Nareen Wetland, North Narrabeen
Plan of Management

Prepared under the Local Government Act, 1993

Prepared by

ecological AUSTRALIA

CMA Sydney Metropolitan Catchment Management Authority

PITTWATER COUNCIL

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Abbreviations

ABBREVIATION	DESCRIPTION
ASS	Acid sulfate 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
SMCMA	Sydney Metropolitan Catchment Management Authority
WSUD	Water Sensitive Urban Design

Executive Summary

Nareen Wetland is a freshwater wetland covering an area of approximately 8 ha in North Narrabeen (Pittwater LGA). It is public land owned by Pittwater Council. The entire site is zoned 6a: Existing Recreation "A" under the *Pittwater Local Environment Plan 1993*.

Urban development in the 1950-80s included construction of the concrete channel downstream of Nareen Wetland. Previously, the wetland would have been an embayment of Narrabeen Lagoon, and would therefore have been a saline system (Cardno Lawson Treloar 2009). Overall, the creek and wetland are now in very poor condition with numerous environmental and hydrological issues.

Nareen Wetland has been identified by Pittwater Council as category Co1: a disturbed area that is likely to be of habitat value due to good crown cover and/or understorey (Burcher 1995). The wetland provides important connections for species (particularly highly mobile and migratory species) inhabiting larger habitat areas to the north and south. It also offers a venue for recreational activities like bird watching and the children's playground.

Implementation of actions in this Plan will help achieve the vision for Nareen Creek to:

> *Maintain and improve existing natural physical and biological diversity in the catchment and return, as much as possible, the diversity that has been lost from the riparian zone.*

High priority actions recommended in this Plan include:

- Control aquatic weeds
- Regenerate the Swamp Oak Floodplain Forest vegetation community
- Maintain the bushfire asset protection zone
- Reduce sources of pollutants and weeds
- Construct a boardwalk and walking trails
- Revegetate the landfill area in collaboration with the community
- Community education

1 Introduction

1.1 CONTEXT

Pittwater Council has prepared this Plan of Management (PoM) with assistance from the NSW Government's Catchment Action New South Wales Program (funding allocated by Sydney Metropolitan CMA), which provides funds to prepare PoMs for selected wetlands in the local government area (LGA). The preparation of these plans 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 has developed this Plan of Management for Nareen Wetland in consultation with Council, the community and interest groups. The Plan identifies 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)
- *Nareen Creek Rehabilitation Plan* (Hyder Consulting, May 2008)

1.2 STUDY AREA

Nareen Wetland is a freshwater wetland covering an area of approximately 8 ha in North Narrabeen (Pittwater LGA). The wetland is situated on the southern side of the middle reaches of Nareen Creek. Narroy Park, a grassed area of open space fringed with *Casuarina* trees, is located on the northern side of the creek. This park is not included in the study area for this PoM. The wetland is surrounded by low lying residential areas and a number of commercial properties downstream, adjacent to Pittwater Road.

Water flows into the wetland via 200 m of pipe connected to the Tatiara Crescent culvert. Nareen Creek flows the full length of the wetland and then into a concrete-lined channel downstream of Narroy Road. This channel flows into Narrabeen Lagoon.

The site and surrounding area are depicted in **Figure 1**.

Figure 1: Study location

1.3 PROJECT NEED AND OBJECTIVES

This plan has been developed to meet the requirement of "valuing and caring for our natural environment" in the Pittwater Council Strategic Management Plan.

Nareen Creek and the associated wetland are valued by the local community (Hyder Consulting 2008) because the area provides opportunities for recreation and habitat for a number of native flora and fauna species. Overall, the creek and wetland are in poor condition with numerous environmental and hydrological issues. The need to resolve these issues requires a detailed plan of management to guide the conservation and management of Nareen Wetland.

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. The Plan also addresses key issues in relation to the management of the reserves, including conservation, management, access and public safety.

This PoM for Nareen 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 future appropriate recreation options
    - Activities and management actions aiming to engage the local community

This PoM supplements on the Nareen Creek Rehabilitation Plan (Hyder Consulting 2008), which outlines broad management strategies for six reaches within Nareen Creek. This PoM examines those strategies and provides detailed management actions in a ready-to-implement format for the two reaches that comprise Nareen Wetland.

1.4 CONSULTATION

1.4.1 Previous community consultation

A total of 104 residents participated in community survey and consultation undertaken in 2007 during the development of the *Nareen Creek Rehabilitation Plan* (Hyder Consulting 2008). This information was valuable in developing the current PoM in that it allowed an up-front identification of the values, issues and actions for Nareen Creek and wetland, as perceived by the community. While the consultation process focused on the whole of Nareen Creek, the findings below are also directly applicable to the two reaches of the creek that make up Nareen Wetland.

- The community places a high level of importance on the Nareen Creek system in terms of their lifestyle and business.
- Key values identified by the community for Nareen 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.

- A significant proportion of survey respondents view Nareen Creek system as 'unhealthy' or 'very unhealthy'.
- Key issues identified as 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 Nareen Creek include: education, weed removal and native re-vegetation 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

A list of legislation and policy that has been taken into consideration in the development of this Plan of Management is given 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:

- *Nareen Creek Rehabilitation Plan 2008:* Provides an assessment of the current condition of Nareen Creek and broad management strategies to improve the physical and biological diversity of the creek and catchment.
- *Nareen Creek Floodplain Risk Management Study and Plan (Draft) 2009*: Investigates what can be done to reduce and manage the effects of flooding in the Nareen Creek Catchment.
- *Narrabeen Lagoon Estuary Management Plan 2002*: Aims to achieve long-term sustainable management of the lagoon. This plan provided the impetus for the development of the Nareen Creek Rehabilitation Plan.
- *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 Nareen Wetland. More specifically, the *Nareen Creek Rehabilitation Plan* (Hyder Consulting 2008) presents a vision for Nareen Creek to:

> *Maintain and improve existing natural physical and biological diversity in the catchment and return, as much as possible, the diversity that has been lost from the riparian zone.*

The management strategies and actions in this Plan of Management have been designed to work towards achieving this specific vision for Nareen Wetland, acknowledging the entire wetland as a component of the Nareen Creek riparian zone.

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 Nareen Wetland have been prepared in accordance with the above principles.

3.3 COUNCIL MANAGEMENT

Nareen Wetland is public land owned by Pittwater Council. The entire site is zoned 6a: Existing Recreation "A" under the *Pittwater Local Environment Plan 1993*.

The two major vegetation management programs currently taking place are a restoration program of the Swamp Oak Floodplain Forest at the western end and aquatic weed control works within the freshwater

areas at the eastern end of the wetland. Aquatic weed control is currently focused on Cockspur Coral Tree (*Erythrina cista-galli*), Cassia (*Senna pendula* var. *glabrata*), Ludwigia (*Ludwigia peruviana*) and Willow (*Salix* spp.) throughout all accessible areas of the wetland.

Parkland in the south-east corner of the site is mown regularly.

3.4 COMMUNITY ACTIVITIES

Nareen Creek and adjacent Narroy Park are currently well used by the local community. The most commonly undertaken activities include walking, bird watching and dog recreation. There is a viewing platform on the northern side of Nareen Creek that overlooks the creek and provides views across to the wetland area. In the south-eastern corner of the study area (i.e. between the wetland and Narroy Road) there is a grassy area with children's play equipment. This area is used as a meeting area for groups with young children and an informal dog off-leash park (note that this area has not been allocated by Council as an official dog exercise area).

Viewing platform overlooking Nareen Wetland

4 Resource overview and site features

4.1 VALUES STATEMENT

The values of Nareen Wetland include:

- Biodiversity including endangered ecological communities
- Habitat and wildlife corridor provision
- Recreation
- Aesthetic / visual amenity
- Storm- and flood-water retention

4.2 SITE HISTORY

Nareen Wetland is a highly modified environment that is vastly different from its original natural state (refer to historic aerial photographs in **Appendix A**). Under pre-development conditions (i.e. prior to construction of the concrete channel downstream of the wetland) Nareen Wetland would have been an embayment of Narrabeen Lagoon, and would therefore have been a saline system (Cardno Lawson Treloar 2009).

Rapid urban development in the 1950-80s saw much of the area adjacent to Narrabeen Lagoon filled. Hydrological modification of the entire Nareen Creek catchment was associated with this development. The natural drainage channels of the upper catchment have been supplemented with an extensive network of stormwater pipes, culverts and an open channel, while the downstream portion of Nareen Creek consists of a concrete-lined open channel.

4.3 TOPOGRAPHY, GEOLOGY & SOILS

4.3.1 Topography

Nareen Wetland is situated in a naturally low lying area at the base of the Elanora Escarpment. It is fed by freshwater inflows from Nareen Creek and discharges into Narrabeen Lagoon. The creek flows through the full length of the wetland and then into a concrete-lined open channel. The open channel rises up to 0.83 m AHD. This limits the tidal inflow of water into the wetland and promotes freshwater storage.

4.3.2 Geology and soils

Soils within the Nareen Creek catchment are dominated by Warriewood soil landscapes, which generally occur in swampy areas and are not considered suitable for urban development. The soils have low fertility and can be highly acidic.

Soil landscape mapping indicates the majority of the Nareen Wetland area is ‘disturbed’ i.e. a previous tip/fill site. This is thought to be related to rapid land reclamation and housing development in the 1950-80s. The quality of the fill is unknown, however it is believed to be mostly sand dredged from Narrabeen Lagoon (Cardno Lawson Treloar 2009).

4.3.3 Contaminated sediments

Potential acid sulfate soils (ASS) are natural soils that form in seawater or brackish 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.

Potential ASS 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.

Land that may contain potential ASS has been identified from maps provided by the former NSW Department of Land and Water Conservation. These 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 Nareen wetland is identified as Class 2 (**Figure 2**).

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

Sediment testing at six sites across Nareen Weltand in 2009 indicated that these sites were strongly acid sulfate. Requirements to effectively manage these sediments if extracted/disturbed include bunding of the extracted sediment, mixing with the appropriate quantity of lime (to neutralize the acidity), and return of ASS materials to anaerobic conditions as soon as possible (Ecology Lab 2009).

Testing for other contaminants revealed that heavy metal concentrations were within the recommended guidelines apart from arsenic, lead and zinc which were above ANZECC guidelines levels at one site. Organochlorine compounds were generally below the level of reporting except for DDE, DDD, chlordane and dieldrin at the downstream testing and dieldrin at the upstream testing site. Any works in these areas presents a significant risk of mobilizing these contaminants and impacting biodiversity (Ecology Lab 2009).

4.3.4 Erosion and sedimentation

Erosion has been identified as an issue impacting on the health of all reaches of Nareen Creek, including the wetland areas (Hyder Consulting 2008). Chief causes of erosion are stormwater runoff and lack of riparian vegetation.

Eroded sediments from upstream appear to be accumulating in Nareen wetland. Hyder Consulting (2008) has recommended further investigation into the causes of sedimentation and the possibility of manual sediment removal.

4.4 WATER AND FLOODING

4.4.1 Water quality

There is very little information available regarding water quality in Nareen Wetland. Hyder Consulting (2008) undertook a limited program of water quality testing in 2007 at sites throughout Nareen Creek. These results indicated very low dissolved oxygen concentration in the middle reaches of Nareen Creek (<20% compared to guideline levels of 85-110%). The concentrations of nitrogen and phosphorus were five and eight times the recommended guidelines levels within the creek reach adjacent to the wetland.

The concrete channel downstream of Nareen Wetland inclines upward, and therefore the wetland is typically only flushed during periods of heavy rainfall. During periods of reduced rainfall, the absence of flushing can lead to deterioration of water quality within the wetland. The majority of local residents feel that water quality in Nareen Creek is poor or very poor, and report odours, oily or frothy slicks and floating matter within the creek system (Hyder Consulting 2008).

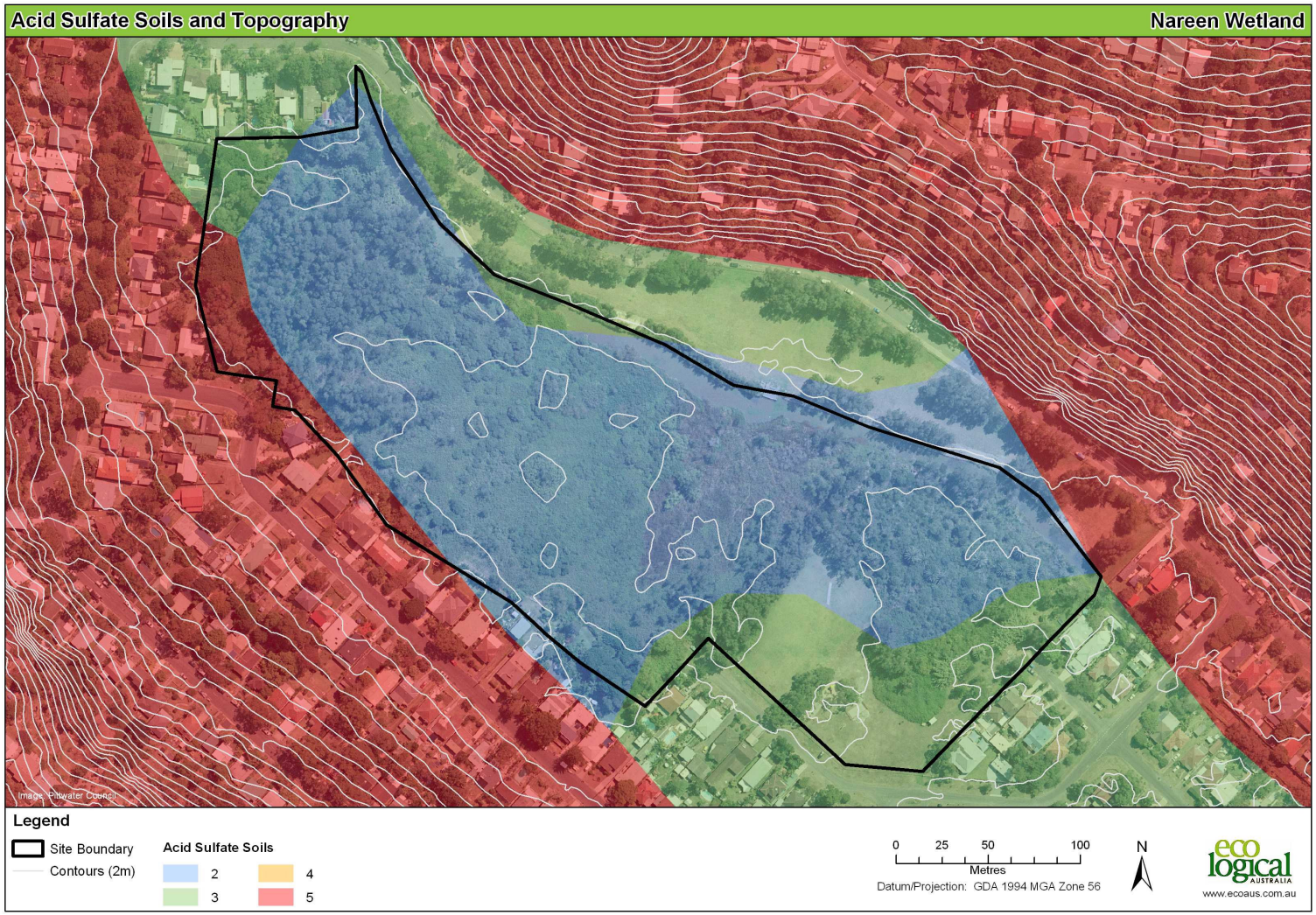

Figure 2: Topography and potential acid sulfate soils

4.4.2 Flood behaviour

Cardno Lawson Treloar (2009) assessed the flooding behaviour and risk for the Nareen Creek floodplain. Major floods have occurred in the Nareen Creek catchment in March 1942, May 1974, August 1986, October 1987, April 1998 and May 2003. The whole of Nareen Wetland lies within the five year ARI flood extent and Narroy Park currently provides a large flood storage area. Numerous properties and roads within the Nareen Creek catchment have been identified as being at high risk from even small-scale flood events.

The water levels in Narrabeen Lagoon are an important control on flooding in Nareen Wetland and are influenced by lagoon entrance conditions, tidal state and storm surges. High water levels within the lagoon can prevent or impede flood water from effectively discharging from the wetland creating a 'backwater effect' (Cardno Lawson Treloar 2009). Pittwater Council are currently working with Warringah Council on the Narrabeen Lagoon Flood Study, which is a large joint project due for completion in 2012. The backing up of floodwaters from Narrabeen Lagoon into Nareen Wetland is being assessed within the scope of this study.

4.4.3 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). Under modelled scenarios of 55 cm and 91 cm sea level rise, Nareen Wetland is likely to be almost fully inundated on a mean spring tide (Cardno Lawson Treloar 2009). This will result in regular inundation of the currently freshwater wetland with saline water. This may result in the conversion of the wetland into a brackish/saline system.

4.5 PLANT AND PLANT COMMUNITIES

4.5.1 Vegetation communities

The distribution of vegetation communities at Nareen Wetland was mapped by botanists from Eco Logical Australia during the development of this plan (**Figure 3**). Vegetation communities in the study area include:

- Herbaceous Swamp Complex – *Isachne globosa* and *Persicaria strigosa* dominated
- Herbaceous Swamp Complex - *Ludwigia peruviana* (weed species) and *Typha orientalis* dominated
- *Casuarina glauca* Swamp Sclerophyll Forest/Woodland

Approximately one quarter of the study area is cleared or semi-cleared.

The vegetation communities at Nareen Wetland are consistent with Endangered Ecological Communities (EECs) listed under the NSW *Threatened Species Conservation Act 1995*. *Casuarina glauca* Swamp Sclerophyll Forest/Woodland is consistent with the Swamp Oak Floodplain Forest EEC (DECC 2005a), while the Herbaceous Swamp Complexes are consistent with the Sydney Freshwater Wetland EEC (DECC 2005b).

Pittwater Council has mapped the entire study area as Sydney Freshwater Wetland EEC. This broad scale mapping includes some areas identified as Swamp Oak Floodplain Forest within the Sydney Freshwater Wetland EEC. The Sydney Freshwater Wetland EEC does not have a tree or shrub layer (DECC 2005b), while the Swamp Oak Floodplain Forest is dominated by a sparse to dense tree layer dominated by *Casuarina glauca* (DECC 2005a), which is characteristic of two patches of vegetation at Nareen Wetland.

EECs recognised under the *NSW Threatened Species Conservation Act 1995* (TSC Act) face a very high risk of extinction in NSW in the near future (DECC 2005). Threats to the Swamp Oak Floodplain Forest and Sydney Freshwater Wetland EECs include (DECC 2005a, b):

- Activation of acid sulfate soils
- Clearing for urban and rural development, and the subsequent impacts from fragmentation
- Climate change
- Flood mitigation and drainage works
- Grazing and trampling by stock and feral animals
- Habitat degradation resulting from altered hydrology/nutrient levels, weed invasion, off-road vehicles, illegal waste dumping and sand extraction
- Landfilling and earthworks associated with urban and industrial development
- Localised areas, particularly those within urbanised regions, may also be exposed to frequent burning which reduces the diversity of woody plant species.
- Pollution from urban and agricultural runoff
- Rubbish dumping

Strategies required to recover EECs have been identified by DECCW in the Priority Action Statement (2005). Actions for the Swamp Oak Floodplain Forest EEC at Nareen Wetland are listed below. Not all actions may be relevant or feasible at Nareen Wetland. Management recommendations put forward in this PoM are consistent with the relevant stated recovery actions.

- Control access to remnants by installing fencing and signage and rationalising informal tracks through the community.
- Ensure that the fire sensitivity of the community is considered when planning hazard reduction and asset management burning.
- Improve vegetative connectivity within and between remnants through revegetation /regeneration programs and provide vegetative buffers around these remnants.
- Install stormwater control mechanisms to prevent off-site impacts from adjacent development.
- Promote public involvement in restoration activities.
- Protect habitat by minimising further clearing of the community. This requires recognition of the values of all remnants in the land use planning process, particularly development consents, rezonings and regional planning.
- Restore natural drainage conditions.
- Undertake restoration including bush regeneration and revegetation.
- Weed control.

Sydney Freshwater Wetland EEC

The Sydney Freshwater Wetland EEC is in a degraded state. Early aerial photography (1945 - see **Appendix A**) indicates the area currently covered by this community comprised a large open water section fringed by Swamp Oak Floodplain Forest within a sheltered embayment of Narrabeen Lagoon. However, hydrological changes and alterations to the land (fill) have resulted in the current wetland vegetation community. There is little diversity within the wetland, with *Typha orientalis* dominating, and isolated individuals of *Persicaria* spp. and *Ludwigia peploides* subsp. *montevidensis*. The introduced *Ludwigia peruviana* and Cockspur Coral Tree (*Erythrina crista galli*) are widespread throughout the wetland and present both a threat to native biodiversity and a significant management issue.

Pittwater Council has conducted aquatic weed control in the wetland. The work focuses on Ludwigia removal and primarily comprises herbicide application by spray. Ludwigia control is reliant on persistent

control for many years and, to be effective, it must be on-going. Patches of Ludwigia infestation have been observed along Nareen Creek a short distance up-steam of the wetland. Control of Cockspur Coral Tree throughout the catchment is also fundamental to the long-term effectiveness of the weed control program.

Sydney Freshwater Wetland EEC - Nareen Wetland

Pittwater Council commissioned a feasibility study to investigate options for the large scale mechanical removal of the aquatic weed mass and dredging of the sediments to extend open water areas within the wetland (Ecology Lab 2009). Assessments at two sites indicate that the presence of acid sulfate soils and other contaminants are likely to significantly constrain the feasibility of dredging proposals for the present due to the need for costly mitigation measures. The benefits to the aquatic ecosystem and recreational amenity associated with increasing open water areas should not preclude the consideration of dredging as a potential long-term management option.

Swamp Oak Floodplain Forest EEC

There are two areas of Swamp Oak Floodplain Forest within the wetland. Bush-regeneration programs within the larger western patch have shown good results with regeneration of number of native species such as Blue Flax-lily (*Dianella caerulea*) and Snake Vine (*Stephania japonica* var. *discolor*). While the resilience of this area is considered to be moderate, the weed cover is heavy in most areas. In accordance with best practise bush regeneration principles, it is important to 'hold the advantage gained' before weeding further areas to make sure weed regrowth does not overtake germinating native plants and habitat is retained for fauna such as Bandicoots and small bush birds.

Further improvement requires that adequate resources are allocated to follow up this work and reduce reinfestation from weeds from the catchment. If this does not occur, the restoration potential of the site will be much reduced in the future.

Swamp Oak Floodplain Forest EEC - Nareen Wetland

The smaller Swamp Oak Floodplain Forest strip at the southern area of the wetland is less resilient due to its smaller size, history of landfill disturbance, and the adjacent highly degraded wetland vegetation. It would be beneficial to delineate this vegetation from the adjacent grassy area with a low log barrier. Weed control of this area should be managed as a part of a maintenance program for the proposed landfill revegetation site.

Weedy Landfill

Examination of 1943 aerial photography (**Appendix A**) shows that by the early 1940s this area was filled, most likely from sand dredged from Narrabeen Lagoon, with a band of large trees (probably *Casuarina glauca*) extending west from Lido Avenue. The area is now almost completely covered by weeds including a number of mature Canary Island Date Palms (*Phoenix canariensis*). These may have been planted in the 1930s. The resilience of this site is practically nil and revegetation with species from the Swamp Oak Floodplain Forest vegetation type is the most suitable management strategy for this zone.

Because the landfill area is relatively large (approximately 1 ha) and densely vegetated with weeds, an efficient approach to preparing the site for revegetation would be to use heavy machinery such as a grader with tractor blade to remove the weeds and up to 10 cm of the topsoil containing weed seed and other contaminants. (Buchanan 2009).

Prior to disturbing the soil, detailed acid sulfate soil and contaminated site assessments will be required. Clearance and replanting of the site should be done in stages to minimise disturbance to fauna habitat and ensure that there are adequate resources to maintain each revegetated section before commencing the next stage.

Weedy Landfill - Nareen Wetland

This Plan recommends that the revegetation of the landfill areas be managed as a community project with the objective of improving natural habitat and engaging the local community. Community planting days and follow-up weeding sessions could be planned as local field days based at the grassy playground area with a BBQ and education material on the history and biodiversity values of the wetland. **Appendix B** contains a list of species that may be suitable for planting. The Swamp Oak Floodplain Forest communities at the western end of Nareen Wetland and within Warriewood Wetlands are considered good local provenance seed collection sites.

Vegetated Buffer

There is no vegetated buffer around the site. The northern, western and southern boundaries of the wetland back directly on to residential areas. The eastern boundary of the site is Nareen Creek. Narroy Park lies to the east of the creek, and this area has a narrow fringe of planted Casuarinas, but is primarily grassy open space.

Figure 3: Vegetation communities

4.5.2 Threatened and protected flora

No threatened flora species have been recorded at Nareen wetland. Two threatened plant species have been recorded within 1 km of the site (*Grevillea caleyi* and *Epacris purpurascens* var. *purpurascens*), however both species inhabit ridge tops/coastal plateaus and will therefore not be found in Nareen Wetland or its immediate surrounds. Four species of significance within the northern Sydney region were identified in Nareen Wetland (**Appendix C**).

4.5.3 Weeds

Weed infestations dominate Nareen Wetland and its drainage lines, and are a major issue for the management of the wetland. Weeds that were recorded at the time of this study are listed in **Table 1**. There are seventeen noxious weeds and three weeds of national significance.

Garden and aquarium escapes and dumping of green waste are a major source of weed invasion into Nareen 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). Specific actions recommended in this Plan for Nareen Wetland are consistent with the general threat abatement measures for this KTP nominated by DEWHA (Commonwealth of Australia 2010).

The *Noxious Weeds Act 1993* (NW Act) specifies the duties of landholders, including Councils, for control of noxious weeds. Noxious weeds are identified in the following table.

Table 1: Weed species in the Nareen wetland

COMMON NAME	SPECIES	STATUS IN PITTWATER LGA	WoNS
Agapanthus	*Agapanthus praecox subsp. orientalis*	Environmental	
Asparagus Fern	*Asparagus aethiopicus*	Noxious - Class 4	
Barnyard Grass	*Echinochloa crus-galli*		
Beach Pennywort	*Hydrocotyle bonariensis*	Environmental	
Black Thistle	*Cirsium vulgare*		
Blackberry	*Rubus fruticosus sp. Agg*	Noxious - Class 4	Yes
Blackberry Nightshade	*Solanum nigrum*		
Blue Morning Glory	*Ipomoea indica*	Noxious - Class 4	
Box Elder	*Acer negundo*		
Broad-leaved Privet	*Ligustrum lucidum*	Noxious - Class 4	
Buffalo Grass	*Stenotaphrum secundatum*		
Camphor-laurel	*Cinnamomum camphora*	Environmental	
Canary Island Date	*Phoenix canariensis*	Environmental	
Cassia	*Cassia (Senna pendula var. glabrata*	Environmental	
Castor Oil Plant	*Ricinus communis*	Noxious - Class 4	
Climbing Asparagus Fern	*Asparagus plumosus*	Noxious - Class 4	
Coast Morning Glory	*Ipomoea cairica*	Noxious - Class 4	
Cobblers Pegs	*Bidens pilosa*	Environmental	
Cockspur Coral Tree	*Erythrina crista-galli*	Environmental	
Common Sow-thistle	*Sonchus oleraceus*		
Coral Tree	*Erythrina x sykesii*		
Crofton Weed	*Ageratina adenophora*	Environmental	
Drain Flat-sedge	*Cyperus eragrostis*		
Fat Hen	*Chenopodium album*		
Fishbone Fern	*Nephrolepis cordifolia*	Environmental	

COMMON NAME	SPECIES	STATUS IN PITTWATER LGA	WoNS
Fruit-salad Plant	*Monstera deliciosa*		
Giant Reed	*Arundo donax*	Noxious - Class 4	
Green Amaranth	*Amaranthus viridis*		
Green Cestrum	*Cestrum parqui*	Noxious - Class 3	
Guinea Grass	*Panicum maximum*		
Jacaranda	*Jacaranda mimosifolia*		
Japanese Honeysuckle	*Lonicera japonica*	Environmental	
Kikuyu	*Pennisetum clandestinum*		
Lantana	*Lantana camara*	Noxious - Class 4/5	Yes
Ludwigia	*Ludwigia peruviana*	Noxious - Class 3	
Madeira Vine	*Anredera cordifolia*	Noxious - Class 4	
Montbretia	*Crocosmia x crocosmiiflora*	Environmental	
Moth Vine	*Araujia sericifera*	Noxious - Class 4	
Mulberry	*Morus alba*		
Mullumbimby Couch	*Cyperus brevifolius*		
Nasturtium	*Tropaeolum majus*		
Oleander	*Nerium oleander*		
Paddy's Lucerne	*Sida rhombifolia*		
Palm Grass	*Setaria palmifolia*		
Panic Veldgrass	*Ehrharta erecta*	Environmental	
Papyrus	*Cyperus papyrus*		
Parrot's Feather	*Myriophyllum aquaticum*		
Paspalum	*Paspalum dilatatum*		
Petty Spurge	*Euphorbia peplus*		
Purpletop	*Verbena bonariensis*		
Small-leaved Privet	*Ligustrum sinense*	Noxious - Class 4	
Summer Grass	*Digitaria sanguinalis*	Environmental	
Tall Fleabane	*Conyza sumatrensis*	Environmental	
Taro	*Colocasia esculenta*		
Thickhead	*Crassocephalum crepidioides*		
Turkey Rhubarb	*Acetosa sagittata*	Noxious - Class 4	
Vasey Grass	*Paspalum urvillei*		
Wandering Jew	*Tradescantia fluminensis*	Environmental	
Wild Aster	*Aster subulatus*		
Wild Tobacco	*Solanum mauritianum*		
Willow	*Salix sp.*	Noxious - Class 5	Yes
Yellow Bamboo	*Phyllostachys aurea*	Noxious - Class 4	
Yellow Ginger	*Hedychium gardnerianum*	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 FAUNA

4.6.1 Threatened fauna

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 Nareen wetland. These species are listed below. No species have been observed within the wetland boundary.

- Osprey (*Pandion haliaetus*) - vulnerable

- Powerful Owl (*Ninox strenua*) - vulnerable
- Spotted-tailed Quoll (*Dasyurus maculatus*) - vulnerable
- Southern Brown Bandicoot (*Isoodon obesulus obesulus*) - endangered
- Koala (*Phascolarctos cinereus*) – vulnerable and endangered population in Pittwater LGA
- Grey-headed Flying Fox (*Pteropus poliocephalus*) - vulnerable

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

4.6.2 Other fauna

There is currently no fauna list available for Nareen Wetland. A number of common bird species were observed during field investigations and are included in the list below. Residents have reported seeing eels and turtles in the creek (Hyder Consulting 2008). The Freshwater Yabby (*Cherax* sp) and Mosquito Fish (*Gambusia holbrooki*) were recorded in Nareen Creek in 2009 (Ecology Lab 2009).

- Pacific Black Duck (*Anas superciliosa*)
- Purple Swamp Hen (*Porphyrio porphyrio*)
- Variegated Fairy Wren (*Malurus assimilis*)
- Australian Magpie (*Gymnorhina tibicen*)
- Rainbow Lorikeet (*Trichoglossus haematodus*)
- Red Wattlebird (*Anthochaera paradoxa*)
- Long-nosed Bandicoot (*Perameles nasuta*) – diggings observed (Feb 2010)

All species listed above have been included in an initial species list for Nareen wetland (**Appendix D**).

Domestic, unleashed dogs and cats are a threat to native fauna in the wetland area. No rabbits or rabbit activity has been observed by Council staff in Nareen Wetland. Some residents have expressed concern about rodents in the Nareen Creek catchment (Hyder Consulting 2008).

4.6.3 Fish Passage

Fish passage between Nareen Wetland and Narrabeen Lagoon is highly restricted. Passage is only possible between the two water bodies when the concrete channel downstream of the wetland contains water, which is usually after high rainfall events.

4.7 HABITAT AND CONNECTIVITY

The Nareen Creek catchment is heavily urbanised and as such does not provide extensive habitat for native fauna. Weedy areas within the wetland provide habitat for small woodland birds and the open water habitat of Nareen Creek is used by water birds e.g. ducks, Dusky Moorhens. The dense weedy area on landfill at the eastern end of the wetland provides habitat for small bush birds such as Variegated Fairy Wrens and small bush birds also frequent the larger Swamp Oak Floodplain Forest at the western end of the wetland.

Pittwater Council has mapped key habitat corridors throughout the LGA. Nareen Wetland has been identified as category Co1: a disturbed area that is likely to be of habitat value due to good crown cover and/or understorey. Strengthening the value of the wetland as a local core habitat area through a program of weed control, bush-regeneration and revegetation is a key outcome of this Plan of Management.

Nareen Wetland has periodic connection to Narrabeen Lagoon via the downstream concrete channel.

4.8 INFRASTRUCTURE

4.8.1 Stormwater

There is an extensive stormwater drainage network of stormwater pipes, culverts and an open channel influencing Nareen Wetland.

Nareen Creek is the main flow-path for stormwater within the catchment. The creek is fed with runoff from the Elanora Escarpment, which runs off the Escarpment via two waterfalls. Flow from both waterfalls flow join and flow into Nareen Creek at a culvert under Tatiara Crescent.

From this culvert, Nareen Creek flows underground for approximately 200 m, before exiting into the wetland near Nareen Parade. The creek flows through the full length of the wetland and then into a concrete-lined open channel. The open channel rises up to 0.83 m AHD, which limits the in-flow from Narrabeen Lagoon and generates a tendency for fresh water to be permanently stored in the wetland. This helps preserve the freshwater ecosystem of the wetland and regulates the wetland's water level. The open channel runs through residential areas, eventually flowing under Pittwater Road into Narrabeen Lagoon.

4.8.2 Sewer overflows and GPTs

Sewer overflows occur mostly during wet weather when the sewage system is overloaded (Cardno Lawson Treloar 2009). Faecal coliform levels are very high in the upper catchment and may indicate contamination of Nareen Creek from a leaking sewer (Hyder Consulting 2008).

There is one Gross Pollutant Trap (GPT) in the upper reach of Nareen Creek within the study area and another at where the creek flows into Narrabeen Lagoon.

4.8.3 Recreation

Recreational activities in Nareen Wetland and adjacent Narroy Park include walking/running, dog walking, bird watching, fishing and picnicking. There is a small viewing platform along the edge of Nareen Creek in Narroy Park that provides views up- and downstream of the Creek and into the wetland area. There is a small park with playground facilities in the southern corner of the study site. This area is also used for informal dog off-leash exercise and as a meeting place for groups with small children

4.8.4 Encroachments

Encroachments and rubbish dumping occurs along the entire southern boundary of the wetland, directly adjacent to residential housing. Encroachments include storage of building materials and campervans,

while the majority of rubbish dumping is green garden waste. Dumped green waste presents a significant threat of increased weed invasion.

4.9 VISUAL AND LANDSCAPE CHARACTER

Landscapes within the study area include:

- Residential – predominantly single dwellings with established gardens and occasional small local parks and playgrounds
- Bushland – native vegetation
- Wetland area – reeds
- Nareen Creek foreshore – grassed parkland with replanted trees (Narroy Park)

Views across the wetland and creek are available from the upper catchment/escarpment and from various locations around the wetland perimeter. An example is provided below.

View from escarpment over wetland

Figure 4: Features of the study area

5 Management issues

The following table summarises the main issues relevant to management of Nareen 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**.

Table 2: Management issues for Nareen Wetland (grouped by themes identified in *Pittwater Natural Areas Draft Plan of Management Part 1, 2009*)

MANAGEMENT THEME	ISSUE	ACTIONS – CROSS REFERENCE TO TABLE 3-7
5.1 Sustainability	Climate change and sea level rise (SLR): wetland area and surrounding houses at risk of regular tidal inundation under SLR scenarios. Council's commitment to management is critical to success of programs. Water Sensitive Urban Design (WSUD): encouraged in new and re-developments. Endangered Ecological Communities (EECs): management to ensure long-term persistence of these vegetation communities.	1, 2, 5, 24, 25
5.2 Research, Education and Community Training and Participation	Engage community to encourage best practise management of properties adjoining wetland, including landscaping with appropriate native species. Encourage community participation through Council coordinated activities e.g. Bushcare, tours and talks and planting days. Promote awareness of biodiversity through interpretive signage and education programs.	13 – 23
5.3 Encroachments	Encroachments along urban interface e.g. campervan parking, children's play equipment. Dumping of "hard rubbish" and green waste e.g. lawn clippings. Exact location of the property boundaries unknown and unmarked.	17, 18

MANAGEMENT THEME	ISSUE	ACTIONS – CROSS REFERENCE TO TABLE 3-7
5.4 View Conservation and Management	Visual amenity is reduced by weeds and poor water quality. Local residents have complained about litter, odours and high weed loads, particularly within Nareen Creek. Views from escarpment over wetland and across to Narrabeen Lagoon. Views from viewing platform in Narroy Park of creek and across to wetland. Views of wetland limited due to poor access and lack of linkage between Narroy Park and playground.	1, 13
5.7 Water Catchment 5.7.1 Stormwater and Surface Runoff	Water quality is very poor due to upstream and urban runoff, retention of decaying matter (primarily aquatic weeds), potential sewer overflows in upper catchment. High gross pollutant loads and lack of pollutant trapping infrastructure. Lack of flow through creek and wetland resulting in sediment, weed and litter accumulation and resulting water quality impacts. Lack of water sensitive urban design.	1, 10, 12
5.7.2 Soil Erosion and Sedimentation	Severe bank erosion and channel scour in Nareen Creek upstream and adjacent to wetland. Sediment build-up within wetland and Nareen Creek adjacent to wetland, which impeded flow and allows weed/*Typha* sp. accumulation. Unknown sediment condition e.g. source of landfill, acid sulfate soils, urban run-off	11 – 12
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.	9
5.8 Geotechnical Risk Management	Unknown sediment condition e.g. source of landfill, acid sulfate soils. High risk of acid sulfate soils (entire wetland mapped as Class 2)	12
5.9 Biodiversity	Biodiversity is compromised from weed invasion and introduced species. Identified as a disturbed area that is likely to be of habitat value due to good crown cover and/or understorey.	1 – 2

MANAGEMENT THEME	ISSUE	ACTIONS – CROSS REFERENCE TO TABLE 3-7
5.9.1 Plant Communities	Endangered Ecological Communities (Swamp Oak Floodplain Forest, Sydney Freshwater Wetland) covering the majority of the study area. Sydney Freshwater Wetland EEC in highly degraded condition vegetation dominated by *Typha* sp and weeds. Swamp Oak Floodplain Forest has responded well to restoration program. Significant weed invasion e.g. Ludwigia, Lantana, Cockspur Coral Cleared/grassed area adjacent to children's playground.	1 – 2
5.9.2 Bushland Restoration	Restoration works in Swamp Oak Floodplain Forest in north west of study area stimulating good native regeneration however will require adequate resourcing for significant time period (10 yrs +) to consolidate resilience. Significant opportunities for restoration including establishing Bushcare groups.	2, 19, 20
5.9.3 Weed Management	Weed invasion is a threat to biodiversity values and extensive management required. Weed inputs from garden escapes and dumping, washed down from upstream. Aquatic weeds include *Ludwigia peruviana*, Willows (*Salix* sp.), Water Milfoil (*Myriophyllum* sp.), Papyrus (*Cyperus papyrus*), and Cockspur Coral. Terrestrial weeds include *Lantana* sp., Canary Island Date Palm (*Phoenix canariensis*) Madeira Vine (*Anredera cordifolia*), Coral trees (*Erythrina crista-galli).* Current aquatic weed control program requires extensive follow-up and continual resourcing. Outbreaks of Ludwigia and other weeds upstream require regular monitoring and control. Previous weed control limited to targeted woody weed removal.	1, 22
5.9.4 Local Fauna	No data are available regarding species known to use site. Weed infested areas provide habitat, particularly for small birds.	4, 5, 7
5.9.5 Introduced Animals	The grassed reserve area is used as informal dog-off leash area. Community concern about increase in predominance of domestic and pest animals which out-compete native	4, 15

MANAGEMENT THEME	ISSUE	ACTIONS – CROSS REFERENCE TO TABLE 3-7
	wildlife.	
5.10 Fire Management	Fire management for biodiversity and asset management is required. Recommended fire interval for forested wetlands (i.e. 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 15 m.	3
5.11 Recreational Uses	Main recreational uses are walking (including on leash dog-walking) and bird watching. Grassy parkland area in south-east of site with small children's playground and cricket pitch. Grassy area used as meeting place for mothers groups and as informal dog-off leash area would benefit from planting of shade trees. Limited other facilities e.g. no picnic tables, barbeques, public toilets No connection between grassy parkland area and Narroy Park.	13 – 23
5.13 Walking Tracks, Vehicle Access and Parking	No walking tracks limiting access and connection to Narroy Park (access to creek possible from Narroy Park). Off-street parking adjacent to grassy parkland.	13
5.15.Risk Management and Public Safety	Encroachments and illegal structures. Potential risks from chemical weed/pest management to people and domestic animals. Access to deep swampy areas for aquatic weed control is potentially hazardous. Release of ASS and other contaminants from sediment during restoration works.	1, 12, 17, 18

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 Nareen 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 **Tables 3 to 7** 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 5.**

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.

Table 3: Biodiversity management actions for Nareen Wetland

NO.	ACTION	PRIORITY	PERFORMANCE MEASURES
BIODIVERSITY: On-ground works			
1	Weed control: 1. Continue aquatic weed control program prioritising woody weeds and *Ludwigia*. Specific methods for controlling weed species are provided in **Appendix E**. Ensure on-going commitment to follow up works before major control programs are commenced. 2. Investigate the need to and feasibility of removing any substantial build-up of dead weed biomass from wetland to ensure nutrient build-up is minimised. Ensure disposal is appropriate. 3. Control weeds in upper catchment (as per Council's Strategic Weed Control Plan currently in prep) and ensure upstream creek rehabilitation works use appropriate species for revegetation. 4. Provide any Yellow Bamboo that is harvested to Taronga Zoo as part of the arrangement for providing food for the Chinese Pandas	High	1. Reduced weed infestation. 2. Excess weed biomass removed appropriately if necessary. 3. Reduced inputs of weeds from upstream.
2	Regeneration works: 1. Continue regeneration program in all resilient areas of the Swamp Oak Floodplain Forest. Ensure that worked areas are adequately followed up before new areas are worked. 2. Revegetate land fill site to Swamp Oak Floodplain Forest as a major community project. Capitalise on any opportunities that arise through flood mitigation works. 3. Plant indigenous native vegetation in areas surrounding wetland. Focus on plantings in Narroy Park, widening the revegetated strip on the northern bank of Nareen Creek and existing residences adjacent to wetland (facilitate latter through native plant give away – see community engagement below). 4. Plant limited number of trees in playground to increase biodiversity and provide shade. Appropriate species include *Casuarina glauca* and *Eucalyptus robusta*.	High Medium Medium Low	1. Minimal maintenance level achieved 2. Establishment of Swamp Oak Floodplain Forest. 3. Increased native vegetation in areas surrounding wetland. 4. Increased number of shade trees in playground.

NO.	ACTION	PRIORITY	PERFORMANCE MEASURES
3	Create trafficable asset protection zone between wetland and adjacent housing. Ensure APZ is maintained and weeds controlled.	High	Creation and appropriate maintenance of APZ.
BIODIVERSITY: Monitoring and review			
4	Monitor pest animal populations and control where necessary. Determine if rodents (community concern) are introduced species and control as required. If native rodents, include information in community education programs.	High	Pest numbers reduced.
5	Monitor wetlands for changes associated with climate change e.g. shift in species distribution, arrival of new species. Amend and develop management actions as required. Monitoring could be best undertaken at fixed locations that are resurveyed every 3-5 years.	High	Management actions developed if necessary.
6	Review adequacy of green waste and hard rubbish collection. Consider expanding collection to reduce amount of waste entering wetlands from adjacent properties.	High	Illegal dumping of waste reduced.
7	Record wildlife observations both during on-ground works and any community information days. Record data in Council databases and NSW Wildlife Atlas. Use this data as a basis for monitoring change e.g. improvements from management, climate change impacts. Key focus on bird species (esp threatened and migratory species) and other regionally significant species e.g. bandicoots.	Medium	Database of wildlife records.

Table 4: Water and sediment management actions for Nareen Wetland

NO.	ACTION	PRIORITY	PERFORMANCE MEASURES
8	Investigate and fix sewer overflows in consultation with Sydney Water.	High	Fixed sewer overflow if problems found.
9	Flood mitigation actions: 1. Monitor changes to hydrology (particularly associated with flood mitigation and upstream creek rehabilitation) and associated impacts of flora and fauna. Implement management actions as necessary e.g. sediment removal, weed control. 2. Review management of downstream concrete channel considering flooding, climate change, water quality and vegetation management issues (noting that short-term wetland drying and/or salt water intrusion can be used to effectively manage aquatic weeds). 3. Implement flood study recommendations, ensuring negative impacts to biodiversity are minimised.	Medium	1. Management actions implemented as necessary. 2. Management actions implemented as necessary. 3. Implementation of actions as appropriate.
10	Investigate need for and feasibility of additional pollutant and sediment trapping devices.	Medium	Additional devices installed if necessary.
11	Investigate opportunities for re-creating natural banks (as opposed to current constructed channels) of Nareen Creek, particularly as weed and erosion control mechanism upstream of wetland.	Low	Re-creation of natural banks if deemed appropriate.
12	Investigate sediment sources and options for removal (as per Nareen Creek Rehabilitation Plan recommendations).	Low	Sediment study.

Table 5: Recreation management actions for Nareen Wetland

NO.	ACTION	PRIORITY	PERFORMANCE MEASURES
13	Walking trail / access provision actions: 1. Create walking trail in APZ area. 2. Investigate feasibility of creating boardwalk traversing Swamp Oak Floodplain Forest at the western end of Nareen Wetland with links between playground and Narroy Park to improve recreational opportunities, improve amenity and provide access for weed control. See **Figure 5** for example locations. 3. Create a walking trail through the landfill site as a part of the revegetation project and link the trail to Narroy Park with a bridge across Nareen Creek.	High Medium Medium	Walking trails created.
14	Consider need for rubbish bins, picnic facilities, public toilets and seating. This should be undertaken in conjunction with the development of Narroy Park PoM.	Medium	Facilities installed if necessary.
15	Consider need to designate an official dog exercise area. This decision will need to consider native fauna observed in the area.	Medium	Decision made.

Table 6: Community learning actions for Nareen Wetland

NO.	ACTION	PRIORITY	PERFORMANCE MEASURES
16	Prepare and install interpretive and instructional signage at playground, in Narroy Park (e.g. on viewing platform) and strategically along boardwalk/trail. Topics should include bird identification, weed control, EEC identification/values, allowed/prohibited activities.	High	Signage installed.
17	Undertake a survey of all property boundaries and mark with permanent structures that are visible to residents (e.g. bollard concreted into ground). Location of property boundary should be communicated to all residents adjoining wetland	High	Property boundaries clearly marked.
18	Liaise with residents who are known to dump rubbish and or are encroaching into wetland areas. Make encroachers aware of property boundary. Ensure Council's encroachment policy implemented.	High	Removal of existing and reduced new encroachments.
19	Support on-going bushcare opportunities and expand. Consider expanding works areas depending on OH&S requirements of working in wet areas. Encourage groups to report fauna sightings and monitor weed hotspots.	High	Sustained bushcare activities.
20	Commence revegetation of the landfill area as a major community project with the objective of improving natural habitat and engaging the local community. Organise community planting days and follow-up weeding sessions as local field days based near the grassy playground area. Include a BBQ and education material on the history and biodiversity values of the wetland and other activities	Medium	Uptake by residents
21	Deliver community education events e.g. birdwatching tours, weed and native vegetation information sessions (potentially in conjunction with landfill revegetation project).	Medium	Community events attended 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.	Low	New residents receive information pack.
23	Include information about "safe disposal" of unwanted aquarium species (both plants and fish) in community education information packages.	Low	Information provided.

Table 7: Management and financial arrangement actions for Nareen Wetland

NO.	ACTION	PRIORITY	PERFORMANCE MEASURES
24	Ensure management actions are coordinated across relevant sections of Council.	High	All relevant sections of Council aware of management activities.
25	Include follow-up works for major weed control treatment in maintenance budgets to ensure long-term success.	High	On-going works included in budgets.
26	Use this Plan of Management to support grant applications and to secure internal funding.	High	Funding secured.

Figure 5: Location-specific management actions (numbers correspond to management actions in Tables 3-7)

7 Implementation

7.1 FACILITATE ACTIONS AND FURTHER INVESTIGATION

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

- Before any actions are undertaken, a specific and clearly measureable KPI must be set and this should be in line with those recommended in the action table. For example, a 10% reduction in weed density within 1 year and 40% reduction within 3 years.
- 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. Avoid opening up resilient Swamp Oak Floodplain Forest areas through woody weed removal until there are adequate resources to control weed regrowth.
- 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. Suitable seed collection sites are the Swamp Oak Floodplain Forest at the western end of Nareen Wetland and within Warriewood Wetlands
- Enforce Noxious Weeds Act e.g. in relation to sale of weeds species in nurseries and aquarium shops.
- 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.
- Ensure works are undertaken in a manner that minimizes acid sulfate soils release. Geotechnical investigation and an acid sulfate soil management plan may be required for larger works e.g. boardwalk construction/widening
- Maintain existing stormwater pollution control devices immediately after heavy rainfall (or at least every year).
- 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.
- Do not invest substantial resources in up-front works if commitment to on-going and follow-up needs is not secure.
- Ensure development of Narroy Park PoM is consistent with aims, objectives and recommend works in 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 any necessary approvals to implement vegetation management works e.g. licences from DECCW to work in EECs.
- Seek adequate funds to implement the PoM.

7.2 FUNDING & RESOURCES

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

- State and Commonwealth government environmental grants
- Pittwater Council's Environmental Infrastructure Levy
- 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

7.3 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 Nareen Wetland include threatened and migratory species. 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 8: Environmental approvals

TASK	REQUIREMENT
Boardwalk construction	Boardwalk construction will be exempt from Development Consent under the Infrastructure SEPP, provided the project is undertaken by Council. 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 *Threatened Species Conservation Act 1995)* and/or *Environmental Impact Statement* (EIS) (under EP&A Act) may be required. Matters of National Environmental Significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* should be considered when preparing the flora and fauna study to determine if a Referral is required. A licence from DECCW will be required to undertake works in an EEC.
Vegetation management and weed control	A licence from DECCW will be required to undertake works in an EEC.

7.4 SPECIES FOR REPLANTING

Local provenance species should be used for replanting where possible. A stock-take 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 B**. It includes some of the species that could be used for replanting. Species suitable for residential gardens have been identified through Council's Native Plants for Your Garden website (http://www.pittwater.nsw.gov.au/environment/species_lists)

7.5 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: 1943 aerial photo of wetland


1943 Aerial Photograph
Nareen Wetland
Legend
Site Boundary
Data Sources:
Aerial Photography (SKM 2007)
0
30
60
120
Metres
Datum/Projection: GDA 1994 MGA Zone 56
N
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Appendix B: Species Suitable for Revegetation

SPECIES	COMMON NAME	FORM	VEGETATION TYPE
Trees			
Casuarina glauca	Swamp Oak	Tree	Moist Forest/Swampy Areas
Glochidion ferdinandi	Cheese Tree	Tree	Dry/Moist Forest
Eucalyptus botryoides	Bangalay	Tree	Dry/Moist Forest
Eucalyptus robusta	Swamp Mahogany	Tree	Moist Forest/Swampy Areas
Livistona australis	Cabbage Palm	Tree	Moist Forest
Cyathea cooperi	Straw Tree-fern	Tree Fern	Moist Forest
Shrubs			
Acmena smithii	Lilly-pilly	Shrub/Tree	Moist Forest
Polyscias sambucifolia	Elderberry Panax	Shrub	Dry Forest
Elaeocarpus reticulatus	Blueberry Ash	Shrub	Dry Forest
Monotoca elliptica	Tree Broom-heath	Shrub	Dry Forest
Breynia oblongifolia	Coffee Bush	Shrub	Dry Forest
Pultenaea villosa		Shrub	Dry Forest
Viminaria juncea	Native Broom	Shrub	Moist Forest
Acacia decurrens	Black Wattle	Shrub	Dry Forest
Acacia elongata	Swamp Wattle	Shrub	Moist Forest
Acacia floribunda	White Sally	Shrub	Moist Forest
Acacia longifolia	Sydney Golden Wattle	Shrub	Dry Forest
Acacia parramattensis	Parramatta Wattle	Shrub	Dry Forest
Acacia suaveolens	Sweet Wattle	Shrub	Dry Forest
Callistemon citrinus	Scarlet Bottlebrush	Shrub	Moist Forest/Swampy Areas
Callistemon linearis	Narrow-leaved Bottlebrush	Shrub	Moist Forest
Leptospermum juniperinum	Prickly Tea-tree	Shrub	Moist Forest
Melaleuca ericifolia	Swamp Paperbark	Shrub	Swampy Areas
Melaleuca linariifolia	Flax-leaved Paperbark	Shrub	Moist Forest
Groundcovers			
Blechnum camfieldii	Water Fern	Fern	Moist Forest
Blechnum indicum	Swamp Water Fern	Fern	Swampy Areas
Entolasia marginata	Bordered Panic	Grass	Moist Forest
Hemarthria uncinata	Mat Grass	Grass	Moist Forest/Swampy Areas
Imperata cylindrica	Blady Grass	Grass	Dry Forest
Isachne globosa	Swamp Millet	Grass	Swampy Areas
Oplismenus aemulus	Broad-leaved Basket Grass	Grass	Moist Forest
Paspalum distichum	Water Couch	Grass	Swampy Areas
Themeda australis	Kangaroo Grass	Grass	Dry Forest
Alternanthera denticulata	Common Joyweed	Herb	Swampy Areas

SPECIES	COMMON NAME	FORM	VEGETATION TYPE
Ludwigia peploides subsp. *montevidensis*	Water Primrose	Herb	Swampy Areas
Viola hederacea	Native Violet	Herb	Moist Forest
Alisma plantago-aquatica	Water-plantain	Herb	Swampy Areas
Alocasia brisbanensis		Herb	Moist Forest
Commelina cyanea	Blue Spiderwort	Herb	Moist Forest
Triglochin microtuberosum		Herb	Swampy Areas
Triglochin procerum	Water Ribbons	Herb	Swampy Areas
Lomandra longifolia	Spiny-headed Mat-rush	Herb	Dry/Moist Forest
Philydrum lanuginosum	Woolly Waterlily	Herb	Swampy Areas
Dianella caerulea	Blue Flax-lily	Herb	Dry/Moist Forest
Dianella caerulea var. *producta*		Herb	Dry/Moist Forest
Baumea articulata	Jointed Twig-rush	Sedge/Rush	Moist Forest/Swampy Areas
Baumea juncea	Bare Twig-rush	Sedge/Rush	Moist Forest/Swampy Areas
Baumea rubiginosa	Soft Twig-rush	Sedge/Rush	Moist Forest/Swampy Areas
Bolboschoenus fluviatilis	Club-rush	Sedge/Rush	Moist Forest/Swampy Areas
Carex appressa	Tall Sedge	Sedge/Rush	Moist Forest/Swampy Areas
Cladium procerum		Sedge/Rush	Swampy Areas
Cyperus exaltatus	Giant Sedge	Sedge/Rush	Moist Forest/Swampy Areas
Eleocharis equisetina		Sedge/Rush	Swampy Areas
Eleocharis sphacelata	Tall Spike-rush	Sedge/Rush	Swampy Areas
Ficinia nodosa	Knobby Club-rush	Sedge/Rush	Moist Forest/Swampy Areas
Gahnia sieberiana	Red-fruited Saw-sedge	Sedge/Rush	Moist Forest/Swampy Areas
Schoenoplectus mucronatus		Sedge/Rush	Moist Forest/Swampy Areas
Schoenoplectus validus	River Club-rush	Sedge/Rush	Moist Forest/Swampy Areas
Juncus kraussii subsp. australiensis	Sea Rush	Sedge/Rush	Moist Forest/Swampy Areas
Juncus polyanthemus	Tussock Rush	Sedge/Rush	Dry/Moist Forest
Juncus usitatus		Sedge/Rush	Dry/Moist Forest
Baloskion tetraphyllum	Tassel Cord-rush	Sedge/Rush	Moist Forest
Leptocarpus tenax		Sedge/Rush	Moist Forest
Climbers			
Pandorea pandorana	Wonga Vine	Climber	Dry Forest
Hardenbergia violacea	False Sarsaparilla	Climber	Dry Forest
Kennedia rubicunda	Dusky Coral-pea	Climber	Dry Forest
Stephania japonica var. discolor	Snake Vine	Climber	Moist Forest
Clematis glycinoides	Headache Vine	Climber	Dry/Moist Forest
Morinda jasminoides	Morinda	Climber	Moist Forest
Cayratia clematidea	Slender Grape	Climber	Dry/Moist Forest
Cissus hypoglauca	Native Grape, Water Vine	Climber	Dry/Moist Forest
Eustrephus latifolius	Wombat Berry	Climber	Dry/Moist Forest

Appendix C: Native species list

Native plant species recorded in Nareen Wetland (refer to **Table 1** for weed species).

SPECIES	COMMON NAME	REGIONAL SIGNIFICANCE
Acacia longifolia	Sydney Golden Wattle	
Alocasia brisbanensis		Northern Sydney
Azolla pinnata	Ferny Azolla	
Casuarina glauca	Swamp Oak, Swamp She-oak	
Centella asiatica	Pennywort	
Cissus hypoglauca	Native Grape, Water Vine	
Cyathea cooperi	Straw Tree-fern, Scaly Tree-Fern	
Dianella caerulea	Blue Flax-lily	
Eucalyptus botryoides	Bangalay	
Eucalyptus robusta	Swamp Mahogany	
Glochidion ferdinandi	Cheese Tree	
Hibiscus sp.		
Homalanthus populifolius	Bleeding Heart, Native Poplar	
Hypolepis muelleri	Harsh Ground Fern	
Imperata cylindrica	Blady Grass	
Isachne globosa	Swamp Millet	Northern Sydney
Juncus usitatus		
Kunzea ambigua	Tick-bush	
Leptocarpus tenax		
Livistona australis	Cabbage Palm, Cabbage-tree Palm	
Lobelia alata	Angled Lobelia	
Ludwigia peploides subsp. *montevidensis*	Water Primrose	
Oplismenus aemulus	Broad-leaved Basket Grass	
Parsonsia straminea	Common Silkpod, Monkey Rope	
Persicaria decipiens	Slender Knotweed	
Persicaria lapathifolia	Pale Knotweed	
Persicaria strigosa	Bristly Knotweed	
Phragmites australis	Common Reed	
Pittosporum undulatum	Sweet Pittosporum	
Platycerium superbum	Staghorn Fern, Elkhorn Fern	
Pteridium esculentum	Bracken	
Schoenoplectus validus	River Club-rush	Northern Sydney
Sigesbeckia orientalis	Indian Weed	
Spirodela sp.	Duckweed	
Stephania japonica var. *discolor*	Snake Vine	
Typha orientalis	Broad-leaf Cumbungi, Bulrush	

Appendix D: Native fauna list (initial)

The following list of species that have been observed in Nareen wetland recently. This list should be expanded on as additional fauna are observed.

SPECIES	COMMON NAME
Anas superciliosa	Pacific Black Duck
Anthochaera paradoxa	Red Wattlebird
Cherax sp	Freshwater Yabby
Gambusia holbrooki	Mosquito Fish
Gymnorhina tibicen	Australian Magpie
Malurus assimilis	Variegated Fairy Wren
Perameles nasuta	Long-nosed Bandicoot
Porphyrio porphyrio	Purple Swamp Hen
Trichoglossus haematodus	Rainbow Lorikeet

Appendix E: Weed control techniques

Weed control techniques for species found in Nareen Wetland.

SPECIES	COMMON NAME	CONTROL METHODS
Acetosa sagittata	Turkey Rhubarb	▪ 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.
Ageratina adenophora	Crofton Weed	▪ 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
Anredera cordifolia	Madeira Vine	▪ 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.
Araujia sericifera	Moth Vine	▪ 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.
Cardiospermum grandiflorum	Balloon Vine	▪ 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.
Cestrum parqui	Green Cestrum	▪ 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 stem-scraped at the nodes and immediately painted with roundup.
Cinnamomum camphora	Camphor Laurel	▪ 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.
Conyza sp	Fleabane	▪ 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.
Coreopsis lanceolata	Common Tick-seed	▪ 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 see set. ▪ Dispose of all propagules at a registered green waste disposal centre.
Cortaderia selloana	Pampas Grass	▪ 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.
Cotoneaster sp	Cotoneaster	▪ 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.
Crocosmia x crocosmiiflora	Montbretia	▪ 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.

		▪ Tubers must be dug from the ground using a trowel and bagged ▪ Dispose of all plant material at a registered green waste disposal centre.
Delairea odorata	Cape Ivy	▪ 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.
Ehrharta erecta	Panic Veldgrass	▪ 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.
Erythrina crista-galli	Cockspur Coral Tree	▪ 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.
Hedychium gardnerianum	Yellow Ginger	▪ Tubers must be dug from the ground using a trowel and bagged. ▪ Dispose of all plant material at a registered green waste disposal centre.
Ipomoea indica and *Ipomoea cairica*	Morning Glory	▪ 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 treatements.
Lantana camara	Lantana	▪ 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.
Ligustrum lucidum and	Large-leafed Privet /	▪ Small plants (<1cm trunk diameter) can be hand pulled without breaking the root system. Assist the plant by

Ligustrum sinense	Small-leafed Privet	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.
Lilium formosanum	Formosan Lily	▪ 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.
Lonicera japonica	Honey Suckle	▪ 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.
Ludwigia peruviana	Ludwigia	▪ 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.
Nerium oleander	Oleander	▪ Oleander is a highly poisonous species and care must be taken in its removal. Wear protective clothing. ▪ Cut and paint multiple trunks with herbicide.
Ochna serrulata	Mickey Mouse Plant	▪ 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.
Olea europaea subsp. *cuspidate*	African Olive	▪ 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.
Parietaria judaica	Wall Pellitory	▪ Remove and bag entire plant ▪ Young seedlings can be sprayed with herbicide. ▪ Multiple and regular site visits will be required to ensure full control.
Phytolacca octandra	Inkweed	▪ 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.
Ricinus communis	Castor Oil Plant	▪ 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.
Rubus fruticosus	Blackberry	▪ 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.
Salix spp.	Willow	▪ 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
Salvinia molesta	Salvinia	▪ 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 *Cyrtobagous salviniae* (Salvinia weevil) into Warriewood Wetland should be undertaken.
Senna pendula var. *glabrata*	Cassia	▪ 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 (> 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.
Tradescantia fluminensis	Wandering Jew	▪ 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.

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