isachne globosa*), sedges and aquatic herbs such as *Persicaria strigosa* (Bristly Knotweed) and *Ludwigia peploides* subsp. *montevidensis* (Water Primrose, native). It is likely that *Salvinia*, and *Myriophyllum aquaticum* (Parrot's Feather) are present in ponded water areas – although this was not confirmed in the field investigation (2010).

Resilience: Moderate to High

Strategy:

- Monitor for outbreaks of *Ludwigia* and open areas of *Salvinia* using windrow access, dry weather periods, observations from local residents and high resolution aerial photography (if appropriate).
- Control outbreaks of *Ludwigia* and open areas of *Salvinia* using herbicide and weevils if appropriate.

Management Issues: Access to this zone to undertake weed control is extremely difficult and may only be feasible during prolonged dry weather periods. The vegetation in this zone has very high conservation significance and comprises the most intact area of the wetland, accordingly its protection is of high priority.

Zone 6: Northern Phragmites/Swamp Millet Marshland

Objective: Enhance and maintain a protective buffer to zones 5 and 7 through major *Ludwigia* control in the southern section.

Description: The vegetation surrounding the boardwalk and in approximately three-quarters of this zone is a mixture of Common Reed (*Phragmites australis*) and *Isachne globosa* (Swamp Millet) with some *Typha orientalis* (Broad-leaf Cumbungi) patches. Coastal Morning-glory (*Ipomoea cairica*) has invaded the canopy of a stand of Swamp Oak and Heath-leaved Paperbark on elevated land south of the boardwalk. Beyond the stand, an extensive infestation of *Ludwigia* dominates the entire southern quarter of

the zone and appears to be intruding into the understorey of a strip of Heath-leaved Paperbark growing on an elevated windrow on the boundary of zone 5.

Resilience: Nil - Low as this zone is in the process of transformation from a diverse plant assemblage to domination by a few species.

Strategy:

- Commence sustained control program of the extensive *Ludwigia* infestation with herbicide spraying. Continue spot spraying of *Ludwigia* patches throughout the remainder of the zone.
- Control Coastal Morning-glory and other weeds on elevated stands of terrestrial vegetation.
- Undertake *Salvinia* and Cockspur Coral Tree control as required (see **Appendix D** for control techniques).
- Permanent but discreet access for weed control and monitoring should be established from the windrow (zone 4) in the west and the sandstone capped area (zone 7) in the east.

Management Issues:

- High water levels and dense floating mats of vegetation make access to this zone for weed control extremely problematic and potentially hazardous.
- Previous vegetation mapping (1994 Plan of Management) shows larger areas of *Isachne globosa* (Swamp Millet) and *Persicaria strigosa* (Bristly Knotweed) wet grassland in this zone. This zone appears to be undergoing a gradual conversion to a less diverse species assemblage dominated by Common Reed (*Phragmites australis*) and *Typha orientalis* (Broad-leaf Cumbungi) and *Ludwigia* most likely due to hydrological changes (e.g. sedimentation) within in catchment. Inflows should be investigated including:
 - Overflows from the subdivision (at the end of Shearwater Drive) currently enter the wetland in the area of extensive infestation of *Ludwigia*.
 - The drainage line with heavy weed infestation (including *Ludwigia*) flowing through a poplar plantation on 12 Macpherson Rd.
 - General overland flow from properties at 10 – 6 Macpherson Rd.

Zone 7: Older landfill and recent sandstone capped areas

Objective: Ongoing weed control and ensure no soil disturbance.

Description: The re-vegetation of the sandstone capped area is progressing well. The old landfill area comprises a mixture of weedy grasses and seeding poplars. Native vegetation is predominantly Swamp Oak forest.

Strategy: Continue weed control and replacement planting on the sandstone capped area, control weedy grasses and seeding poplars on old landfill area. No soil disturbance is permitted in this area.

Zone 8: North-east Paperbark Scrub and Swamp Oak Forest

Objective: Protect the relatively intact Paperbark scrub and undertake bush regeneration in the Swamp forest. Note this may commence after residential development of adjacent Boondah Rd.

Description: The Paperbark Scrub has very high conservation significance and along with zone 5 is one of the most intact areas of the wetland. *Salvinia* is present in all wet areas as scattered clumps under the canopy. Patches of *Ludwigia* probably also occur in the Paperbark scrub. The wetter edges of the Swamp Oak forest are in relatively good condition with a diverse understorey. Where the Swamp Oak forest occurs on drier sites adjacent to old landfill, there is a weedy understorey including poplar

seedlings with a low diversity of native species. Encroaching at the rear of 14 Boondah St. is a high and unstable landfill batter comprising of large concrete blocks, dumped machinery and a variety of demolition rubbish. A Lantana thicket covers much of the batter.

Resilience: Low in some of the drier swamp Oak sites and nil on the landfill batter behind 14 Boondah Rd. Moderate to High elsewhere.

Strategy:

- Monitor for outbreaks of Ludwigia and open areas of Salvinia in the difficult to access wet Melaleuca scrub during dry weather periods and using high resolution aerial photography.
- Manual removal of Salvinia within accessible native vegetation areas and in the wet Paperbark Scrub during dry weather periods.
- Control outbreaks of Ludwigia and open areas of Salvinia using herbicide and weevil if appropriate.
- Control other weeds on dry Swamp Oak Forest areas as necessary, retain lantana as a barrier on landfill batter at the rear of 14 Boondah St.
- Encroachments should be investigated and remedial action undertaken.

Management Issues: Extreme care should be taken at the rear of 14 Boondah St as the landfill is unstable, may contain contaminated material and leachate. Prior to any works beginning in this area, an investigation of the state of the landfill should be undertaken and remediation actions employed if necessary.

Zone 9: Mixed Paperbark Scrub and Wet Grassland

Objective: Extend Ludwigia control beyond reach of board-walk to protect zone 8. Implement Salvinia control. Experiment with control of *Isolepis prolifera*.

Description: Floating clumps of native wet grassland species with scattered Heath-leaved Paperbark forming thickets on the grassland edges. Patches of Ludwigia (currently controlled by herbicide sprayed from boardwalk) and scattered Salvinia forming larger clumps in open water around boardwalk. Parrot's Feather and *Isolepis prolifera* are present throughout zone.

Resilience: High - Moderate

Strategy:

- Continue and extend Ludwigia control to the northern and southern edges of the zone.
- Manually remove Salvinia and trial manual removal of *Isolepis prolifera*, with emphasis on removal of propagules

Management Issues: Manual aquatic weed removal will require operators to stand in deep swampy environment. Floating planks should be considered for extending Ludwigia control.

Zone 10: Mixed Swamp Oak Forest and Paperbark Scrub north and west of Warriewood Shopping Centre

Objective: Sustained on-going program of weed control using bush regeneration techniques. Enhance and maintain a protective buffer to zones 5 and 9 through Ludwigia control.

Description: The zone is a diverse mosaic of Swamp Oak (*Casuarina glauca*) Forest and *Melaleuca ericifolia* (Heath-leaved Paperbark) Scrub with patches of Wet Grassland in the low lying areas. Species diversity is high. Access for weed control is generally good due to the presence of the trail. As with all

other zones, *Salvinia* is distributed throughout all wet areas as scattered clumps under the canopy. Dense lantana thickets are located to the north and just off the track to the west. Heavy *Ludwigia* outbreaks occur beyond the lantana as on the western and northern boundaries threatening zones 5 and 9. Weeds such as African Olive and Buffalo grass occur sporadically along the track edges. Of serious concern is a strip of heavy weed growth including *Cardiospermum grandiflorum* (Balloon Vine) and *Anredera cordifolia* (Madera Vine) invading the wetland from the carpark area behind the shopping-centre. This has resulted from ongoing dumping of grass clippings and other vegetation rubbish either from the public or landscape contractors.

Resilience: Good to Moderate

Strategy:

- Manage the weeds invading from the car-park edge and engage Warriewood Shopping Centre to cease dumping
- Commence sustained *Ludwigia* control program targeting the boundaries of zones 5 and 9
- Manually remove easily accessible *Salvinia* under the canopy and undertake ongoing weed control on the track edges
- Any lantana removal should be carefully staged to minimise loss of habitat, public access and replacement of other weed species
- Trial *Salvinia* weevil introduction in the open sunny wet patches throughout this zone

Management Issues: Access to the *Ludwigia* infestations on the wet western and northern boundaries of the zone is difficult. Amphibious vehicles are likely to disturb the zone too much. Consider creating temporary access thorough the lantana (while retaining lantana as a barrier) and using floating planks (see above).

Zone 11: Garden St Open Water and Marshland

Objective: Extend and continue *Ludwigia*, *Salvinia* and Cockspur Coral Tree control. Prevent weed incursion into zone 5 and prioritise aquatic weed control in the *Melaleuca ericifolia* (Heath-leaved Paperbark) Scrub patch in the north-eastern corner of the zone.

Description: This zone has been most altered in the wetland by weed invasion and vegetation type conversion through hydrological changes. It is comprised of elevated islands of Swamp Mahogany, Swamp Oak and Heath-leaved Paperbark surrounded by a diverse marshland of aquatic weeds and some open water areas. *Ludwigia* control has been successful in this zone but is restricted to the reach of herbicide spray hoses (10 – 15m) from the boardwalk and dry land. Outside this radius there are extensive *Ludwigia*, *Salvinia* and Cockspur Coral Tree infestations. A large floating mass of *Salvinia* and other aquatic weeds chokes the Garden St concrete channel (Feb 2010).

Resilience: Low as this zone is in the process of transformation from a diverse plant assemblage to domination by a few species.

Strategy:

- Continue and extend control of *Ludwigia*, *Salvinia* and Cockspur Coral Tree beyond the reach of the board-walk and dry land
- Prioritise extending aquatic weed control to the less weedy boundary of zone 5 and the *Melaleuca* Scrub area
- Control weeds on the islands of trees

- Consider large scale mechanical removal of the Salvinia mass and other aquatic weeds choking the Jackson Rd concrete channel to promote open water areas and improve water drainage/circulation
- Trial Salvinia weevil establishment once Salvinia mass has reduced
- Consider aeration device/fountain to maintain open water and improve aeration
- Consider construction of a loop boardwalk to extend recreational experience and assist with weed control (see **Figure 9**)

Management Issues: Access to this area for weed control beyond the board-walk and dry land is extremely difficult, hazardous for operators and expensive. Floating planks and amphibious vehicles are options (see above).

Zone 12: Katoa Close Entrance

Objective: Continue work of bushcare group and extend weed control to Swamp Oak and Heath-leaved Paperbark vegetation towards Jackson Rd drain.

Description: Most of this zone is on a small landfill peninsular surrounded by the marshland of zone 11. It is an attractive setting for the board-walk entrance as the Swamp Oak forest has been maintained well by a group of bushcare volunteers and is virtually weed free. The zone becomes weedy where it drops down to the west towards the Jackson Road drain.

Resilience: Nil to Low. Nil on the landfill – low where the landfill drops to the swampy area to the west.

Strategy: Continue weed control maintenance and extend weed control to Swamp Oak and Heath-leaved Paperbark vegetation towards Jackson Road drain.

Zone 13: Strip behind properties in Garden St

Objective: Control weeds and address encroachments.

Description: The zone is very narrow and weedy to a point about halfway along where it widens to include an informal access road to the rear of houses and an open mown area extending down to the creek bank. The narrow weedy section includes a variety of the usual private property encroachments e.g. extension of gardens, landfill.

Strategy:

- Control the weeds and revegetate creek bank in mown area
- Establish track for bike riders and walkers along property boundary

Management Issues: Reinvasion of weeds along the narrow strip will continue to be a problem unless the residents are involved in their management. Constraints to establishing a bicycle track include areas of boggy ground, narrow width between private property boundaries and creek bank and resident opposition.



Figure 8: Vegetation management zones



Figure 9: Access to management zones

6.6 WATER AND SEDIMENT MANAGEMENT ACTIONS

Table 8: Water and sediment management actions for Warriewood Wetland

NO.	ACTION	PRIORITY	PERFORMANCE MEASURES
12	Maintain existing stormwater pollution control devices immediately after heavy rainfall (or at least every year) and investigate the need for additional control devices.	High	Optimise efficiency of stormwater pollution control devices.
13	Ensure all adjacent development complies with Warriewood Valley Urban Land Release Water Management Specification and relevant DCPs.	High	Compliance.
14	Determine feasibility of a water quality monitoring program if funding becomes available to undertake water quality management works.	High	Water quality monitoring undertaken if funding available.

6.7 RECREATION MANAGEMENT ACTIONS

Location specific actions are marked on **Figure 9**.

Table 9: Recreation management actions for Warriewood Wetland

NO.	ACTION	PRIORITY	PERFORMANCE MEASURES
15	Consider additional boardwalk across wetland to connect existing pathways and provide improved access for weed control.	Medium	Decision made regarding boardwalk construction.
16	Construct bike path along western edge of wetland to create circuit path with Warriewood Valley pedestrian and cycleway network. This will assist keeping bikes off boardwalk, provide additional non-motorised access from new residential developments to shopping centre and provide a means of managing encroachments/dumping.	Medium	Bike path constructed.
17	Consider feasibility of widening existing boardwalk to accommodate bike riding and ensure design meets Australian Standards.	Low	Boardwalk widened

NO.	ACTION	PRIORITY	PERFORMANCE MEASURES
18	Investigate additional access points to existing boardwalk in areas adjacent to new developments and opportunities for funding this from new development projects.	Low	Additional access points provided

6.8 COMMUNITY ENGAGEMENT AND EDUCATION ACTIONS

Table 10: Community learning actions for Warriewood Wetland

NO.	ACTION	PRIORITY	PERFORMANCE MEASURES
19	Liaise with residents who are known to dump rubbish and or are encroaching into wetland areas. Make encroachers aware of property boundary and impacts of their activities.	High	Removal of existing and reduced new encroachments.
20	Investigate implementing native plant give-away program (e.g. four plants per household; plus educational brochures)	Medium	Increasing uptake of offer by residents
21	Investigate establishment of community biodiversity monitoring group to report fauna sightings and monitor weed hotspots. Potentially an extension of Bushcare and/or from community information events. Liaison with existing bird watching groups and schools should be undertaken.	High	On-going monitoring of wildlife by residents.
22	Develop and distribute information pack to new residents highlighting values of wetlands and opportunities to be involved in use and enjoyment (including management) e.g. Bushcare, recreational opportunities.	High	New residents receive information pack.
23	Liaise with local businesses to establish "sponsorship" of wetlands e.g. donating funds for rehabilitation.	Low	Uptake by local business.
24	Include information about "safe disposal" of unwanted aquarium species (both plants and fish) in community education information packages. Brochures are available from I&I NSW regarding dumping of aquarium species.	Low	Information provided.

6.9 MANAGEMENT AND FINANCIAL ARRANGEMENTS ACTIONS

Table 11: Management and financial arrangements actions for Warriewood Wetland

NO.	ACTION	PRIORITY	PERFORMANCE MEASURES
25	Ensure management actions are coordinated across relevant sections of Council.	High	All relevant sections of Council aware of management activities.
26	Assign responsibility for investing, accessing and reporting on grant funding.	High	Grant funding secured.
27	Include follow-up works for major weed control treatment in maintenance budgets to ensure long-term success.	High	On-going works included in budgets.
28	Do not invest substantial resources in up-front works if commitment to on-going and follow-up needs is not secure.	High	Commitment to on-going works
29	Use this Plan of Management to support grant applications and to secure internal funding.	High	Funding secured.

7 Implementation

The following steps are recommended to facilitate on-ground works and further investigation:

- Ensure all bush regeneration is undertaken according to current best practice techniques and by suitably qualified personnel.
- All Bushcare activities must be appropriately supervised by suitably qualified personnel.
- Use local provenance terrestrial and aquatic plants for revegetation and rehabilitation activities. Stocktake nursery supplies and increase tubestock and seed supply to enable revegetation in accordance with the PoM.
- Use chemical controls strictly according to licensing and safety recommendations to ensure impacts to native wildlife are minimized. Stay abreast of current research into chemical controls to ensure best practice management is being followed.
- Update NSW Wildlife Atlas records based on existing records and ongoing monitoring. Use this data as a basis for monitoring change e.g. improvements from management, climate change impacts.
- Ensure upstream creek rehabilitation works use appropriate species for revegetation
- Ensure that all recreation management actions fully consider the likely disturbance to biodiversity, both as a result of their construction and usage. All proposals for new or modified boardwalks and trails should consider the biodiversity outcomes as a priority over recreational outcomes. The consequences of not providing/upgrading recreational facilities for biodiversity should also be considered.
- Monitor and enforce track use to prevent illegal/unwanted activities (e.g. dog walking, bike riding).
- Boardwalk maintenance including fixing railings with sturdier material and removing graffiti.
- Prepare and install temporary / low cost interpretive signage. Theme should be “Did you notice ...” and explain current happenings in wetland e.g. weed control, fauna sightings.
- Support on-going Bushcare opportunities and expand. Consider expanding works areas depending on OH&S requirements of working in wet areas.
- Deliver community education events e.g. birdwatching tours, weed and native vegetation information sessions (potentially in conjunction with native plant give away).
- Education to encourage rainwater tanks, reduced use of lawn fertilisers and greater use of native plants in gardens. Via Council newsletters, information booths, information packs, letterbox drops.
- Seek commitment from relevant parties to implement this PoM.
- Determine if contractors are needed to implement high priority works (e.g. aquatic weed control, regenerate degraded bushland). If so, commence purchasing process. If not, allocate tasks to relevant staff and implement.
- Obtain necessary approvals and implement vegetation management works.
- Seek additional funds to support implementation of the PoM.
- Monitoring and adaptive management.

7.1 FUNDING AND RESOURCES

Limited funds are currently available to implement this Plan of Management. Additional funding and in-kind contributions should be sought from a range of sources, for example:

- State and Commonwealth government environmental grants.
- Future Council levies for projects environmental works.
- Bushcare volunteers and other community groups (e.g. schools, scouts) can assist with bush regeneration and revegetation; with supervision, plants and equipment provided by Council.
- Donations e.g. Pittwater Natural Heritage Association.
- Sponsorship from local businesses.

7.2 STATUTORY APPROVALS AND LICENCES

Approvals required for tasks described in this Plan of Management are outlined here. These are in addition to requirements under the *Noxious Weeds Act 1993*.

Any flora and fauna studies will need to address potential ecological impacts under the *Threatened Species Conservation Act 1995*. Ecological impacts associated with proposed development or activities need to be assessed using a test of significance for threatened species or communities (i.e. seven part test). More detailed assessment (e.g. Species Impact Statement) may be required where there is likely to be a significant impact.

The flora and fauna studies also need to consider matters of national environmental significance (NES matters) under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). NES matters for Warriewood Wetland include threatened and migratory species (refer **Table 4**). Approval from the Commonwealth Environment Minister is required under the EPBC Act if the action (which can include a project, development, undertaking or activity) will, or is likely to, have a significant impact on NES matters.

Table 12: Environmental approvals

TASK	REQUIREMENT
Boardwalk construction and/or significant modification e.g. widening involving additional pylons.	<p>Boardwalk construction will be exempt from Development Consent under the Infrastructure SEPP, provided the project is undertaken by Council.</p> <p>However, a flora and fauna study should be undertaken to identify the likelihood of significant impacts to threatened species/communities. If significant impact is found to be likely, then a Species Impact Statement (SIS) (in accordance with the <i>Threatened Species Conservation Act 1995</i>) and/or <i>Environmental Impact Statement</i> (EIS) (under EP&A Act) may be required. Matters of National Environmental Significance under the Commonwealth <i>Environmental Protection and Biodiversity Conservation Act 1999</i> should be considered when preparing the flora and fauna study to determine if a Referral is required.</p> <p>A licence from DECCW will be required to undertaken</p>

TASK	REQUIREMENT
	works in an EEC.
Vegetation management and weed control.	A licence from DECCW will be required to undertake works in an EEC.

7.3 SPECIES FOR REPLANTING

Local provenance species should be used for replanting where possible. A stocktake of the Council plant nurseries will help to determine requirements for additional supplies. Allowance should be made for replacement planting and on-going maintenance.

A preliminary list of flora species suited to different applications is given in **Appendix E**. It includes some of the species that could be used for replanting. Species suitable for residential gardens can be identified through Council's Native Plants for Your Garden website (http://www.pittwater.nsw.gov.au/environment/species_lists)

7.4 MONITORING AND ADAPTIVE MANAGEMENT

Monitoring has been incorporated in many actions within the Plan of Management e.g. terrestrial and aquatic species, water quality, habitats. Proper record keeping will assist ongoing management. Results of monitoring will be essential to inform adaptive management practices, particularly during the restoration of the lagoon.

Environmental managers often deal with considerable uncertainty and complexity about how ecosystems and the physical environment interact. Adaptive management is a widely accepted approach to natural resource management that involves learning from implementation. By following the adaptive management cycle, practitioners ensure that learning is focussed on management needs and that new knowledge feeds back to inform future management choices.

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Appendix A: Vegetation community profiles

A description of the biophysical and floristic characteristics of the each vegetation community within the Warriewood Wetland has been provided below.

***Eucalyptus robusta* Swamp Sclerophyll Forest/Woodland**

The *Eucalyptus robusta* Swamp Sclerophyll Forest/Woodland is part of the Swamp Sclerophyll Forest on Coastal Floodplains Endangered Ecological Community (EEC). This vegetation is predominantly restricted to the slightly elevated sections in the west of Warriewood Wetland.



Description: This vegetation community has an open forest structure (Specht and Specht 2002) with approximately 40-60% foliage projected cover. Two separate areas in the west have been mapped as supporting this community with the northerly area supporting a more open form with regrowth Swamp Mahogany.

Canopy: Up to 20 m in height, dominated by *Eucalyptus robusta* (Swamp Mahogany).

Midstorey: Up to 12 m in height. *Glochidion ferdinandi* (Cheese Tree), Straw Tree-fern (*Cyathea cooperi*) and occasional *Livistona australis* (Cabbage Palm).

Groundcover: *Calochlaena dubia* (Rainbow Fern), *Blechnum camfieldii* (Water Fern), *Gahnia sieberiana* (Red-fruited Saw-sedge) and *Stephania japonica* var. *discolor* (Snake Vine).

Weeds: *Erythrina crista-galli* (Cockspur Coral Tree), *Ipomoea indica* (Blue Morning Glory), *Ligustrum sinense* (Small-Leaved Privet), Senna (*Senna pendula* var. *glabrata*) and Lantana.

***Eucalyptus robusta* – *Casuarina glauca* Swamp Sclerophyll Forest/Woodland**

The *Eucalyptus robusta* – *Casuarina glauca* Swamp Sclerophyll Forest/Woodland is part of the Swamp Sclerophyll Forest on Coastal Floodplains Endangered Ecological Community (EEC). This vegetation occurs downslope to the east of the *Eucalyptus robusta* Swamp Sclerophyll Forest/Woodland and is subject to more frequent inundation allowing an increase in dominance of *Casuarina glauca* (Swamp Oak) and a range of serious aquatic weeds such as Ludwigia and Salvinia.



Description: This vegetation community has an open forest structure (Specht and Specht 2002) with approximately 40-60% foliage projected cover. This vegetation community occurs downslope of the adjoining Swamp Mahogany Forest and is subject to more frequent inundation. Due to the more frequent inundation, this community has been disturbed by a greater range of environmental weed species.

Canopy: Up to 20 m in height, Dominated by *Eucalyptus robusta* (Swamp Mahogany) with a gentle transition into a canopy co-dominated by *Casuarina glauca* (Swamp Oak).

Midstorey: Up to 12 m in height. Consisting primarily of juvenile Swamp Mahogany and Swamp Oak with occasional *Glochidion ferdinandi* (Cheese Tree) in more elevated situations.

Groundcover: *Phragmites australis* (Common Reed), *Gleichenia dicarpa* (Pouched Coral-fern), *Gahnia sieberiana* (Red-fruited Saw-sedge) and *Stephania japonica* var. *discolor* (Snake Vine).

Weeds: *Erythrina crista-galli* (Cockspur Coral Tree), *Ipomoea indica* (Blue Morning Glory), *Ludwigia peruviana*, *Cortaderia selloana* (Pampas Grass) and *Salvinia molesta* (Salvinia).

***Casuarina glauca* Swamp Sclerophyll Forest/Woodland**

The *Casuarina glauca* Swamp Sclerophyll Forest/Woodland is part of the Swamp Oak Floodplain Forest on Coastal Floodplains Endangered Ecological Community (EEC). This vegetation occurs to the east of Warriewood Woodlands and is most noticeable immediately behind Warriewood shopping centre. This vegetation has been modified through the construction of a rising sewer main which is likely to have increased and prolonged the period of inundation.



Description: This community (Specht and Specht 2002 with approximately 10-50% foliage projected cover. This vegetation community occurs in the east of Warriewood Wetland. Due to the more frequent and prolonged inundation, this community has been disturbed by a greater range of environmental weed species.

Canopy: Up to 20 m in height, Dominated by *Casuarina glauca* (Swamp Oak).

Midstorey: Consisting primarily of juvenile Swamp Oak with occasional *Glochidion ferdinandi* (Cheese Tree), *Breynia oblongifolia* (Coffee Bush) and *Polyscias sambucifolia* (Elderberry Panax) in more elevated situations.

Groundcover: *Phragmites australis* (Common Reed) and *Gahnia sieberiana* (Red-fruited Saw-sedge).

Weeds: *Ludwigia peruviana*, *Cortaderia selloana* (Pampas Grass), *Salvinia molesta* (Salvinia) and *Isolepis prolifera*. Lantana occurs in dense thickets in the peripheral areas of this vegetation community and on slightly elevated sections.

***Casuarina glauca* – *Melaleuca ericifolia* Swamp Sclerophyll Forest/Woodland**

The *Casuarina glauca* – *Melaleuca ericifolia* Swamp Sclerophyll Forest/Woodland is part of the Swamp Oak Floodplain Forest on Coastal Floodplains Endangered Ecological Community (EEC). This vegetation occurs downslope of the pure Swamp Oak forest and is subject to long periods of inundation. Several good examples of this vegetation community can be viewed from the access track which heads north from Warriewood shopping centre along the rising sewer main.



Description: This vegetation community has a woodland structure (Specht and Specht 2002) with approximately 10-30% foliage projected cover. This vegetation community occurs in the eastern and central areas of Warriewood Wetland. Due to the more frequent and prolonged inundation, this community has been disturbed by a greater range of environmental weed species.

Canopy: Up to 20 m in height, dominated by *Casuarina glauca* (Swamp Oak).

Midstorey: Up to 8 m in height, dominated by *Melaleuca ericifolia* (Swamp Paperbark).

Groundcover: *Gahnia sieberiana* (Red-fruited Saw-sedge), *Enydra fluctuans*, *Carex appressa* (Tall Sedge), *Ludwigia peploides* subsp. *montevidensis* (Water Primrose) and *Eleocharis equisetina*.

Weeds: *Ludwigia peruviana*, *Cortaderia selloana* (Pampas Grass), *Salvinia molesta* (Salvinia) and *Isolepis prolifera*.

***Melaleuca ericifolia* Swamp Sclerophyll Scrub**

The *Melaleuca ericifolia* Swamp Sclerophyll Scrub is part of the Swamp Oak Floodplain Forest on Coastal Floodplains Endangered Ecological Community (EEC). This vegetation occurs in the central and northern areas of the wetland and is subject to long periods of inundation. Several good examples of this vegetation community can be viewed from northern boardwalk within the wetland.



Description: The structure of this community ranges from an open herbland to a tall shrubland (Specht and Specht 2002) with approximately 10-30% foliage projected cover. This vegetation community occurs in central and northern areas of the wetland. Several areas of this community constitute the most intact and diverse areas within the wetland.

Canopy: Up to 8 m in height, dominated by *Melaleuca ericifolia* (Swamp Paperbark).

Midstorey: Absent.

Groundcover: *Isachne globosa* (Swamp Millet), *Gahnia sieberiana* (Red-fruited Saw-sedge), *Enydra fluctuans*, *Carex appressa* (Tall Sedge), *Ludwigia peploides* subsp. *montevidensis* (Water Primrose), *Alisma plantago-aquatica* (Water-plantain), *Triglochin microtuberosum* (Water Ribbons), *Alternanthera denticulata* (Common Joyweed), *Persicaria* spp. (Knotweed) and *Eleocharis equisetina*.

Weeds: *Ludwigia peruviana*, *Salvinia molesta* (Salvinia) and *Isolepis prolifera*.

Herbaceous Swamp Complex

The Herbaceous Swamp Complex is part of the Sydney Freshwater Wetlands Endangered Ecological Community (EEC). This vegetation has a scattered distribution across the wetland and occurs where the surrounding canopy is sparse to absent. A good example of this vegetation community can be viewed from northern boardwalk within the wetland. Areas of this community have become dominated by *Ludwigia peruviana* and have been mapped as part of the Herbaceous swamp complex – *Ludwigia peruviana* form.



Description: This vegetation has a herbland structure (Specht and Specht 2002) with with approximately 30-60% foliage projected cover. This vegetation community occurs in a range of condition states from relatively intact to areas dominated by *Ludwigia peruviana*

Canopy: Absent.

Midstorey: Absent.

Groundcover: *Isachne globosa* (Swamp Millet), *Phragmites australis* (Common Reed), *Typha orientalis* (Broad-leaf Cumbungi), *Enydra fluctuans*, *Carex appressa* (Tall Sedge), *Ludwigia peploides* subsp. *montevidensis* (Water Primrose), *Alisma plantago-aquatica* (Water-plantain), *Triglochin microtuberosum* (Water Ribbons), *Alternanthera denticulata* (Common Joyweed), *Persicaria* spp. (Knotweed) and *Eleocharis equisetina*.

Weeds: *Ludwigia peruviana*, *Salvinia molesta* (Salvinia) and *Erythrina crista-galli* (Cockspur Coral Tree)

Appendix B: Native flora species

Native flora observed in Warriewood Wetland Feb 2010. Note that none of the below species are listed under the EPBC or TSC Acts. Refer to **Table 3** for weed species recorded in the study area.

SPECIES	COMMON NAME	REGIONALLY THREATENED
<i>Acacia decurrens</i>	Black Wattle	
<i>Acacia floribunda</i>	White Sally	
<i>Acacia longifolia</i>	Sydney Golden Wattle	
<i>Acacia parramattensis</i>	Parramatta Wattle, Sydney Green Wattle	
<i>Acacia sophorae</i>	Coastal Wattle	
<i>Acmena smithii</i>	Lilly-pilly	
<i>Alisma plantago-aquatica</i>	Water-plantain	Northern Sydney
<i>Alocasia brisbanensis</i>		Northern Sydney
<i>Alternanthera denticulata</i>	Common Joyweed	Pittwater
<i>Asplenium australasicum</i>	Birds-nest Fern	
<i>Baloskion tetraphyllum</i>	Tassel Cord-rush, Tassel Rush	
<i>Baumea articulata</i>	Jointed Twig-rush	
<i>Baumea rubiginosa</i>	Soft Twig-rush	
<i>Billardiera scandens</i>	Appleberry, Dumplings, Snotberry	
<i>Blechnum camfieldii</i>	Water Fern	Northern Sydney
<i>Blechnum indicum</i>	Swamp Water Fern	Northern Sydney
<i>Bolboschoenus fluviatilis</i>	Club-rush	Northern Sydney
<i>Breynia oblongifolia</i>	Coffee Bush	
<i>Callistemon citrinus</i>	Scarlet Bottlebrush	
<i>Callistemon linearis</i>	Narrow-leaved Bottlebrush	
<i>Calochlaena dubia</i>	Rainbow Fern, False Bracken	
<i>Carex appressa</i>	Tall Sedge	Pittwater
<i>Cassytha glabella</i>	Devil's Twine, Dodder-laurel	
<i>Casuarina glauca</i>	Swamp Oak, Swamp She-oak	
<i>Cayratia clematidea</i>	Slender Grape	
<i>Cerastium glomeratum</i>	Mouse-ear Chickweed	
<i>Cissus hypoglauca</i>	Native Grape, Water Vine	
<i>Cladium procerum</i>		
<i>Clematis glycinoides</i>	Headache Vine, Traveller's Joy	
<i>Commelina cyanea</i>	Blue Spiderwort	
<i>Cyathea cooperi</i>	Straw Tree-fern, Scaly Tree-Fern	
<i>Cyperus polystachyos</i>		
<i>Dianella caerulea</i> var. <i>producta</i>		
<i>Dianella congesta</i>	Dune Flax-lily	

SPECIES	COMMON NAME	REGIONALLY THREATENED
<i>Dodonaea triquetra</i>	Hopbush	
<i>Elaeocarpus reticulatus</i>	Blueberry Ash	
<i>Eleocharis equisetina</i>		
<i>Entolasia marginata</i>	Bordered Panic	
<i>Enydra fluctuans</i>		
<i>Eucalyptus robusta</i>	Swamp Mahogany	
<i>Eustrephus latifolius</i>	Wombat Berry	
<i>Ficinia nodosa</i>	Knobby Club-rush	
<i>Ficus coronata</i>	Creek Sandpaper Fig	
<i>Ficus rubiginosa</i>	Port Jackson Fig, Rusty Fig	
<i>Gahnia sieberiana</i>	Red-fruited Saw-sedge	
<i>Geranium homeanum</i>	Native Geranium	
<i>Gleichenia dicarpa</i>	Pouched Coral-fern	
<i>Glochidion ferdinandi</i>	Cheese Tree	
<i>Glycine clandestina</i>	Twining Glycine	
<i>Hakea dactyloides</i>	Broad-leaved Hakea	
<i>Hardenbergia violacea</i>	False Sarsaparilla	
<i>Histiopteris incisa</i>	Batwing Fern, Oak Fern	
<i>Homalanthus populifolius</i>	Bleeding Heart, Native Poplar	
<i>Hypolepis muelleri</i>	Harsh Ground Fern	
<i>Imperata cylindrica</i>	Blady Grass	
<i>Isachne globosa</i>	Swamp Millet	Northern Sydney
<i>Juncus continuus</i>		
<i>Kennedia rubicunda</i>	Dusky Coral-pea	
<i>Kunzea ambigua</i>	Tick-bush	
<i>Leptocarpus tenax</i>		
<i>Livistona australis</i>	Cabbage Palm, Cabbage-tree Palm	
<i>Lobelia alata</i>	Angled Lobelia	
<i>Lomandra longifolia</i>	Spiny-headed Mat-rush	
<i>Ludwigia peploides</i> subsp. <i>montevidensis</i>	Water Primrose	
<i>Melaleuca ericifolia</i>	Swamp Paperbark	
<i>Melaleuca linariifolia</i>	Flax-leaved Paperbark	
<i>Monotoca elliptica</i>	Tree Broom-heath	
<i>Morinda jasminoides</i>	Morinda	
<i>Oplismenus aemulus</i>	Broad-leaved Basket Grass	
<i>Oxalis perennans</i>	Oxalis	Northern Sydney
<i>Pandorea pandorana</i>	Wonga Vine	
<i>Parsonsia straminea</i>	Common Silkpod, Monkey Rope	
<i>Paspalidium</i> sp.		
<i>Persicaria orientalis</i>	Princes Feathers	
<i>Persicaria strigosa</i>	Bristly Knotweed	

SPECIES	COMMON NAME	REGIONALLY THREATENED
<i>Phragmites australis</i>	Common Reed	
<i>Pittosporum undulatum</i>	Sweet Pittosporum	
<i>Platycerium bifurcatum</i>	Elkhorn Fern, Staghorn Fern	
<i>Polyscias sambucifolia</i>	Elderberry Panax	
<i>Pteridium esculentum</i>	Bracken	
<i>Pyrrosia rupestris</i>	Rock Felt Fern, Creeping Fern	
<i>Ranunculus inundatus</i>	River Buttercup	
<i>Rumex brownii</i>	Slender Dock	
<i>Schoenoplectus mucronatus</i>		Northern Sydney
<i>Schoenoplectus validus</i>	River Club-rush	Northern Sydney
<i>Sigesbeckia orientalis</i>	Indian Weed	
<i>Solanum aviculare</i>	Kangaroo Apple	Northern Sydney
<i>Stephania japonica</i> var. <i>discolor</i>	Snake Vine	
<i>Tetragonia tetragonioides</i>	New Zealand Spinach	
<i>Themeda australis</i>	Kangaroo Grass	
<i>Triglochin microtuberosum</i>		
<i>Typha orientalis</i>	Broad-leaf Cumbungi, Bulrush	
<i>Viminaria juncea</i>	Native Broom	
<i>Viola hederacea</i>	Native Violet, Ivy-leaved Violet	

Appendix C: Fauna species

The following list is based on NSW Wildlife Atlas data records, species observed by during field investigation for the development of this plan and fauna lists in the previous Plan of Management (Water Resources Consulting Services 1997).

SCIENTIFIC NAME	COMMON NAME	EPBC ACT STATUS	TSC ACT STATUS
BIRDS			
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill		
<i>Acanthiza lineate</i>	Striated Thornbill		
<i>Acanthiza nana</i>	Yellow Thornbill		
<i>Acanthiza pusilla</i>	Brown Thornbill		
<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill		
<i>Accipiter fasciatus</i>	Brown Goshawk		
<i>Accipiter novaehollandiae</i>	Grey Goshawk		
<i>Acridotheres tristis</i>	Common Myna*		
<i>Acrocephalus australis</i>	Australian Reed Warbler		
<i>Acrocephalus stentoreus</i>	Clamorous Reed Warbler	Migratory	
<i>Alcedo azurea</i>	Azure Kingfisher		
<i>Anas castanea</i>	Chestnut Teal		
<i>Anas gibberifrons</i>	Grey Teal		
<i>Anas platyrhynchos</i>	Mallard Duck		
<i>Anas superciliosa</i>	Pacific Black Duck		
<i>Anthochaera carunculata</i>	Little Wattlebird		
<i>Anthochaera paradoxa</i>	Red Wattlebird		
<i>Ardea alba</i>	White Egret	Migratory	
<i>Ardea intermedia</i>	Intermediate Egret		
<i>Ardea novaehollandiae</i>	White-faced Heron		

SCIENTIFIC NAME	COMMON NAME	EPBC ACT STATUS	TSC ACT STATUS
<i>Ardea pacifica</i>	White-necked Heron		
<i>Cacatua galerita</i>	Sulphur Crested Cockatoo		
<i>Cacatua roseicapillus</i>	Rose Breasted Galah		
<i>Cacomantis variolosus</i>	Brush Cuckoo		
<i>Calyptorhynchus funereus</i>	Yellow-tailed Black Cockatoo		
<i>Carduelis carduelis</i>	European Goldfinch*		
<i>Cecropis ariel</i>	Fairy Martin		
<i>Centropus phasianinus</i>	Pheasant Coucal		
<i>Chenonetta jubata</i>	Maned Wood Duck		
<i>Chenonetta jubata</i>	Australian Wood Duck		
<i>Chrysococcyx lucidus</i>	Shining Bronze Cuckoo		
<i>Cincloramphus cruralis</i>	Brown Songlark		
<i>Circus approximans</i>	Swamp Harrier		
<i>Cisticola exilis</i>	Golden-headed Cisticola		
<i>Columba livia</i>	Feral Pigeon*		
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike		
<i>Coracina tenuirostris</i>	Cicadabird		
<i>Cormobates leucophaeus</i>	White-throated Treecreeper		
<i>Corvus coronoides</i>	Australian Raven		
<i>Coturnix australis</i>	Brown Quail		
<i>Coturnix chinensis</i>	King Quail		
<i>Cracticus torquatus</i>	Grey Butcherbird		
<i>Cuculus pyrrhophanus</i>	Fan-tailed Cuckoo		
<i>Dacelo novaeguineae</i>	Laughing Kookaburra		
<i>Daphoenositta chrysoptera</i>	Varied Sittella		
<i>Dicaeum hirundinaceum</i>	Mistletoe Bird		
<i>Dicrurus bracteatus</i>	Spangled Drongo		
<i>Elanus axillaris</i>	Black-shouldered Kite		

SCIENTIFIC NAME	COMMON NAME	EPBC ACT STATUS	TSC ACT STATUS
<i>Elseyornis melanops</i>	Black-fronted Dotterel		
<i>Eopsaltria australis</i>	Eastern Yellow Robin		
<i>Eudynamys scolopacea</i>	Common Koel		
<i>Eurystomus orientalis</i>	Dollarbird		
<i>Gallinago hardwickii</i>	Japanese/Latham's Snipe	Migratory	
<i>Gallinula tenebrosa</i>	Dusky Moorhen		
<i>Gallirallus philippensis</i>	Buff-banded Rail		
<i>Geopelia striata</i>	Peaceful Dove		
<i>Gerygone mouki</i>	Brown Gerygone		
<i>Gerygone olivacea</i>	White-throated Gerygone		
<i>Glossopsitta concinna</i>	Musk Lorikeet		
<i>Glossopsitta pusilla</i>	Little Lorikeet		
<i>Grallina cyanoleuca</i>	Australian Magpie Lark		
<i>Gymnorhina tibicen</i>	Australian Magpie		
<i>Halcyon chloris</i>	Sacred Kingfisher		
<i>Haliastur sphenurus</i>	Whistling Kite		
<i>Hirundapus caudacutus</i>	White-throated Needletail	Migratory	
<i>Hirundo neoxena</i>	Welcome Swallow		
<i>Ixobrychus flavicollis</i>	Black Bittern		Vulnerable
<i>Larus pacificus</i>	Silver Gull		
<i>Lathamus discolor</i>	Swift Parrot	Endangered	Endangered
<i>Lichenostomus chrysops</i>	Yellow-faced Honeyeater		
<i>Lichenostomus fuscus</i>	Fuscous Honeyeater		
<i>Lichenostomus ornatus</i>	Fuscous Honeyeater		
<i>Lonchura castaneothorax</i>	Chestnut-breasted Mannikin*		
<i>Lopholaimus antarcticus</i>	Topknot Pigeon		
<i>Malurus assimilis</i>	Variegated Wren		
<i>Malurus cyaneus</i>	Superb Blue Wren		

SCIENTIFIC NAME	COMMON NAME	EPBC ACT STATUS	TSC ACT STATUS
<i>Manorina melanocephala</i>	Noisy Miner		
<i>Megalurus grammurus</i>	Little Grassbird		
<i>Megalurus timoriensis</i>	Tawny Grassbird		
<i>Meliphaga lewinii</i>	Lewin's Honeyeater		
<i>Melithreptus gularis</i>	Black-chinned Honeyeater		
<i>Monarcha melanopsis</i>	Black-faced Monarch	Migratory	
<i>Myiagra ruficollis</i>	Leaden Flycatcher		
<i>Myzomela elithreptus lunatus</i>	White-naped Honeyeater		
<i>Myzomela sanguinolenta</i>	Scarlet Honeyeater		
<i>Neochmia temporalis</i>	Red-browed Firetail		
<i>Neochmia temporalis</i>	Red-browed Finch		
<i>Ninox novaeseelandiae</i>	Southern Boobook		
<i>Nycticorax caledonicus</i>	Rufous/Nankeen Night Heron		
<i>Ocyphaps lophotes</i>	Crested Pigeon		
<i>Oriolus sagittatus</i>	Olive-backed Oriole		
<i>Pachycephala pectoralis</i>	Golden Whistler		
<i>Pachycephala rufiventris</i>	Rufous Whistler		
<i>Pardalotus punctatus</i>	Spotted Pardalote		
<i>Passer domesticus</i>	House Sparrow*		
<i>Pelecanus conspicillatus</i>	Australian Pelican		
<i>Petroica rosea</i>	Rose Robin		
<i>Phalacrocorax melanoleucos</i>	Little Pied Cormorant		
<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant		
<i>Phalacrocorax varius</i>	Pied Cormorant		
<i>Philemon corniculatus</i>	Noisy Friarbird		
<i>Phylidonyris nigra</i>	White-cheeked Honeyeater		
<i>Phylidonyris novaehollandiae</i>	New Holland Honeyeater		
<i>Pitta versicolor</i>	Noisy Pita		

SCIENTIFIC NAME	COMMON NAME	EPBC ACT STATUS	TSC ACT STATUS
<i>Platylea regia</i>	Royal Spoonbill		
<i>Platycercus eximius</i>	Eastern Rosella		
<i>Podogargus strigoides</i>	Tawny Frogmouth		
<i>Porphyrio porphyrio</i>	Purple Swamphen		
<i>Psophodes olivaceus</i>	Eastern Whipbird		
<i>Pycnonotus jocosus</i>	Red-whiskered Bulbul*		
<i>Rhipidura fuliginosa</i>	Grey Fantail		
<i>Rhipidura leucophrys</i>	Willy Wagtail		
<i>Rhipidura rufifrons</i>	Rufous Fantail	Migratory	
<i>Scythrops novaehollandiae</i>	Channel-billed Cuckoo		
<i>Sericornis frontalis</i>	White-browed Scrubwren		
<i>Sericornis magnirostris</i>	Largebilled Scrubwren		
<i>Sternus vulgaris</i>	Common Starling*		
<i>Strepera graculina</i>	Pied Currawong		
<i>Streptopelia chinensis</i>	Spotted Pouter*		
<i>Threskiornis aethiopicus</i>	Sacred Ibis		
<i>Trichoglossus chlorolepidotus</i>	Scaly Breasted Lorikeet		
<i>Trichoglossus haematodus</i>	Rainbow Lorikeet		
<i>Vanellus miles</i>	Masked Lapwing		
<i>Xanthomyza phrygia</i>	Regent Honeyeater	Endangered, migratory	Endangered
<i>Zosterops lateralis</i>	Silveryeye		

FROGS

<i>Limnodynastes peronii</i>	Striped marsh Frog		
<i>Limnodynastes tasmaniensis</i>	Spotted Grass Frog		
<i>Litoria fallax</i>	Dwarf Tree Frog		
<i>Ranidella signifera</i>	Common Eastern Froglet		

MAMMALS

<i>Antechinus stuartii</i>	Brown Antechinus		
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SCIENTIFIC NAME	COMMON NAME	EPBC ACT STATUS	TSC ACT STATUS
<i>Canis familiaris</i>	Dog*		
<i>Felis catus</i>	Cat*		
<i>Mus domesticus</i>	Mouse*		
<i>Rattus rattus</i>	Black Rat		
<i>Vulpes vulpes</i>	European Fox*		
<i>Petaurus breviceps</i>	Sugar Glider		
<i>Phascolarctos cinereus</i>	Koala		Vulnerable
<i>Pseudocheirus perigrinus</i>	Common Ring-tailed Possum		
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	Vulnerable	Vulnerable
<i>Perameles nasuta</i>	Long-nosed Bandicoot		
<i>Rattus lutreolus</i>	Swamp Rat		
<i>Trichosurus vulpecula</i>	Common Brushtail Possum		

REPTILES

<i>Chelodina longicollis</i>	Long Necked Tortoise		
<i>Lampropholis delicata</i>	Grass Skink		
<i>Pseudechis porphyriacus</i>	Red Bellied Black Snake		
<i>Sphenomorphus quoii</i>	Golden Water Skink		
<i>Tiliqua scincoides</i>	Eastern Blue Tongue		

Appendix D: Weed control techniques

Weed control techniques for species found in Nareen Wetland.

SPECIES	COMMON NAME	CONTROL METHODS
<i>Acetosa sagittata</i>	Turkey Rhubarb	<ul style="list-style-type: none"> Remove and bag propagules (if present) Tubers must be dug from the ground using a trowel and bagged. Dispose of all propagules at a registered green waste disposal centre.
<i>Ageratina adenophora</i>	Crofton Weed	<ul style="list-style-type: none"> Remove and bag propagules (if present) and then plants can be hand pulled without breaking the root system. Assist the plant by handling the plant at the base and using a garden fork or knife to slowly pry out of the ground. Uprooted plants should be placed upside-down with their roots in the air, to dry out
<i>Anredera cordifolia</i>	Madeira Vine	<ul style="list-style-type: none"> Remove and bag propagules including aerial tubers. Small plants and seedlings can be dug out being careful to remove all tubers. Larger plants should be stem-scraped at the nodes and immediately painted with Glyphosate herbicide. Dispose of all propagules at a registered green waste disposal centre.
<i>Araujia sericifera</i>	Moth Vine	<ul style="list-style-type: none"> Remove and bag propagules (if present) Plants and seedlings can be hand pulled without breaking the root system. Assist the plant by handling the plant at the base and using a garden fork or knife to slowly pry out of the ground. Uprooted plants should be placed upside-down with their roots in the air, to dry out. Larger plants should be stem-scraped at the nodes and immediately painted with Glyphosate herbicide.
<i>Cardiospermum grandiflorum</i>	Balloon Vine	<ul style="list-style-type: none"> Remove and bag propagules (if present) Plants and seedlings can be hand pulled without breaking the root system. Assist the plant by handling the plant at the base and using a garden fork or knife to slowly pry out of the ground. Uprooted plants should be placed upside-down with their roots in the air, to dry out. Seedlings can be sprayed with Glyphosate.
<i>Cestrum parqui</i>	Green Cestrum	<ul style="list-style-type: none"> Remove and bag propagules (if present) Small plants and seedlings can be hand pulled without breaking the root system. Assist the plant by handling the plant at the base and using a garden fork or knife to slowly pry out of the ground. Uprooted plants should

		<p>be placed upside-down with their roots in the air, to dry out.</p> <ul style="list-style-type: none"> ▪ Larger plants should be stem-scraped at the nodes and immediately painted with roundup.
<i>Cinnamomum camphora</i>	Camphor Laurel	<ul style="list-style-type: none"> ▪ Trees less than 3 metres must be stem injected or cut close to ground and stump painted within 30 seconds, using a registered herbicide. ▪ Trees 3 metres or higher may be removed by cutting trees close to ground and paint stump within 30 seconds, or stem inject where this will not pose a risk to life or property, using a registered herbicide. ▪ Dispose of all propagules at a registered green waste disposal centre or chip.
<i>Conyza sp</i>	Fleabane	<ul style="list-style-type: none"> ▪ Remove and bag propagules (if present) and then small plants (<1cm trunk diameter) can be hand pulled without breaking the root system. Assist the plant by handling the plant at the base and using a garden fork or knife to slowly pry out of the ground. Uprooted plants should be placed upside-down with their roots in the air, to dry out.
<i>Coreopsis lanceolata</i>	Common Tick-seed	<ul style="list-style-type: none"> ▪ Small plants can be hand pulled without breaking the root system. Assist the plant by handling the plant at the base and using a garden fork or knife to slowly pry out of the ground. Uprooted plants should be placed upside-down with their roots in the air, to dry out. ▪ Larger infestations can be sprayed with a registered herbicide. Spray infestations as flowers first appear to prevent seed set. ▪ Dispose of all propagules at a registered green waste disposal centre.
<i>Cortaderia selloana</i>	Pampas Grass	<ul style="list-style-type: none"> ▪ Remove and bag propagules (if present) ▪ Small plants and seedlings can be hand pulled without breaking the root system. Assist the plant by handling the plant at the base and using a garden fork or knife to slowly pry out of the ground. Uprooted plants should be placed upside-down with their roots in the air, to dry out. ▪ Larger plants should be cut close to ground and paint stump within 30 seconds.
<i>Cotoneaster sp</i>	Cotoneaster	<ul style="list-style-type: none"> ▪ Remove and bag propagules (if present) ▪ Small plants (<1cm trunk diameter) can be hand pulled without breaking the root system. Assist the plant by handling the plant at the base and using a garden fork or knife to slowly pry out of the ground. Uprooted plants should be placed upside-down with their roots in the air, to dry out. ▪ Trees (> 5cm trunk diameter) can be drilled/frilled and saplings (< 5cm trunk diameter) can be cut and painted and a registered herbicide applied. Herbicide should be applied within 30 seconds of making the cut to ensure maximum intake by the plant. Ringbarking has proven to be ineffective. Follow-up control may be necessary. ▪ Dispose of all propagules at a registered green waste disposal centre.
<i>Crocasmia x crocosmiiflora</i>	Montbretia	<ul style="list-style-type: none"> ▪ Remove and bag propagules (if present) and then plants can be hand pulled without breaking the root system. Assist the plant by handling the plant at the base and using a garden fork or knife to slowly pry out of the ground.

		<ul style="list-style-type: none"> Tubers must be dug from the ground using a trowel and bagged Dispose of all plant material at a registered green waste disposal centre.
<i>Delairea odorata</i>	Cape Ivy	<ul style="list-style-type: none"> Remove and bag propagules (if present) Plants and seedlings can be hand pulled without breaking the root system. Assist the plant by handling the plant at the base and using a garden fork or knife to slowly pry out of the ground. Uprooted plants should be placed upside-down with their roots in the air, to dry out. Larger plants can be cut and painted with Glyphosate if difficult to access for hand pulling.
<i>Ehrharta erecta</i>	Panic Veldgrass	<ul style="list-style-type: none"> Remove and bag propagules (if present) Small plants and seedlings can be hand pulled without breaking the root system. Assist the plant by handling the plant at the base and using a garden fork or knife to slowly pry out of the ground. Uprooted plants should be placed upside-down with their roots in the air, to dry out. Large infestations can be sprayed with a registered herbicide. Follow-up spray will be necessary prior to seeding.
<i>Erythrina crista-galli</i>	Cockspur Coral Tree	<ul style="list-style-type: none"> Small plants (<1cm trunk diameter) can be hand pulled without breaking the root system. Assist the plant by handling the plant at the base and using a garden fork or knife to slowly pry out of the ground. Uprooted plants should be placed upside-down with their roots in the air, to dry out. Trees (> 5cm trunk diameter) can be drilled/frilled and saplings (< 5cm trunk diameter) can be cut and painted and a registered herbicide applied. Herbicide should be applied within 30 seconds of making the cut to ensure maximum intake by the plant. Ringbarking has proven to be ineffective. Follow-up control may be necessary. Dispose of all plant material at a registered green waste disposal centre.
<i>Hedychium gardnerianum</i>	Yellow Ginger	<ul style="list-style-type: none"> Tubers must be dug from the ground using a trowel and bagged. Dispose of all plant material at a registered green waste disposal centre.
<i>Ipomoea indica</i> and <i>Ipomoea cairica</i>	Morning Glory	<ul style="list-style-type: none"> Plants and seedlings to be hand pulled without breaking the root system. Assist the plant by handling the plant at the base and using a garden fork or knife to slowly pry out of the ground. Uprooted plants should be placed upside-down with their roots in the air, to dry out. Cut and paint with herbicide to control edge areas and final hand-weed of area. Spraying large areas if no natives present. May require several spray treatments.
<i>Lantana camara</i>	Lantana	<ul style="list-style-type: none"> Small plants and seedlings can be hand pulled without breaking the root system. Assist the plant by handling the plant at the base and using a garden fork or knife to slowly pry out of the ground. Uprooted plants should be placed upside-down with their roots in the air, to dry out. Larger plants (> 5cm trunk diameter) can be cut and painted and a registered herbicide applied. Herbicide should be applied within 30 seconds of making the cut to ensure maximum intake by the plant.
<i>Ligustrum lucidum</i> and	Large-leafed Privet /	<ul style="list-style-type: none"> Small plants (<1cm trunk diameter) can be hand pulled without breaking the root system. Assist the plant by

<i>Ligustrum sinense</i>	Small-leafed Privet	<p>handling the plant at the base and using a garden fork or knife to slowly pry out of the ground. Uprooted plants should be placed upside-down with their roots in the air, to dry out.</p> <ul style="list-style-type: none"> Trees (> 5cm trunk diameter) can be drilled/frilled and saplings (< 5cm trunk diameter) can be cut and painted and a registered herbicide applied. Herbicide should be applied within 30 seconds of making the cut to ensure maximum intake by the plant. Ringbarking has proven to be ineffective. Follow-up control may be necessary.
<i>Lilium formosanum</i>	Formosan Lily	<ul style="list-style-type: none"> Remove and bag propagules (if present) Plants and seedlings should be hand pulled without breaking bulbs. Assist the plant by handling the plant at the base and using a garden fork or knife to slowly pry out of the ground. Dispose of bulbs at a registered green waste disposal centre.
<i>Lonicera japonica</i>	Honey Suckle	<ul style="list-style-type: none"> Small plants and seedlings can be hand pulled without breaking the root system. Assist the plant by handling the plant at the base and using a garden fork or knife to slowly pry out of the ground. Uprooted plants should be placed upside-down with their roots in the air, to dry out. Cut and paint any larger trunks that cannot be hand pulled with herbicide. No surface roots should remain exposed and untreated.
<i>Ludwigia peruviana</i>	Ludwigia	<ul style="list-style-type: none"> Remove and bag propagules (if present) Small plants and seedlings can be hand pulled without breaking the root system. Assist the plant by handling the plant at the base and using a garden fork or knife to slowly pry out of the ground. Uprooted plants should be placed upside-down with their roots in the air, to dry out. Larger plants and infestations will require chemical control. Chemical control is to be undertaken in accordance with the requirements of the local control authority. Dispose of all plant material at a registered green waste disposal centre.
<i>Nerium oleander</i>	Oleander	<ul style="list-style-type: none"> Oleander is a highly poisonous species and care must be taken in its removal. Wear protective clothing. Cut and paint multiple trunks with herbicide.
<i>Ochna serrulata</i>	Mickey Mouse Plant	<ul style="list-style-type: none"> Small plants can be hand pulled without breaking the root system. Assist the plant by handling the plant at the base and using a garden fork or knife to slowly pry out of the ground. Uprooted plants should be placed upside-down with their roots in the air, to dry out. Larger plants should be stem-scraped at ground and immediately painted with roundup. Dispose of all propagules at a registered green waste disposal centre.
<i>Olea europaea</i> subsp. <i>cuspidate</i>	African Olive	<ul style="list-style-type: none"> Small plants and seedlings can be hand pulled without breaking the root system. Assist the plant by handling the plant at the base and using a garden fork or knife to slowly pry out of the ground. Uprooted plants should be placed upside-down with their roots in the air, to dry out. Larger plants (> 5cm trunk diameter) can be cut and painted or drilled and filled with a registered herbicide applied. Herbicide should be applied within 30 seconds of making the cut to ensure maximum intake by the

		plant. Follow-up may be required.
<i>Parietaria judaica</i>	Wall Pellitory	<ul style="list-style-type: none"> Remove and bag entire plant Young seedlings can be sprayed with herbicide. Multiple and regular site visits will be required to ensure full control.
<i>Phytolacca octandra</i>	Inkweed	<ul style="list-style-type: none"> Remove and bag propagules (if present) Small plants and seedlings can be hand pulled without breaking the root system. Assist the plant by handling the plant at the base and using a garden fork or knife to slowly pry out of the ground. Uprooted plants should be placed upside-down with their roots in the air, to dry out.
<i>Ricinus communis</i>	Castor Oil Plant	<ul style="list-style-type: none"> Remove and bag propagules (if present) Larger plants (> 5cm trunk diameter) can be cut and painted and a registered herbicide applied. Herbicide should be applied within 30 seconds of making the cut to ensure maximum intake by the plant.
<i>Rubus fruticosus</i>	Blackberry	<ul style="list-style-type: none"> Small infestations can be dug out, however all parts of the root system must be removed to avoid reshooting. This control technique is not advisable on slopes, riparian zones or in situations where accelerated erosion may potentially occur. Herbicide control is most effective from November to April, when the plant is flowering /fruiting and actively growing. The weed must not be treated when dormant. Blackberry can be sprayed with a registered herbicide. Several follow-up treatments may be required. Cut and paint techniques can be effective during flowering.
<i>Salix</i> spp.	Willow	<ul style="list-style-type: none"> Small plants (<1cm trunk diameter) can be hand pulled without breaking the root system. Assist the plant by handling the plant at the base and using a garden fork or knife to slowly pry out of the ground. Uprooted plants should be placed upside-down with their roots in the air, to dry out. Trees (> 5cm trunk diameter) can be drilled/frilled and saplings (< 5cm trunk diameter) can be cut and painted and a registered herbicide applied. Herbicide should be applied within 30 seconds of making the cut to ensure maximum intake by the plant
<i>Salvinia molesta</i>	Salvinia	<ul style="list-style-type: none"> Small infestations can be removed by hand, however all parts of the plant must be bagged and removed. Large infestations can be mechanically removed or treated with herbicide. Any chemical control is to be undertaken in accordance with the requirements of the local control authority. Investigation into other techniques should be undertaken (such as booms, fences, harvesters, herbicides etc.) Investigation into acclimatising and introducing <i>Cyrtobagous salviniae</i> (Salvinia weevil) into Warriewood Wetland should be undertaken.
<i>Senna pendula</i> var. <i>glabrata</i>	Cassia	<ul style="list-style-type: none"> Remove and bag propagules (if present) Small plants and seedlings can be hand pulled without breaking the root system. Assist the plant by handling the plant at the base and using a garden fork or knife to slowly pry out of the ground. Uprooted plants should

		<p>be placed upside-down with their roots in the air, to dry out.</p> <ul style="list-style-type: none"> ▪ Larger plants (> 5cm trunk diameter) can be cut and painted and a registered herbicide applied. Herbicide should be applied within 30 seconds of making the cut to ensure maximum intake by the plant.
<i>Tradescantia fluminensis</i>	Wandering Jew	<ul style="list-style-type: none"> ▪ Infestations require mechanical removal (e.g. raking) as spraying is not entirely effective, however it can help to rake and roll difficult areas after initial spray. ▪ Rake and roll into pile. Turn and compact regularly. Monitor pile and allow to decompose on site. ▪ Black builders plastic can be utilised to smother dense infestations. ▪ Dispose of hand weeded plant material at a registered green waste disposal centre.

Appendix E: Species suitable for revegetation

SPECIES	COMMON NAME	LIFE FORM	VEGETATION TYPE
Trees			
<i>Casuarina glauca</i>	Swamp Oak	Tree	Moist Forest/Swampy Areas
<i>Glochidion ferdinandi</i>	Cheese Tree	Tree	Dry/Moist Forest
<i>Eucalyptus botryoides</i>	Bangalay	Tree	Dry/Moist Forest
<i>Eucalyptus robusta</i>	Swamp Mahogany	Tree	Moist Forest/Swampy Areas
<i>Livistona australis</i>	Cabbage Palm	Tree	Moist Forest
<i>Cyathea cooperi</i>	Straw Tree-fern	Tree Fern	Moist Forest
Shrubs			
<i>Acmena smithii</i>	Lilly-pilly	Shrub/Tree	Moist Forest
<i>Polyscias sambucifolia</i>	Elderberry Panax	Shrub	Dry Forest
<i>Elaeocarpus reticulatus</i>	Blueberry Ash	Shrub	Dry Forest
<i>Monotoca elliptica</i>	Tree Broom-heath	Shrub	Dry Forest
<i>Breynia oblongifolia</i>	Coffee Bush	Shrub	Dry Forest
<i>Pultenaea villosa</i>		Shrub	Dry Forest
<i>Viminaria juncea</i>	Native Broom	Shrub	Moist Forest
<i>Acacia decurrens</i>	Black Wattle	Shrub	Dry Forest
<i>Acacia elongata</i>	Swamp Wattle	Shrub	Moist Forest
<i>Acacia floribunda</i>	White Sally	Shrub	Moist Forest
<i>Acacia longifolia</i>	Sydney Golden Wattle	Shrub	Dry Forest
<i>Acacia parramattensis</i>	Parramatta Wattle	Shrub	Dry Forest
<i>Acacia suaveolens</i>	Sweet Wattle	Shrub	Dry Forest
<i>Callistemon citrinus</i>	Scarlet Bottlebrush	Shrub	Moist Forest/Swampy Areas
<i>Callistemon linearis</i>	Narrow-leaved Bottlebrush	Shrub	Moist Forest

SPECIES	COMMON NAME	LIFE FORM	VEGETATION TYPE
<i>Leptospermum juniperinum</i>	Prickly Tea-tree	Shrub	Moist Forest
<i>Melaleuca ericifolia</i>	Swamp Paperbark	Shrub	Swampy Areas
<i>Melaleuca linariifolia</i>	Flax-leaved Paperbark	Shrub	Moist Forest

Groundcovers

<i>Blechnum camfieldii</i>	Water Fern	Fern	Moist Forest
<i>Blechnum indicum</i>	Swamp Water Fern	Fern	Swampy Areas
<i>Entolasia marginata</i>	Bordered Panic	Grass	Moist Forest
<i>Hemarthria uncinata</i>	Mat Grass	Grass	Moist Forest/Swampy Areas
<i>Imperata cylindrica</i>	Blady Grass	Grass	Dry Forest
<i>Isachne globosa</i>	Swamp Millet	Grass	Swampy Areas
<i>Oplismenus aemulus</i>	Broad-leaved Basket Grass	Grass	Moist Forest
<i>Paspalum distichum</i>	Water Couch	Grass	Swampy Areas
<i>Themeda australis</i>	Kangaroo Grass	Grass	Dry Forest
<i>Alternanthera denticulata</i>	Common Joyweed	Herb	Swampy Areas
<i>Ludwigia peploides</i> subsp. <i>montevidensis</i>	Water Primrose	Herb	Swampy Areas
<i>Viola hederacea</i>	Native Violet	Herb	Moist Forest
<i>Alisma plantago-aquatica</i>	Water-plantain	Herb	Swampy Areas
<i>Alocasia brisbanensis</i>		Herb	Moist Forest
<i>Commelina cyanea</i>	Blue Spiderwort	Herb	Moist Forest
<i>Triglochin microtuberosum</i>		Herb	Swampy Areas
<i>Triglochin procerum</i>	Water Ribbons	Herb	Swampy Areas
<i>Lomandra longifolia</i>	Spiny-headed Mat-rush	Herb	Dry/Moist Forest
<i>Philydrum lanuginosum</i>	Woolly Waterlily	Herb	Swampy Areas
<i>Dianella caerulea</i>	Blue Flax-lily	Herb	Dry/Moist Forest
<i>Dianella caerulea</i> var. <i>producta</i>		Herb	Dry/Moist Forest
<i>Baumea articulata</i>	Jointed Twig-rush	Sedge/Rush	Moist Forest/Swampy Areas
<i>Baumea juncea</i>	Bare Twig-rush	Sedge/Rush	Moist Forest/Swampy Areas
<i>Baumea rubiginosa</i>	Soft Twig-rush	Sedge/Rush	Moist Forest/Swampy Areas

SPECIES	COMMON NAME	LIFE FORM	VEGETATION TYPE
<i>Bolboschoenus fluviatilis</i>	Club-rush	Sedge/Rush	Moist Forest/Swampy Areas
<i>Carex appressa</i>	Tall Sedge	Sedge/Rush	Moist Forest/Swampy Areas
<i>Cladium procerum</i>		Sedge/Rush	Swampy Areas
<i>Cyperus exaltatus</i>	Giant Sedge	Sedge/Rush	Moist Forest/Swampy Areas
<i>Eleocharis equisetina</i>		Sedge/Rush	Swampy Areas
<i>Eleocharis sphacelata</i>	Tall Spike-rush	Sedge/Rush	Swampy Areas
<i>Ficinia nodosa</i>	Knobby Club-rush	Sedge/Rush	Moist Forest/Swampy Areas
<i>Gahnia sieberiana</i>	Red-fruited Saw-sedge	Sedge/Rush	Moist Forest/Swampy Areas
<i>Schoenoplectus mucronatus</i>		Sedge/Rush	Moist Forest/Swampy Areas
<i>Schoenoplectus validus</i>	River Club-rush	Sedge/Rush	Moist Forest/Swampy Areas
<i>Juncus kraussii</i> subsp. <i>australiensis</i>	Sea Rush	Sedge/Rush	Moist Forest/Swampy Areas
<i>Juncus polyanthemus</i>	Tussock Rush	Sedge/Rush	Dry/Moist Forest
<i>Juncus usitatus</i>		Sedge/Rush	Dry/Moist Forest
<i>Baloskion tetraphyllum</i>	Tassel Cord-rush	Sedge/Rush	Moist Forest
<i>Leptocarpus tenax</i>		Sedge/Rush	Moist Forest

Climbers

<i>Pandorea pandorana</i>	Wonga Vine	Climber	Dry Forest
<i>Hardenbergia violacea</i>	False Sarsaparilla	Climber	Dry Forest
<i>Kennedia rubicunda</i>	Dusky Coral-pea	Climber	Dry Forest
<i>Stephania japonica</i> var. <i>discolor</i>	Snake Vine	Climber	Moist Forest
<i>Clematis glycinoides</i>	Headache Vine	Climber	Dry/Moist Forest
<i>Morinda jasminoides</i>	Morinda	Climber	Moist Forest
<i>Cayratia clematidea</i>	Slender Grape	Climber	Dry/Moist Forest
<i>Cissus hypoglauca</i>	Native Grape, Water Vine	Climber	Dry/Moist Forest
<i>Eustrephus latifolius</i>	Wombat Berry	Climber	Dry/Moist Forest

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