

IRRAWONG RESERVE
PLAN OF MANAGEMENT

Pittwater Council

April 1996

Landuse Planning Table (Adopted for this plan by Council 12/2/2001)

Permissible Uses Exempt (these may be subject to approval under Part 5 of the EPA Act 1979)	Permissible Uses Requiring Development Consent	Prohibited Uses
Bush regeneration, habitat restoration and weed control	Utility installations and similar	Extractive industries and agriculture
Fire hazard reduction activities	Buildings ancillary or incidental to the reserve	Sporting facilities
Ecological burns	Major public drainage works	Permanent private access across a reserve
Multi-use tracks other than motor vehicle	Major rock / soil stabilization works and earthworks	Commercial signage
Boardwalks and minor bridges	Major facilities (not buildings) being viewing platforms, bridges, educational facilities and the like	Dumping of refuse (including building materials, soil, fill, household wastes, etc.)
Temporary activities or developments requiring a lease or licence under the Local Government Act (1993)	Commercial Eco-tourism Activities	Vegetation removal not in accordance with Councils Tree Preservation and Management Order
Appropriate sustainable low impact recreation activities and facilities (other than buildings)	Vehicle access (emergency access, fire breaks and service trails).	Private alienation or encroachment
Minor public drainage and stormwater works		Introduction of exotic flora and fauna
Minor fences		Playground facilities
Compliance, directional, interpretive, identification and safety signs		Flood structures (damming and reduction of environmental flows)
Environmental education activities		Removal of habitat features such as soil, leaf litter, rocks, stones, pebbles and the like
Any use as permitted under Council's Tree Preservation and Management Order		Recreational motor sports (including 4 wheel driving, motorbike riding, etc.)
Minor rock works and earthworks associated with soil stabilization and erosion control		Domestic drainage outlets
Any activity as defined in Management Plans consistent with the core objectives and management objectives		Horse riding facilities
Feral animal control and eradication.		Unleashed dog exercise areas
Biodiversity recovery and enhancement		Water extraction

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Executive Summary

Irrawong Reserve is an area of remnant bushland at the southern end of the Warriewood Valley. The Reserve is Crown land owned by the Department of Land and Water Conservation and under the care, control and management of Pittwater Council. The Draft Irrawong Reserve Plan of Management has been prepared in order to:

- ❖ guide Council's management of the land in accordance with relevant legislation.
- ❖ provide details of the management objectives and performance targets developed for Irrawong Reserve which are consistent with the aims and objectives of Pittwater Council's Draft Urban Bushland Plan of Management, Volume 1 - Policy.

Irrawong Reserve is of regional conservation significance and has value as:

- ❖ The most significant remaining stand of *Eucalyptus robusta* (Swamp Mahogany) in the Sydney region;
- ❖ A wildlife corridor linking the Ingleside escarpment to the Warriewood wetlands;
- ❖ A site for scientific research and education;
- ❖ An educational and recreational resource for the local community;
- ❖ Habitat for Koalas (Vulnerable fauna) and over 90 species of resident and migratory birds.
- ❖ It provides a site for control of local flooding;
- ❖ The management objectives for Irrawong Reserve are:
 - ❖ To protect natural features of the Reserve, particularly to conserve the regionally significant Swamp Mahogany (*Eucalyptus robusta*) community;
 - ❖ To protect the Reserve's value as an important fauna habitat and part of a wildlife corridor linking Warriewood Wetlands to the escarpment;
 - ❖ To prevent weed invasion and control weed species occurring in the Reserve;
 - ❖ To maintain the structural and floristic diversity of native vegetation within the Reserve;
 - ❖ To adequately manage the bushland/urban interface so as to minimise adverse external influences;

- ❖ To prevent further damage to the Reserve from urban run-off, stormwater and pollution, restore habitats already degraded and establish and maintain a near natural water cycle to achieve the objective of aquatic ecosystem health and health of Swamp Mahoganies;
- ❖ To protect human life and property in and adjacent to the Reserve from wildfire and maintain ecological processes in the Reserve by seeking to maintain a near-natural fire regime in the body of the Reserve;
- ❖ To control and eradicate, where possible, feral animals within the Reserve;
- ❖ To provide opportunities for low impact recreational, scientific and educational use of the Reserve, consistent with other objectives;
- ❖ To encourage community and neighbour participation in bushland management.

POLICY	ACTION	RESPONSIBILITY	COMPLETED BY	COSTS	PERFORMANCE MEASURES
Weed Control	Bush Regeneration contractors	Environmental Officer & Contractors	Current contract to 1997	\$20,000 per year	Annual report and site assessment
Hydrology and water quality	Initiate appropriate studies Implement Stage 1 Creek restoration works	Environmental Officer	1996/97	\$5,000 - Studies \$45,000 Creek restoration	Report with recommendations Improvement in the stand health of the Swamp Mahogany forest
Stormwater controls	Construct sediment controls, wet filter and energy dissipators	Environmental Officer and Reserves Landscape Technician	Stage 1-1996 Stage 2-1996/97 Stage 3-1997/98	Stage 1 - Grant funds secured Stage 2 - \$20,000	Environmental Trust Grant Report. Amounts of sediment contained.
Fauna	Continued monitoring by Council and community	Environmental Officer	ongoing		Numbers of native species continuing to reside in or use the reserve
Introduced Predators	Control of Domestic Pets	Compliance Officers	ongoing		Less free roaming domestic pets
Habitat Improvement	Replacement of weed species to native and leaving thicket vegetation within restoration process	Environmental Officer and Bush Regeneration Contractors	ongoing within bush regeneration contract		
Recreation and Access	Construct a raised walking track, Reserve restoration and creation of entrance area, Extension of walking track to Garden St.	Environmental Officer and Reserves Landscape Technician	Stage 1-1996 Stage 2-1996/97 Stage 3-1997/98	Stage 1 - Grant Funds secured Stage 2 - \$55,000 Stage 3 - \$25,000	Completion, then increased public awareness and appreciation of regional natural resource
Boardwalk	Construct a boardwalk to middle of the	Environmental Officer and Reserves Landscape	Stage 1-1996 Stage 2 - 1996/97	Stage 1 - Grant Funds	Completion, then increased public awareness and

	Reserve with viewing platform, Stage 2 -extend boardwalk to continue walking track	Technician		secured. Stage 2 - \$35,00	appreciation of regional natural resource
Signage and Environmental Education	Design, produce and erect interpretive signs for the walkway	Environmental Officer	September 1996	\$4,800	Completion and increased public awareness on environmental importance of the reserve

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Any activity as defined in Management Plans consistent with the core objectives and management objectives		Horse riding facilities
Feral animal control and eradication.		Unleashed dog exercise areas
Biodiversity recovery and enhancement		Water extraction

1. Introduction

1.1. Overview

Irrawong Reserve is an area of remnant bushland in the Warriewood/Ingleside area, at the southern end of the Warriewood Valley. The Reserve is approximately 4.45 hectares in area and located within the flood plain of Mullet Creek, forming the upper reaches of the same system as the Warriewood Wetlands.

Today the area is perceived as a mainly cultural landscape with remnants of the natural environment (Tropman and Tropman 1993). Irrawong Reserve is one such important vegetation remnant. The cultural land use patterns have been superimposed on the natural environment through land grants, sub-division, uses imposed by government zoning, development and transportation routes.

The Reserve contains the largest remaining stand of Swamp Mahogany (*Eucalyptus robusta*) in the Sydney region (Benson and Howell 1995). Cunningham (1994) considered Irrawong Reserve as an area essential for retention to conserve its significant vegetation characteristics. The vegetation understorey has been disturbed and shows a high degree of weed invasion. Bush regeneration work has been carried out in the Reserve for a number of years and continuation of the rehabilitation work is required if the bushland integrity is to be maintained.

Irrawong Reserve is considered to be an area essential for the retention of significant fauna populations and must, therefore, be conserved. The Reserve provides habitat for birds, reptiles, amphibians, fish, insects and mammals such as flying-foxes and possums, and Swamp Mahogany is a favoured food tree species of the Koala in the Sydney region.

Agricultural and urban development within the Mullet Creek catchment continues to have a significant impact upon the reserve. Future development in the catchment has the potential to increase the pressures on the Reserve.

1.2. Need for a Plan of Management

One of the major issues facing bushland management at the Local Government level is the preservation of the qualities of urban bushland. Plans of Management are prepared as part of the process of addressing these issues.

It is important that any plan of management remains sufficiently flexible to allow modification and improvement in response to the changing attitudes and expectations of both Council managers and the public. This Plan of Management has been prepared to guide Council's management of this unique area and to provide a basis for conservation and future restoration work in the Reserve.

1.3. PLANNING CONTEXT

1.3.1. Crown Land Management Act 1989

Irrawong Reserve is Crown land and is under the jurisdiction of the Crown Land Management Act 1989 (CLMA). The CLMA states that a plan of management may be prepared for Crown land and Section 11 of the CLMA lists the principles of Crown land management as follows:

- Environmental protection principles be observed in relation to the management and administration of Crown land.
- The natural resources of Crown land (including water, soil, flora, fauna and scenic quality) be conserved wherever possible.
- Public use and enjoyment of appropriate Crown land be encouraged.
- Where appropriate, multiple use of Crown land be encouraged.
- Where appropriate, Crown land should be used and managed in such a way that both the land and its resources are sustained in perpetuity.
- Crown land may be occupied, used, sold, leased or otherwise dealt with in the best interests of the State consistent with the above principles.

1.3.2. Local Government Act 1993 (Section 36)

The Local Government Act 1993 (Section 36) requires Council to prepare a draft plan of management for community land. Such a plan must identify:

- the category of the land;
- the objectives and performance targets of the plan with respect to the land;
- the means by which these objectives and performance targets will be achieved;
- the methodology which will be used to assess whether performance targets and objectives are being achieved.

Under this act, community land is to be categorised and Irrawong Reserve would fall within category a) natural area and can be further categorised as wetland, watercourse and bushland.

Although the Local Government Act does not apply to Irrawong Reserve, the above criteria have been used in this Plan of Management to ensure consistency with other bushland management plans in the area.

1.3.3. State Environmental Planning Policies

State Environmental Planning Policy No. 14 (SEPP 14) was devised to protect coastal wetlands in NSW. However, the Sydney region was made exempt from this policy, although Irrawong Reserve could meet the criteria for a coastal wetland, SEPP 14 does not apply.

State Environmental Planning Policy No. 19 (SEPP 19) - Bushland in Urban Areas was made to protect remnant bushland in urban areas within New South Wales. The Policy applies to land zoned or reserved as Public Open Space.

Irrawong Reserve meets the criteria for inclusion under SEPP 19. Under the Policy, Councils may prepare management plans for bushland areas within such land.

Circular No. B13 of the Department of Urban Affairs and Planning states that a management plan should:

- describe the bushland in light of the aims and objectives of the Policy;
- include measures to enable the recreational use of bushland, where appropriate;
- specify the intended methods of bush fire reduction, measures to prevent bushland degradation and restore degraded areas.

SEPP 19 requires that Council take into account the effect of future development and building works on urban bushland and, in particular, on soil erosion, the siltation of streams and waterways and the spread of weeds and exotic plants.

The Department of Urban Affairs and Planning has also published management guidelines for urban bushland. The guidelines identify the need to prepare a resource inventory of the bushland area, to identify management objectives and strategies, and to derive an action plan for the bushland.

State Environmental Planning Policy 44 Koala Habitat Protection commenced on the February 13, 1995. Pittwater is identified in schedule 1 so that the policy applies to the local government area. Schedule 2 lists *Eucalyptus robusta* as a primary food tree, whereas these trees must constitute at least 15% of the total tree strata to qualify as potential Koala habitat. In November 1995, Pittwater Council resolved to prepare a koala habitat plan of management for the whole government area which will identify areas of potential and core habitat and take steps towards its conservation.

1.3.4. Local Planning Policies

Local Environmental Plan

The current Pittwater Local Environmental Plan 1993 zones Irrawong Reserve as 6(a) Public Open Space.

Urban Bushland Plan of Management

The Pittwater Draft Urban Bushland Plan of Management 1995 - Volume 1, Policy (UBPM) is a generic plan of management for bushland within the Pittwater local government area. The role of the UBPM is to establish clear and consistent management policies across all bushland areas. The Irrawong Reserve Plan of Management provides details of the management objectives and performance targets specific to Irrawong Reserve which are consistent with the aims and objectives of the UBPM.

2. Objectives for Management

2.1. Significance of the Reserve

Few major cities the size of Sydney have substantial areas of natural bushland within their boundaries. Sydney's urban bushland makes an important contribution to the city's character as a place of great natural beauty.

Urban bushland areas throughout the Sydney region are significant for the following reasons:

- They provide 'green space' in the urban environment, contributing to the amenity of the city and enriching the urban experience for both local residents and visitors.
- They provide a habitat for many species of native flora and fauna that would otherwise disappear from urban areas. Urban bushland is also important when it acts as a wildlife corridor, providing migratory or nomadic species with a refuge while passing through the urban area.
- They are an important scientific resource, especially as a record of a district's original landscape and vegetation. Even weed invasion and other adverse influences provide opportunities for important research.
- They are an important educational resource, as a first point of contact with nature for many urban residents as well as a venue for formal education. They provide nearby schools and other educational institutions with natural areas which can be visited without the need for a major excursion, and where it is feasible to carry out studies involving repeated visits.
- They provide recreational opportunities, enabling urban residents to undertake recreational pursuits in a bushland setting.

In addition to these general features Irrawong Reserve has particular significance for the following reasons:

- The reserve has an important function as a habitat for the regionally significant plant species *Eucalyptus robusta*, (Swamp Mahogany) and contains part of the last sizeable stand of this vegetation in the Sydney region (Benson and Howell 1990);
- The Reserve contains a portion of a larger rainforest vegetation community with the Rare or Threatened Australian Plant (ROTAP) *Syzygium paniculatum* listed as Vulnerable on Schedule 2 of the Threatened Species Conservation Act, 1995.
- The reserve provides suitable habitat and food trees for Koalas. This species is listed as Vulnerable on Schedule 2 of the Threatened Species Conservation Act, 1995, and is considered under considerable threat of local extinction;

- The reserve provides an important wildlife corridor linking the open forest, tall open forest, woodland and heath habitats of the Ingleside escarpment, linking Garigal and Ku-ring-gai National Parks to the coastal wetland habitats of the Warriewood Wetlands;
- It supports a wide diversity of fauna species in the context of urban bushland in the Sydney region and is a significant coastal wetland habitat for resident and migratory birds.
- It is used by a number of institutions such as the University of New South Wales and Macquarie University as a site for scientific research and education;
- It is used as an open air classroom by schools and community groups.
- The reserve is within the flood plain of Mullet Creek and hence is important as a control on local flooding.

2.2. Management Objectives

The management objectives for Irrawong Reserve are:

- To protect natural features of the Reserve, particularly to conserve the regionally significant Swamp Mahogany (*Eucalyptus robusta*) community;
- To protect the Reserve's value as an important fauna habitat and part of a wildlife corridor linking Warriewood Wetlands to the escarpment;
- To prevent weed invasion and control weed species occurring in the reserve;
- To maintain the structural and floristic diversity of native vegetation within the Reserve;
- To adequately manage the bushland/urban interface so as to minimise adverse external influences;
- To prevent further damage to the Reserve from urban run-off, stormwater and pollution, restore habitats already degraded and establish and maintain a near natural water cycle, to achieve the objective of aquatic ecosystem health and health of Swamp Mahoganies;
- To protect human life and property in and adjacent to the Reserve from wildfire and maintain ecological processes in the Reserve by seeking to maintain a near-natural fire regime in the body of the Reserve;
- To control and eradicate, where possible, feral animals within the Reserve;

- To provide opportunities for low impact recreational, scientific and educational use of the Reserve, consistent with other objectives;
- To encourage community and neighbour participation in bushland management.

3. Reserve Description

3.1. Location and Description

Irrawong Reserve occupies an area of approximately 4.5 hectares in the suburb of North Narrabeen, 22 km north of Sydney's CBD (Figure 1). It is located between the Ingleside escarpment to the west and the Warriewood Wetlands to the east, with Garden Street forming the boundary between Irrawong Reserve and the Warriewood Wetlands. The fill embankment of Irrawong Road forms the southern boundary, while the northern boundary which has also been subjected to infilling, is formed by cleared non-urban land and a retirement village.

The overall shape of the Reserve is linear, with an east-west orientation. The small size of Irrawong Reserve, its location on the flood plain of Mullet Creek and its linear shape give the Reserve a long perimeter for its area. These factors, combined with the flood plain nature of the reserve, make it vulnerable to external influences especially water borne pollution such as nutrients, sediments and weed propagules.

Figure 1 - Location of Irrawong Reserve

3.2. History

The original inhabitants of the Reserve were most likely aboriginal people who lived in the area for several thousand years prior to European occupation. The local aboriginals were part of the Guringai group who inhabited the land between Port Jackson and Broken Bay (Koetig 1993).

Shortly after the arrival of the first fleet, the Narrabeen and Pittwater area began to be explored (Steege 1984).

The first land grant in the Warriewood area was made to James Jenkins in 1824 (Tropman and Tropman 1993). It consisted of 100 acres, a further 250 acres adjoining this was granted to Mr Jenkins in 1825. Correspondence in 1829 between Mr Jenkins and the Colonial Secretaries office records that Mr Jenkins possessed 440 head of horned cattle and 14 horses. He states that he had cleared 17 acres of land, installed fences and built a weather board dwelling.

By 1830 most of the arable land in the Warriewood valley had been granted. Early Parish maps from this period depict part of the Warriewood valley as swampland and known as the Narrabeen Swamp.

The Pittwater area remained an isolated pioneering settlement until the small settlements and farms became more consolidated in the 1850's. Pittwater Road had been surveyed by 1870, and by the 1880's a bridge had replaced the ford at the opening of Narrabeen Lagoon making way for further urban expansion.

A Crown Reserve, which is now Irrawong Reserve, was designated for Water Supply on 20 May 1899.

Warringah Shire Council was proclaimed a Shire on 6 March 1906. In the same year a major subdivision of the Warriewood area occurred. The area was mostly subdivided into small farm blocks. The sales brochure for this development reveals a great deal of information on the character of Warriewood at this time.

"All farm blocks are situated in a sheltered vale, intersected by Narrabeen and Fern creeks, being protected from the winds."

"The soil is very rich, black, deep, slightly sandy loam, of the kind so prized by Nurserymen, and easily worked. The estate being so handy to the city by a first-class road, growers can take their own produce to market, thereby saving all freight and agency charges."

"Fine timber, including Ironbark, Grey Gum, Turpentine, Mahogany, Forest Oak and others are available in plenty for building, fencing, firewood, and other purposes."

It was after this subdivision that market gardening became established in the area. It did not develop on a large scale, however, until the 1920's and 1930's. The Warriewood valley became known as "glass city" due to the large expanses of glass

houses. Market gardening continued to grow until the 1950's, becoming one of the largest tomato growing areas in Sydney.

By the 1960's the decline of market gardening was apparent from the degradation of the farmland and the glass houses. Community pressure to re-zone rural areas to allow urban development increased and further residential development occurred in the areas adjacent to and surrounding Irrawong Reserve.

3.3. Land Tenure

Irrawong Reserve is identified as Crown Reserve 91364 for Public Recreation on 19 January 1979. Prior to this it was known as Crown Reserve 29375, notified on 20 May 1899, for Water Supply .

Irrawong Reserve is Crown land owned by the Department of Land and Water Conservation. Pittwater Council is responsible for the care, control and management of Irrawong Reserve.

No leases or licences currently affect the land. Given the nature of the reserve it is unlikely that any leases or licences will arise, however, any proposals should be considered on their merit and in consideration of how they meet the objectives of this plan.

3.4. Topography

A plateau, of Hawkesbury Sandstone, forms the backdrop to the coastal plain. Irrawong Reserve lies in a valley at the base of the north-south escarpment of this plateau. The highest points in the reserve are on its southern and western boundaries. The southern boundary, which consists of a fill batter supporting Irrawong Road, is considerably steeper than the northern boundary which has also been subject to areas of land fill. The lowest point is on the eastern boundary at the Garden Street culvert. Within the reserve, the landscape is the gently sloping flood plain of Mullet Creek.

3.5. Geology and Soils

The Pittwater area is part of the deeply dissected sandstone of the Hornsby Plateau. The parent geology of the Ingleside escarpment features Hawkesbury sandstone with underlying Narrabeen group sediments on the foot slopes and low hills enclosing the Warriewood Valley. This group is composed of shales and sandstones which result in a topography less rugged than those formed from Hawkesbury sandstone. The landscape formed by the Narrabeen group is characterised by narrow, convex crests and ridges, steep colluvial side slopes with occasional sandstone boulders and benches. The soils derived from the Narrabeen group are shallow and sandy on sandstones and moderately deep podsollic soils on shales (See Figure 2).

The soil landscapes have been mapped on the Soil Landscapes of Sydney 1: 100 000 Sheet. Two soil landscapes are present within the Reserve; Watagan and Warriewood (See Figure 3).

The Reserve forms part of the Mullet Creek flood plain and has extensive sedimentation due to the recent and historical erosion of Hawkesbury Sandstone in the upper catchment. The flood plain material overlays soils derived from the Narrabeen Group which have been mapped as the Watagan (wn) soil landscape.

The soil landscape mapped as Warriewood (wa) consists of deep well sorted, sandy humus podzols and dark, mottled siliceous sands overlying buried acid peats in depressions and pale siliceous sandy rises. A swampy gently undulating landscape, the soils are highly permeable and the water table is less than 2 m below the surface.

Figure 2 - Geology

Figure 3 - Soils

3.6. Hydrology

The main water source within Irrawong Reserve is Mullet Creek. The creek traverses the full length of the Reserve from the western to the eastern boundary where it flows through a culvert under Garden Street. Within the Reserve, the creek consists of shallow pools and sandy runs with flood channels and sandy flood deposits along the creek banks. There are also 5 stormwater outlets draining from the residential development along the southern border of the Reserve.

The Reserve and a number of adjoining properties have been identified as areas prone to flooding. Recent investigations (Dodson, 1995) lead to the conclusion that the area has supported a natural wetland for most of the past 1500 years and therefore, the hydrological regime of the Reserve is an important aspect of the area's ecology.

The present hydrological regime in the Reserve is the result of urban development adjacent to the reserve as well as development up stream in the Mullet Creek catchment.

In general, stormwater flows during rainfall events are increased by development which increases the amount of impervious surfaces within a catchment. Water runs off these surfaces more rapidly leading to increased peak flows and lower dry weather flows.

The water level in the reserve is also governed by a culvert under Garden Street, through which run off from the Reserve drains. Stormwater run-off rates in the catchment have been estimated for existing land use conditions using the RAFTS and MIKE II models (PBP/Lawson Treloar 1994). The results of these simulations indicate that the Garden Street culvert has a significant effect on flood flows in Mullet Creek, causing flood water to back up into the Reserve.

The Garden Street culvert also has a significant effect on the water level in the Reserve between rainfall events. The elevation of the base of the culvert restricts drainage from the Reserve, potentially leading to a constantly elevated water level. Evidence of changes in the hydrology of the Reserve is also provided by changes in the vegetation communities within the reserve.

The growth of a dense *Phragmites* understorey indicates increasingly wet conditions. These changes pose a threat to the natural ecology of the Reserve and in particular to the health of the *Eucalyptus robusta* community (Roberts 1995).

3.7. Water Characteristics

3.7.1. Catchment Description

The Mullet Creek catchment has an area of approximately 9.5 km² (Lawson and Treloar 1994) with its highest point at the Bahai Temple in Ingleside. Upstream of

the Ingleside escarpment, Mullet Creek splits into two arms which drain the areas either side of Powderworks Road. (See Figure 4).

The southern arm of the creek has its source in Monash Golf Course, and land use in this subcatchment includes two golf courses, nurseries, market gardens, bushland and residential development. The creek is dammed on Monash golf course and on the east side of Powderworks Road.

The northern arm of the creek flows through the Westpac Training Centre and Ingleside Park. This subcatchment also contains a quarry, market gardens and nurseries.

The two arms of the creek flow over waterfalls on the Ingleside escarpment before joining and flowing over another waterfall, into a large pool and then into the Reserve.

The Ingleside area is largely unsewered. Elanora Heights and parts of the Warriewood area are currently serviced by a stand-alone sewerage system, which drains an area of approximately 20 ha (PBP 1994). The Warriewood sewerage system is essentially in good condition and infiltration/inflows from illegal connections are not major problems (Water Board 1993).

However, sudden onsets of inflows to the system have been reported in medium to heavy rain which are believed to be caused by the inundation of large areas of low-lying land (PBP 1994).

There is a sewerage trunk line which passes through Irrawong Reserve and has at least 3 overflow structures within the reserve.

Figure 4 - Mullet Creek Catchment

3.7.2. Water Quality

The catchment characteristics have a dominant effect on the quality of water entering the reserve. In general, runoff from a catchment with a full cover of natural vegetation seldom carries excessive silt or nutrient load (Cheng 1993). In contrast, a catchment with significant urban, industrial or agricultural development can generate significant pollution including nutrients, suspended solids, bacteria and chemical pollution, seriously affecting the quality of receiving waters.

Nutrients are minerals required by plants to promote growth. The two minerals required in the greatest quantities are nitrogen and phosphorus. The availability of these two nutrients generally limits the growth of aquatic plants.

Phosphorus is quite immobile in soils since it is bound onto clay minerals and other soil components (Cheng 1993). Thus, a high input of phosphorous from the catchment is usually indicative of soil disturbance with the catchment area. Phosphorus inputs are generally easier to control than nitrogen inputs because nitrogen is mobile in soils and often enters the aquatic environment due to soil leaching (Cheng 1993).

The quality of water entering the Reserve was monitored as part of a five month water quality study (Pittwater Council, 1995). Samples were collected from the base of the waterfall upstream of the Reserve and analysed to determine the concentration of nutrients, faecal coliforms and suspended sediments. Measurements of chemical and physical water quality parameters were also performed. The results of this study indicate that nutrient concentrations in water entering the Reserve are consistently greater than that in comparable reference creeks.

Further evidence of nutrient enrichment of water entering the Reserve is provided by the substantial growths of the algal species *Cladophora* and the macrophyte *Egeria densa* on the creek bed within the Reserve and upstream to the base of the waterfall. During an inspection of the creek upstream from the waterfall, both of these species were also found immediately above the waterfall. The lack of aquatic plants further upstream along the southern arm towards the dam at Powderworks Road may indicate that the dam is reducing the nutrient load of the creek.

The north arm of Mullet Creek has algae and water plant growth of *Cladophora*, *Hydrodictyon reticulatum* and *Ludwigia peploides* as well as *Chara vulgaris* which indicates an elevated calcium concentration in the water column. Council's water quality study also revealed consistently alkaline water upstream of the Reserve which is also evidenced by the presence of large numbers of the gastropods *Physastra* sp and *Agrobis* sp. Gastropods are rare in waters with a low pH (Williams 1980) and pH is an important parameter of water quality as it affects the rate of important physico-chemical reactions (Cheng, 1993).

Nutrient enrichment of sediment and water poses a threat the long term viability of the *Eucalyptus robusta* population in the Reserve . A high nutrient status encourages the growth of weeds, leading to significant ecological changes.

High nutrient status is not unexpected for Mullet Creek. The catchment has two large golf courses and a number of plant nurseries which are usually intensively managed using fertiliser and frequent watering. There is also the legacy of intensive market gardening within the catchment. Fertiliser and pesticides are heavily used for market gardening, particularly on low nutrient sandy soils.

A study of potentially contaminated land in the Ingleside / Warriewood area has been undertaken (Gutteridge Haskins and Davey 1993 B) and sites likely to be contaminated by agricultural chemicals were identified in the Mullet Creek catchment. These sites could potentially pose a threat to the Reserve through transport of contaminants via leaching and surface run off.

Local knowledge indicates that the pool upstream of the Reserve was once a favoured swimming hole but is now virtually infilled by sandy sediment (Roberts 1995).

The excessive rate of sediment input into the Reserve has had a negative impact as sediment carries with it nutrients and other chemical contaminants.

3.8. Vegetation

Natural vegetation communities develop in response to the configuration of soils, drainage, topography and aspect. The drainage lines and parts of the valley floor of Warriewood were vegetated by forests, woodlands, and wetland communities. The vegetation included areas of sedge and rushes fringed with *Casuarina glauca* and *Eucalyptus robusta* (Tropman and Tropman 1993).

Cunningham (1994) considered Irrawong Reserve as an area "essential for retention to conserve its significant vegetation characteristics". Due to the Reserve's importance as containing a large portion of the last significant stand of the Swamp Mahogany forest in the Sydney region, Benson and Howell (1990) restoration and rehabilitation is urgently required to insure the long term health and integrity of the plant community.

Along the fringes of the Reserve, the upstream adjoining property, and the areas of disturbed soil landscape and fill, the Swamp Mahogany community is in a degraded condition. In general these areas of the reserve have been heavily invaded by weeds, such as Morning Glory (*Ipomoea indica*), Lantana (*Lantana camara*), Privet (*Ligustrum sinense*), Coral Trees (*Erythrina x sykesii*), Cassia (*Senna floribunda*), Crofton weed (*Ageratina adenophora*), Pampas grass (*Cortaderia selloana*), Castor Oil (*Ricinus communis*) and Potato vine (*Acetosa sagittata*).

Irrawong Reserve has been the subject and partial subject of various vegetation surveys and studies in the past.

These include four annual bush regeneration reports by the Total Earth Care Company beginning from 1991 to 1995, the Mullet Creek Report by Dave Winfield in

1991, the Ingleside/Warriewood Land Release Vegetation Conservation Study by Geoff Cunningham 1994, *Eucalyptus robusta* at Irrawong Reserve by Dr. Jane Roberts, and a field survey by Roger Lembit (Environmental consultant) and Lynn McDougall (of the Total Earth Care Company) for preparation of this Plan of Management (See Figure 5 and Appendix C).

Swamp Mahogany Open Forest with Wet Sclerophyll understorey

The vegetation within Irrawong Reserve consists of Coastal Swamp Forest Complex with the Swamp Mahogany (*Eucalyptus robusta*) community being the primary vegetation unit.

Tree height ranges from 30 to 35 metres forming a medium to tall open forest. The dominant species is Swamp Mahogany (*Eucalyptus robusta*) with other tree species being Cabbage Tree Palms (*Livistona australis*), Swamp Melaleuca (*Melaleuca ericifolia*), and Sydney Peppermint (*Eucalyptus piperita*) on higher sandstone margins. The shrub layer is sparse with species including Bolwarra (*Eupomatia laurina*), Tree Ferns (*Cyathea australis*), Bleeding Heart (*Omalanthus populifolius*) and Pomaderris (*Pomaderris discolor*).

The ground layer is dominated by a cover of ferns and grasses in the drier areas of the swamp, with common species including False Bracken Fern (*Pteridium esculentum*), Swamp Water Fern (*Blechnum indicum*), and Swamp Pennywort (*Centella asiatica*).

Swamp Mahogany Open Forest with Reed understorey

A large part of the Swamp Mahogany Forest Complex has an understorey dominated by Common Native Reed (*Phragmites australis*). This community occurs along the creek and dominates in the low lying sediment delta which makes up the largest area of the Reserve. This is considered to be an understorey which has changed over time with increased water levels, sediment and nutrient loads. This community intergrades into the Swamp Mahogany and Casuarina communities of the Warriewood Wetlands.

Lilly Pilly Closed Forest

The north-western corner bordering Epworth Park features Lilly Pilly closed forest with rainforest components typical of deeper soils and the moist sheltered gullies in the Sydney region. Species include Lilly Pilly (*Acmena smithii*), Cheese Tree (*Glochidion ferdinandi*), Rusty Fig (*Ficus rubiginosa*) and Corkwood (*Endiandra sieberi*). The Rare or Threatened Australian Plant (ROTAP) species Brush Cherry (*Syzigium paniculatum*) is also listed as a Vulnerable Species and has been recorded in the general vicinity of the rainforest (Total Earth Care 1991, and Madden 1994). This record requires confirmation.

The shrub layer contains Bastard Rosewood (*Synoum glandulosum*), Bolwarra (*Eupomatia laurina*), Hairy Clerodendrum (*Clerodendrum tomentosum*) with

climbers and twiners Water Vine (*Cissus hypoglauca*) and Morinda (*Morinda jasminoides*).

Much of the ground layer has been overtaken with a mat of Wandering Jew (*Transcantia albiflora*) dominating throughout. There has been good regeneration of native groundcovers where the Wandering Jew has been removed. Ferns, native wandering jew, and native geranium have all been successful colonisers replacing the monoculture areas of weed.

Figure 5 Distribution of native plant communities within Irrawong Reserve.

3.9. Fauna

A fauna survey was undertaken by the Australian Museum in 1994 for the Ingleside/Warriewood Land Release area and included one site at Irrawong Reserve. The Australian Museum classified the Reserve as an area that is considered "essential for the retention of significant fauna populations that should be conserved". They considered the Swamp Mahogany forest to be a vegetation community which formed a regionally significant seasonal feeding ground for birds, flying foxes and probably arboreal mammals.

Clearing of the weed species and regeneration of the understorey using native species would greatly enhance the habitat for birds, mammals, reptiles and frogs (Australian Museum 1994).

This is particularly true for Koalas and possums that would be able to access trees in the interior of the forest. However, mass clearing of weeds could have a negative impact on many species which use heavily infested weed thickets as shelter from predators and for those bird species which rely on thickets for nesting.

Further detailed fauna surveys have been undertaken in the Reserve for preparation of this plan of management. These have been undertaken and co-ordinated by the Total Earth Care Company and the University of New South Wales on a voluntary basis (see Appendix A).

Birds

Irrawong Reserve and the adjacent Warriewood Wetlands provide significant habitat for birds. A recent bird census was undertaken in the Reserve and surrounding habitats in spring, summer and winter by LW Filewood using ten minute timed transects.

He recorded 86 species of birds in and around Irrawong Reserve (see Appendix B).

Regionally significant species include the Brown Gerygone which is at its southern limit and the Topknot Pigeon which is a summer migrant and a rainforest vector. Other migratory birds recorded include the Brush Cuckoo, Common Koel, Channel-billed Cuckoo, Dollarbird, Cicadabird, Clamorous Reed Warbler, Rose Robin and Black-faced Monarch. A number of birds were present that are considered indicators of good habitat including the Large-billed Scrubwren, Brown Gerygone and Lewins Honeyeater.

The Brown Goshawk and the Little Lorikeet are locally significant. Other features are the large number of small birds such as wrens, silvereyes, fantails, finches and thornbills which require low dense vegetation.

Paul Burcher has highlighted the importance of Irrawong Reserve for the Powerful Owl's feeding range, as the owl was spotlighted in Ingleside Park in winter 1995.

Bird surveys have also been compiled from a number of historic lists which record 99 species using the wet forest and adjoining wetland habitats.

The Regent Honeyeater, a vulnerable species, is known to feed on Swamp Mahogany and has been recorded in a similar habitat in Bayview in the 1970's (Alan Morris pers comm.). The Reserve may also be potential habitat for another vulnerable species, the Black Bittern a migratory bird protected by international treaties JAMBA and CAMBA..

Mammals

Swamp Mahogany is a favoured food tree species of the Koala in the Sydney region. A sighting in 1992 was recorded in Irrawong Reserve (Pittwater Council's Endangered Species Household Survey 1993). The same survey reported several sightings in the Ingleside area which could suggest Koala movement from the National Parks to the richer valley areas including Irrawong Reserve. A Swamp Wallaby (*Wallabia bicolor*) was recently sighted feeding in the reserve in the early morning (P. Fullagar pers com.).

The Reserve was the only habitat in the Ingleside/Warriewood area where the native Swamp Rat (*Rattus lutreolus*) was recorded by the Australian Museum in 1994.

Although generally common, it is uncommon in the Sydney metropolitan area and could be considered locally significant.

Alastair Stratton (Total Earth Care) undertook a mammal survey for Irrawong Reserve and Epworth Park over spring/summer 1995. Methodology included spotlighting and Elliot trapping in dry sclerophyll forest, temperate rainforest and in Swamp Mahogany open forest over three nights.

Several Brown Antechinus (*Antechinus stuartii*) and a Yellow-footed Antechinus (*Antechinus flavipes*) were trapped and Sugar gliders (*Petaurus breviceps*), a Tawny Frogmouth (*Podargus strigoides*), a Grey-headed Flying Fox (*Pteropus poliocephalus*), and a Long Nosed Bandicoot (*Perameles nasuta*) were spotlighted.

Nectarivorous mammals such as Grey-headed Flying-foxes and sugar gliders were found feeding on the flowers of the Swamp Mahogany forest.

Brown Antechinus and Common Ringtail Possums were also recorded in the Reserve by the Museum survey.

The forest complex provides good potential habitat for the vulnerable Tiger Quoll and Squirrel Glider (Paul Burcher, pers. comm. and Australian Museum 1994), however it is not known if Squirrel Gliders use the forest because of local rarity of gliders and difficulty in identification and spotting. The Reserve will be managed with these

species in mind and all dead trees and older trees with hollows and logs will be conserved.

Reptiles and Frogs

A survey of reptiles within the Reserve was undertaken by Andrew McGahey and John Scanlen (Total Earth Care and UNSW 1996) recording several species of snakes and lizards.

There were four snake species found including Swamp Snake (*Hemiaspis signata*) and the regionally significant species Carpet Python (*Morelia spilota*). An abundance (30) of Eastern Water Dragons (*Physignathus lesueurii*) and Eastern Snake-eyed Skinks (*Cryptoblepharus virgatus*) were recorded. This recent survey indicates that the reserve has a diverse resident population of snakes and lizards.

The Swamp Mahogany Forest may once have been suitable habitat for the Green and Golden Bell Frog (Australian Museum 1994). Three frog species have been recorded including the Common froglet (*Crinia signifera*), the Brown-striped Frog (*Limnodynastes peroni*) and Peron's Tree Frog (*Litoria peroni*) by Paul Burcher in summer 1996. The frogs may be experiencing severe predation due to the presence of the introduced predatory Mosquito Fish (*Gambusia affinis*) (Ecology Lab, 1994).

Aquatic Fauna

There is limited information available on the aquatic fauna of the Reserve. Only introduced species of fish have been recorded in the reserve, other organisms include snails and aquatic insects.

Gastropods occur in a wide variety of inland waters, however they are rare in waters which contain low amounts of calcium, low pH (acid) and organically polluted waters (Williams 1980). On the Mullet Creek system gastropods are abundant in the pools, particularly between the waterfall and the weir below the Wetlands. Two species were collected by Hawes (1994); *Physastra* sp. and *Agrobia* sp.; both species are small and common in south-eastern Australia.

Other aquatic organisms collected from within the Reserve include aquatic insects. Hawes (1994) collected several species of water boatmen (Hemiptera) and the larvae of dragonflies (Odonata).

Regionally Significant Species

These recent surveys have highlighted the presence of several regionally significant species. Mammals include the Yellow-footed Antechinus and Long nosed Bandicoot; the birds include the Brown Gerygone and Topknot Pigeon; and reptiles include the

Carpet Python. The record of the Yellow-footed Antechinus however requires confirmation.

Introduced Fauna

The Reserve is located in an area where landuse adjacent to its boundaries is mostly suburban residential housing. The potential for predation of native fauna by domestic cats and dogs is high. Foxes are a significant predator which has adapted to urban living and hunt in the natural areas surrounding Sydney and its suburbs. Foxes, domestic pets, and a ferret have all been observed in the Reserve by local residents (A. McGahey pers comm.).

Hawes (1994) collected Mosquito Fish (*Gambusia affinis*) which are abundant in the creek section within the Reserve. *G. affinis* are native to Central America and were introduced to Australia in the 1920's to control mosquitoes.

They have had little effect on mosquito populations in Australia and have become so abundant in some areas that they are considered a pest, competing with native fish for food and space (Allen 1989). Carp are also present in the Reserve (P.Hawes, pers. obs.).

3.10. Aboriginal Sites and European Heritage

The original inhabitants of the Reserve were most likely aboriginal people of the Guringai group. There are no recorded Aboriginal sites in Irrawong Reserve and due to the nature of the landform, none would be expected (Koettig 1993).

No items of European heritage have been listed for Irrawong Reserve by the National Trust or the heritage study by Tropman and Tropman (1993). A survey of the Reserve could be undertaken as part of any review of the Heritage Study.

4. Management Issues and Strategies

4.1. Weed Invasion, Bush Regeneration and Vegetation Management

Issues

Irrawong Reserve has been extensively affected by weed invasion. These weeds compete with the native species leading to simplification of the Reserve's ecology, loss of biodiversity and poses a serious threat to the health and integrity of the Swamp Mahogany Forest. (see figure 6)

The most intractable aquatic weed species which is threatening the Reserve is the water weed Ludwigia (*Ludwigia peruviana*). This weed is present on private property bordering the reserve as well as in isolated clumps along Mullet Creek where openings in the canopy create open sunny conditions which favours the establishment of Ludwigia infestations. There is a large infestation present downstream in the Warriewood wetlands. Control of this weed is difficult with a combination of repeated chemical control (under license from the EPA and the NRA) and a complementary revegetation strategy being the only successful trialed method (Gutteridge, Haskins and Davey 1993).

There are many widespread and prolific weeds including the woody weeds such as Coral Trees (*Erythrina x sykesii*), Indian Coral Trees (*Erythrina crista-galli*), Lantana (*Lantana camara*), Cassia (*Senna floribunda*), Castor Oil Plant (*Ricinus communis*), and Weeping Willows (*Salix babylonica*). The fill areas are most susceptible to woody weeds however it is expected that infestations will re-occur throughout the floodplain due to the upstream occurrence of these exotic species. The on going bush regeneration program has successfully targeted much of the woody weed infestation however ongoing work to address re-infestation will be required.

Vine species such as Morning Glory (*Ipomea indica*), Potato Vine (*Acetosa sagittata*) and Honeysuckle (*Lonicera japonica*) are present in the Reserve and are a serious threat to not only the understorey but also the health of the canopy which is the highest conservation priority.

In the case of Potato Vine, which produces massive amounts of seed and has underground tubers, control in the floodplain environment is particularly difficult.

An integrated program of herbicide use as well as manual removal is being undertaken within current bush regeneration works.

The high incidence of groundcover weed species is expected in a floodplain system with rich soils, regular inundation events, and higher levels of nutrients in sediments and water from a partially urbanised catchment. This makes restoration difficult as weed sources cannot always be stopped, resulting in the re-occurrence of many weed species. The main groundcover weed species present in Irrawong Reserve are

Crofton (*Ageratium adenophora*), and Wandering Jew (*Tradescantia albiflora*), with several species of annual weeds emerging in spring. Hand removal of select areas of these two species has been successful with the native species such as False Bracken Fern, Gristle fern, *Persicaria*, and Swordgrass colonising the cleared areas.

Beside the road embankment area is introduced fill which has a long history of weed infestation. The seed bank in this area is expected to be high in weed seed, making re-infestation an ongoing problem. However canopy trees exist along the embankment and viable seed is present. An Environmental Trust Grant is funding works to address weed control and stabilisation of the embankment integrated with a walkway for greater public awareness and use of the Reserve.

There appears to have been limited regeneration of *Eucalyptus robusta* in the Reserve with very few juveniles present. *E. robusta* saplings downstream near Warriewood demonstrate that there is viable seed in the area and that appropriate germination conditions do occur (Roberts 1995). The unusual event of the Reserve being partially burnt in the bushfires of January 1994 not only served to advance the bush regeneration program by producing an extremely hot burning of woody weeds and vines on the edges of the reserve but also appeared to create conditions where germination of *Eucalyptus robusta* occurred much more prolifically than in the past.

This could be an indication of favoured environmental conditions resulting from the fire (a more open understorey) rather than the species' response to fire, however research on *E. robusta*'s response to fire is necessary to confirm this.

There is a need to investigate and confirm the presence of *Syzigium paniculatum* in the Reserve and develop appropriate conservation strategies for the species.

Figure 6 - Weed Cover

Strategies

Integrate programs to investigate and remediate conditions to maximise tree health of *E. robusta*.

Continue and expand, if possible, Council's current bush regeneration program to establish further areas requiring only maintenance.

Reassess the bush regeneration program on a yearly basis setting out specific aims, outcomes and techniques to be applied as part of a holistic approach developed for a three year tender based program.

Bush regeneration works are to be integrated with works or actions aimed at mitigating the degrading influences on the reserve.

Primary bush regeneration works should not be undertaken if sufficient follow-up weed control and regeneration work cannot be guaranteed.

Seek additional funding from State and Federal Government sources for continued restoration of the Reserve.

Make greater use of Council's environmental publications to increase community awareness of the impacts of weeds on the environment. Utilise a "Do the Right Thing" approach to reduce dumping of garden refuse in the reserve.

Set access tracks at a minimum width to reduce opportunities for weed invasion.

Encourage and support existing volunteer "Bushcare" groups and expand volunteer bush regeneration work in Irrawong Reserve.

Obtain sponsorship from industries and businesses (particularly local ones) and Council's own suppliers for assistance with regeneration work in the Reserve. Publicly acknowledge the contribution of the sponsors.

Monitor regeneration within the Reserve and prevent re-invasion by weeds from neighbouring properties.

Confirm the location of *Syzigium paniculatum* and develop relevant conservation strategies.

4.2. Hydrology, Water Quality and Ecosystem Health

Issues

The high nutrient concentration in water entering the reserve and elevated water table within the reserve are thought to be having a serious impact on the Reserve ecology.

This poses a potential threat to the value of the Reserve as habitat for the *Eucalyptus robusta* community, as a wildlife corridor and as an educational resource. These issues require further research and investigation.

Reserve Hydrology

As the reserve is located on a naturally occurring floodplain, it is expected that the Swamp Mahogany forest community would be adapted to storm events and periodic inundation. However, the height of the water table is essentially determined by size and height restrictions at the Garden Street culvert. *Eucalyptus robusta* is not normally considered to be tolerant of permanent flooding, hence the long term viability of the stand could be threatened by the elevated water table. In an analogous situation in western NSW, invasion of a wetland understorey under a floodplain tree (eg cumbungi *Typha* spp. under Blackbox *Eucalyptus largiflorens*) is a reliable indicator of an increasingly wet flood regime. If such a regime is allowed to continue, it could lead to the death of the trees within a few years (Roberts 1995).

Water Quality

The National Water Quality Management Strategy (ANZECC 1992) provides guidelines for the protection of freshwater aquatic ecosystems.

In Irrawong Reserve, the presence of elevated nutrient concentrations give weed species a competitive advantage over native plant species, leading to simplification of the ecosystem and loss of habitat and aesthetic values.

The possibility of the Reserve receiving water with pollution from various landuses in its upper catchment poses a threat to the sustainability of the Reserve ecosystem.

Sedimentation

Sediment can be a significant carrier of nutrients and chemical pollutants from the catchment. An increase in sediment deposition will also lead to a decrease in water depth of the creek and may lead to an increase in inundation levels in the Reserve. The sediment content and depth can determine what vegetation the Reserve will support and the future health of the Swamp Mahogany forest.

Future Investigations

For more informed and effective management of the Reserve to occur, more information is required on:

- Water quality, the source of any water quality problems and an implementation strategy to improve water quality.
- Reserve surface and sub-surface hydrology and flow regime with ecological components such as duration, frequency, and seasonality, is needed to assess flooding events and the hydrological needs of a healthy Swamp Mahogany community.
- Current and past rates of sedimentation and level of chemical or nutrient contamination of sediment within the Reserve.
- Research into the preferred hydrological regime of a floodplain Swamp Mahogany Forest.

Strategies

- Obtain an understanding of the rate of sedimentation and the quality of the sediment in the Reserve with regards to its impact on the ecological health of the Swamp Mahogany Forest community. This is undertaken through the analysis of core samples taken at strategic points within the Reserve. These samples can indicate sediment age, depth and the degree of nutrient and chemical contamination.
- A study of water quality and flows both into and out of the Reserve is needed to determine if current flow rates are having a negative impact on the health of the floodplain plant community and investigate remediation strategies.
- A catchment audit with the aim of identifying current and potential sources of water quality problems is necessary for improvement in water quality to be achieved. The audit will also provide a means of direct contact between Council Environmental Officers and local residents, through which public awareness of Reserve management and water quality issues can be addressed.
- The maximum concentrations of toxicants as specified in the Australian Water Quality Guidelines For Fresh and Marine Waters - for protection of aquatic ecosystems, are the long term objectives for the Reserve. Management strategies for pollutants will need to be developed in response to the water and sediment quality studies.
- A reduction in the quantity of nutrients entering the Reserve will be achieved by the implementation of a catchment wide program of community education, designed to change attitudes and practices which are directly impacting on the quality of water entering the Reserve. This education program can be carried out concurrently with the catchment audit and includes visits by Council officers, with particular attention given to potential problem areas such as agricultural sites and golf courses within the catchment. Site visits will be complemented by distribution of a pamphlet detailing actions which can be taken to reduce water pollution.

- No further formal drainage works which exacerbate sediment and nutrient entering the Reserve should be undertaken without thorough environmental assessment.
- Stormwater entering the Reserve from the southern boundary is to be treated by directing it through a sediment pond and wet filter where possible and to construct energy dissipators at stormwater outlets. A program of regular maintenance will be undertaken to ensure the long term effectiveness of these structures through removal of accumulated sediment on a needs basis.
- Planning for any development within the Mullet Creek catchment must address any impact on the Reserve and take into consideration the values of the Reserve and objectives of this plan, particularly with regards to control of runoff quality and
- Quantity in both the construction and post development stage.
- During any construction in the catchment, erosion and sediment control works are to be implemented in accordance with Council's usual standards and practices in erosion and sediment control.
- The peak flows of runoff from residential developments are to be reduced by implementing Council's "On Site Detention of Stormwater Policy" on each lot. For any possible future land release, construction of detention basins would serve numerous lots and reduction of runoff at the source. This reduction can be achieved by a range of measures which primarily reduce the area of impervious surfaces and maximise infiltration.
- The required research into the optimal hydrological requirements of floodplain Swamp Mahogany forest will be investigated.

4.3. Fire Regime

Issues

Urban bushland fire management needs to take into account the ecological needs of the plants and animals in the bushland, as well as the risk posed by wildfires to life and property. Fire management in urban bushland needs to ensure that fire hazard to life or property is minimised whilst protecting the natural features of the bushland.

Fires have occurred as a natural disturbance to bushland in the Sydney region for tens of thousands of years. Many of the plant species found in Sydney's bushland have characteristics which enable them to regenerate after wildfires. Changes to the fire regime (the frequency, intensity and season of fires) can have a severe detrimental effect on some species. Some species may even become locally extinct under an inappropriate fire regime.

The Swamp Mahogany forest in the Reserve is not known to be adapted to fire and is unlikely to have burnt with any frequency in the past. However, the Sydney bushfires of January 1994 did burn portions of Irrawong Reserve. The fire swept down through Epworth Park, burning the drier edges of the reserve and along Irrawong Road which had a very dense weed understorey.

Under these extreme conditions the wildfire burnt into the swamp but did not affect the trees within the wetter part of the reserve. This event, although destroying some residences in the area, did serve to assist the weed control program as it burnt a large area of woody weeds and vines which were severely affecting the health of the forest.

These areas have been re-infested with a new suite of weeds, however the improved access for further weed control has allowed significant gains to be made.

Circular C10 has been examined and due to the narrow width of the Reserve along the edge, the perimeter road (Irrawong Road), its small size, the clearing on its northern edge, the existing environmental conditions and low risk vegetation types present (swamp, rainforest and wetland species) contribute to the assessment that further fuel reduced zones on these edges are not necessary.

Any hazard reduction deemed necessary within Irrawong Reserve should be manually achieved and complement the existing bush regeneration program. Pile burns should only be carried out with permission from Council's Environmental Officer.

Strategies

- Any bush fire hazard reduction should be performed in accordance with the Department of Urban Affairs and Planning's Circular C10 Planning in Bushfire Prone Areas, and also be consistent with on going bush regeneration works.

4.4. Native and Introduced Fauna

Issues

Recent fauna surveys within Irrawong Reserve indicate a high level of faunal activity. The Reserve's importance as a narrow corridor linking the larger wetland habitat of the Warriewood Wetlands to the coastal open forests of the Ingleside area demands that any works within the Reserve must take into account the needs of the fauna residing in or moving through the reserve.

The often thick weed infested vegetation can provide important nesting habitats for many bird species such as honeyeaters and scrub wrens (Filewood pers. com.). These areas also provide nesting opportunities and protection from predation for smaller mammals and reptiles. Therefore, restoration works in the reserve must ensure that some thicket areas are left when primary weed infestations are addressed.

Clearing of large scale areas within the Reserve would be detrimental to fauna. Works should proceed as natural regeneration occurs and thickets of native vegetation replace weed infestation to allow thicket habitats and adequate refuge areas for native fauna during times of disturbance.

Public education on the protection of native fauna in the area would be useful to make surrounding residents aware of the faunal activity in the reserve and their protection under the National Parks and Wildlife Act and the Threatened Species Conservation Act.

Although the extent of the threat posed to urban wildlife by introduced predators has not been quantified, the Reserve's small linear shape, and the presence of cats and dogs in the surrounding residential area constitutes a significant threat. Cats are likely to hunt in the Reserve and take bandicoots and smaller mammals, birds, and reptiles. Dogs and foxes are also a threat to larger mammals such as possums, swamp wallabies, and koalas.

There is a need to investigate and confirm the record of the Yellow-footed Antechinus in the Reserve and develop conservation strategies.

Strategies

- Ensure fauna habitat needs are included within any restoration works within the reserve.
- Additional planting of food species for indigenous fauna should be included within any restoration works within the reserve.
- Maintain habitat and vegetation through a well planned bush regeneration and habitat enhancement program.
- Maintain habitat by preventing removal of logs for firewood and the removal of bushrock, through appropriate signage.
- Continued monitoring of wildlife in the reserve to determine the level of predation occurring.
- Control within the park of introduced predators through implementation of a systematic and humane feral animal trapping program.
- Control of domestic cats and dogs through a public education campaign and by impoundment of free roaming dogs.
- Use of legal measures available to Council for control of domestic cats and dogs to the fullest extent possible.

4.5. Recreation and Access

Issues

Easy access to the Reserve is required to provide opportunities for low impact recreational, scientific and educational use. Access is also necessary if community awareness and interest in the Reserve is to be maintained. However, access needs to be restricted to uses which will have minimal impact on the Reserve's ecology. (See figure 7)

Walking tracks within the Reserve need to be well defined, with the swamp areas avoided except by boardwalk to minimise damage and public safety risks. Signage should be provided at access points to the Reserve to direct recreational users. Interpretive signage along the walkway will provide environmental information and greatly enhance community awareness about wetlands and the Reserve's conservation value.

Irrawong Reserve provides an excellent opportunity for environmental education. It is located within walking distance from North Narrabeen Sports High School and North Narrabeen Primary School as well as Council's Coastal Environment Centre. Currently, Pittwater Council's "Our Coast" program has utilised a site in the Reserve to teach primary students 'hands on' bush regeneration. The Reserve is ideally located to assist teachers in demonstrating to students catchment principles, water quality issues, bushland management and fauna issues. However, any activity other than the use of public walkway and designated areas which may impact on the Reserve's ecology would need prior written approval from Council's Environmental Officer.

Honours students from the University of New South Wales have undertaken environmental studies within the Reserve. Permission for these studies must first be gained from Council's Environmental Officer with the understanding that Council receives a copy of the findings of any such studies.

Figure 7 - Walking Tracks

Strategies

- Provide a well defined walking track and boardwalk with appropriate signage to increase community awareness and interest whilst providing passive recreational facilities for public use.
- Erect interpretive signage along the walkway to provide information to the public and for environmental educational use.
- Prohibit use of the Reserve for horse riding, 4 wheel driving and motorcycle use to avoid soil erosion problems and degradation of the Reserve.
- Formalise points of access so that impacts of access such as weed invasion can be easily controlled.
- Monitor recreational and educational uses of the Reserve and their impact.

4.6. Boundaries and Neighbours

Issues

Irrawong Reserve has a long boundary relative to its area and hence is susceptible to adverse external influences from those boundaries.

Co-operation between contract bush regenerators, Council staff, volunteers and residents is necessary if effective management of the Reserve boundaries is to be achieved. Irrawong Road provides a clear buffer between many of the neighbouring residences with the exception of the few residences which directly border the Reserve in the area of the old horse paddock on the south western edge of the Reserve. This is a section of the Reserve which has been filled, cleared and grassed in the past. It is an area where future works should include additional planting to widen this very narrow vegetated link between Irrawong and the Wetlands.

Neighbours of the Reserve will be encouraged to work with Council to assist in the regeneration and maintenance of the Reserve and to inform Council of any illegal dumping of garden refuse or acts of vandalism which may occur.

A recent survey of the Reserve found encroachments on the northern boundary. These include infilling from adjoining properties, one corner of a glasshouse a landscaped garden and barbeque area from the adjoining retirement village.

Council has responsibilities under the Local Government Act (1993) to manage community lands for community benefit. Encroachments and the private use of community land are unlawful and must be removed.

Strategies

- Council will actively encourage neighbours who border the Reserve to reduce any impacts. Council will target illegal vegetation dumping, predation by domestic animals and encourage involvement in Council's volunteer bush regeneration program
- Council will encourage landholders to create or maintain buffer zones of indigenous vegetation on private land adjoining the Reserve.
- Council will pursue the removal of private encroachments onto the Reserve and require the restoration and regeneration of these areas.

5. Targets, Priorities and Performance

The Local Government Act 1993 requires that plans of management for community lands include performance targets, an implementation strategy for the targets and the method by which performances will be assessed.

Performance assessment will take place in the context of the annual State of the Environment Report required under the Local Government Act 1993. As part of these reporting requirements an annual audit of Irrawong Reserve will be undertaken.

The performance assessment should not divert scarce funds and resources away from Reserve management tasks. Therefore, performance assessment for Irrawong Reserve will stress methods which are simple and practical given the resource and financial constraints on management. They should be undertaken in a manner which improves rather than detracts from management.

Some performance assessment tasks are best undertaken by personnel who rarely visit the Reserve rather than regular visitors, such as bush regeneration contractors. Use of infrequent visitors can expose problems overlooked by regular visitors and allows more of an overview approach..

5.1. Bush Regeneration, Weed Control and Vegetation Management

Performance Targets

Investigate and improve stand health of the Swamp Mahogany forest and investigate and confirm presence of *Syzigium paniculatum*.

Meet the priorities as set out for specific regeneration sites in the bush regeneration contract after a thorough site assessment.

Continue the current integrated program of weed control, bush regeneration and restoration, and where possible expand the program seeking additional funding and more efficient restoration techniques.

Investigate and address major weed sources and mitigate conditions which favour weed growth to assist regeneration

Expand volunteer bush regeneration in the reserve.

Priorities

Priorities for weed control, bush regeneration and vegetation management are:

- to place high priority on conservation of the *E. robusta* forest and investigation of *S. paniculatum*;
- to only undertake primary weeding in areas when resources are available for follow-up weeding;
- to work on a catchment basis concentrating on weed sources and work within best bush regeneration practice concentrating on working from 'good bush' towards weed infestations; and
- to expand areas of work only when previously worked areas are under acceptable control.

Assessment of Performance

The program maximises the conservation opportunities for *E. robusta* and *S. paniculatum*.

The bush regeneration program results in a lower percentage of the Reserve which is weed infested and a larger percentage which is vegetated by native plant communities.

The bush regeneration program results in larger areas of the reserve which require maintenance only.

A greater public awareness and number of volunteers are involved and working in the restoration of the reserve.

5.2. Stormwater Control and Drainage

Performance Targets

To investigate and mitigate any negative impacts of stormwater from the Mullet Creek catchment on ecosystem health especially *E. robusta* forest.

To investigate and implement any remediation strategies necessary for the long term health of the Swamp Mahogany forest.

To reduce the negative impacts of stormwater inflows from the development above Irrawong Road to the Reserve.

Priorities

Construction of one sediment control basin and wet filter, and a series of energy dissipators at stormwater outlet points along the southern boundary of the Reserve.

Investigate Reserve hydrology to determine the dominant influences on and water regime in the Reserve.

Assess the relationship between Reserve's hydrology and its impact on the Swamp Mahogany forest and initiate any actions required.

Undertake regular maintenance of sediment controls to remove accumulated sediments on a needs basis.

Assessment of Performance

Completion of sediment control works and wet filter will mark the completion of an immediate priority in stormwater control.

Performance on the issue of Reserve hydrology can be assessed in two stages. The first stage will have been achieved when sufficient knowledge of the hydrological cycle has been gained for an informed ecological assessment. The second stage will have been reached when any requirements for remediation have been determined and the necessary actions initiated.

5.3. Water Quality and Nutrient Fluxes

Performance Targets

To reduce nutrient flux into the Reserve to a level such that the requirements for Swamp Mahogany are not exceeded, that the need for weed control is minimised and the water column of Mullet Creek meets ANZECC water quality guidelines for Aquatic Ecosystem health in the medium term.

Priorities

Undertake a catchment audit for the Mullet Creek Catchment to identify nutrient sources and develop a strategy for their remediation.

Undertake a public education program providing information on water quality and good environmental practices for the householder.

Monitor water quality through collection of data through a well designed study.

Assessment of Performance

The catchment audit stage of the plan will be complete when there is sufficient information available to develop an implementation strategy to reduce nutrients and improve water quality.

A quantitative assessment of the overall performance of any public education program is difficult to gauge however, increased enquires and public comment to Council on water quality issues could be used as an indicator.

5.4. Fire Management

Performance Target

To ensure that Reserve boundaries do not have excess fuel build up which could threaten neighbouring properties. Woody weed control to be undertaken within the bush regeneration program.

To maintain a near natural fire regime for conservation of the plant communities in the Reserve.

Priorities

To protect life and property from the risk of bushfire.

To protect flora and fauna ecosystems by maintaining a near natural fire regime.

To utilise a combination of burning and manual techniques as determined by ecological considerations, to address the above.

Assessment of Performance

The assessment of the success of fire protection policies and strategies can only be undertaken by monitoring fire occurrences in the area and their impacts.

Ecological assessment of fire management in the Reserve can be assessed through the use of surveys, photographs, regular observations by bush regeneration contractors, Council staff and residents.

Review of policies and strategies should take place in light of this experience.

5.5. Native and Introduced Fauna

Performance Targets

Conserve and enhance the habitat qualities of the Reserve through an integrated restoration program.

Investigate presence of Yellow-footed Antechinus.

Continue monitoring the fauna of the Reserve to obtain additional knowledge of diversity, abundance and habitat requirements of the species which use the Reserve.

Undertake a systematic, humane, trapping program for feral animals in the Reserve.

Enforce dog legislation in the area to lessen the impacts on native fauna by domestic pets and raise public awareness regarding cats.

Priorities

Undertake sampling program for the Yellow-footed Antechinus.

Ensure the habitat values of the Reserve are adequately protected for all native fauna whilst undertaking any restoration program. This would include leaving some thickets of weed infestation for protection from predation and nesting of fauna which require these habitats.

Acquire funding to instigate a feral animal trapping program.

Assessment of Performance

Regular surveys to monitor faunal activity in the Reserve.

Interview residents regarding the urban wildlife in the area of Irrawong Reserve.

The number of feral animals successfully trapped in the Reserve.

The number of free roaming domestic pets detained by Council's Rangers.

5.6. Recreation and Access

Performance Targets:

Provision of public access in Irrawong Reserve for the purpose of providing low impact recreational and educational use by visitors in order to promote their appreciation of the Reserve, consistent with its natural values.

Priorities

Construction of a raised walkway and boardwalk with a viewing platform to allow visitors a safe, well defined area in the Reserve for passive recreation such as bird watching.

Provision of interpretive signage on the walkway to increase public interest and awareness in the Reserve.

Assessment of Performance

Monitoring of the public's views and use of the improved access will be undertaken. Vegetation along the tracks will be monitored to ensure that there is no negative impact on the Reserve associated with the presence of access tracks.

5.7. Boundaries and Neighbours

Performance Targets

Develop a spirit of co-operation between the Reserves neighbours, the Council, bush regenerators and volunteers in addressing management problems in the Reserve.

Encourage a better understanding of the values of the Reserve and the issues associated with its protection and management.

Priorities

Increase where possible buffer zones of indigenous vegetation between private property and the Reserve.

Address any encroachment issues promptly and within best practice management principles.

Assessment of Performance

The attitude of neighbours and the public will be monitored through systematic recordings of responses to information days, complaints and compliments. More detailed assessment by formal survey techniques could be considered as part of a Council-wide survey of residents' attitudes.

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APPENDIX A Mammals, Reptiles and Frogs Irrawong Reserve

Mammals

Antechinus flavipes

Yellow-footed Antechinus

Antechinus stuartii

Brown Antechinus

**Canis familiaris*

Dog

**Felis catus*

Cat

**Mus domesticus*

Common house mouse

Perameles nasuta

Long Nosed Bandicoots

Petaurus breviceps

Sugar Glider

Phascolarctos cinereus

Koala

Pseudocheirus peregrinus

Common Ringtail Possum

Pteropus poliocephalus

Grey headed Flying Fox

Rattus lutreolus

Swamp Rat

**Rattus rattus*

Black Rat

Trichosurus vulpecula

Common Brushtail Possum

**Vulpes vulpes*

Red Fox

Wallabia bicolor

Swamp Wallaby

Reptiles and Frogs

Cacophis squamulosus
Golden Crown Snake

Cryptoblepharus virgatus
Eastern Snake-eyed Skinks

Hemiaspis signata
Swamp Snake

Morelia spilota
Carpet Python

Phyllurus platurus
Southern Leaf Tailed Gecko

Physignathus lesueurii
Eastern Water Dragon

Pseudechis porphyriacus
Red-bellied Black-snake

Limnodynastes peroni
Brown-striped Frog

Litoria peroni
Peron's Tree Frog

Crinia signifera
Common Eastern Froglet

APPENDIX B

BIRDS RECORDED IN IRRAWONG RESERVE AND WARRIEWOOD WETLANDS

Key:

HWS33 - Birds observed in Warriewood Swamp spring 1933 ES Hoskin
HWS52 - Birds observed in Warriewood Swamp autumn 1952 ES Hoskin
BBWW72-83 - Birds banded in Warriewood Wetlands between 1972 - 1983
M78 - Birds observed at the junction of Mullet Creek and Narrabeen Creek 1978 A.R. McGill
SWS87 - Birds observed in Warriewood Wetlands summer 1987 Shortlands Wetlands Centre
ACSP93 - Birds observed in Casuarina Woodland spring 1993 Australian Museum
ACS93 - Birds observed in Casuarina Woodland summer 1993 Australian Museum
ASSP93 - Birds observed in Swamp Mahogany Forest spring 1993 Australian Museum
ASS93 - Birds observed in Swamp Mahogany Forest summer 1993 Australian Museum
FIS94 - Birds observed in Irrawong Reserve during summer 1994 LW Filewood
FIS95 - Birds observed in Irrawong Reserve during summer 1995 LW Filewood
FIW95 - Birds observed in Irrawong Reserve during winter 1995 LW Filewood
FWS94 - Birds observed in Warriewood Wetlands during summer, 1994 LW Filewood
FWS95 - Birds observed in Warriewood Wetlands during summer 1995 LW Filewood
FWW95 - Birds observed in Warriewood Wetlands during winter 1995 LW Filewood
FOS94 - Birds observed near Irrawong Reserve in summer 1994 LW Filewood
FOS95 - Birds observed near Irrawong Reserve in summer 1995 LW Filewood
FOW95- Birds observed near Irrawong Reserve in winter 1995 LW Filewood
* - Introduced Species

Scientific Name

Common Name
Code

Phalacrocorax varius
Pied Cormorant
FOS94;

Phalacrocorax sulcirostris
Little Black Cormorant
FIS95;

Phalacrocorax melanoleucos
Little Pied Cormorant

FOW95

Pelecanus conspicillatus
Australian Pelican
FWS94; FOS94;

Ardeola alba
White Egret
FOS94; M78

Ardea novaehollandiae
White-faced Heron
SWS87; M78

Dupetor flavicollis
Black Bittern
HWS33; SWS87

Threskiornis aethiopicus
Sacred Ibis
FOS94

Anas superciliosa
Pacific Black Duck
SWS87; FWS94; FIS95; ASSP93; M78

Anas platyrhynchos
Mallard Duck
FOS94

Chenonetta jubata
Maned Wood Duck
FIW95; ASSP93

Vanellus miles
Masked Lapwing
FOS94; FOS95; FOW95

Accipiter fasciatus
Brown Goshawk
FWS94

Circus approximans
Swamp Harrier
HWS52

Elanus notatus
Black-shouldered Kite
M78

Coturnix chinensis
King Quail
BBWW72-83

Porphyrio porphyrio
Purple Swamphen
SWS87; ACS93; FWS94?; M78

Gallinula tenebrosa
Dusky Moorhen
ACSP93; ASSP93; ASS93; FWS94?; FIS95; FIW95; M78

Larus pacificus
Silver Gull
FIS94; FOS94;

Gallinago hardwickii
Japanese Snipe
HWS33; BBWW72-83

Streptopelia chinensis
Spotted Turtle dove*
BBWW72-83;
ACSP93; ASSP93; FIS94; FIS95; FWS94; FWS95; FIW95; M78

Columba livia
Feral Pigeon*
FOS95; FIS95?; FIW95

Ocyphaps lophotes
Crested Pigeon
FOS94; FOS95; FIW95

Geopelia striata
Peaceful Dove
SWS87

Lopholaimus antarcticus
Topknot Pigeon
FOS94

Cacatua roseicapilla
Rose Breasted Galah
ASSP93; FOS94; FOS95; FIW95

Cacatua galerita
Sulphur Crested Cockatoo
ASSP93; FOS94; FIS94; FIS95; FOW95

Trichoglossus haematodus

Rainbow Lorikeet

ACSP93; ACS93; ASSP93; ASS93; FIS94; FIS95; FOS94; FOS95; FIW95; M78

Trichoglossus chlorolepidotus

Scaly Breasted Lorikeet

FOW95

Glossopsitta pusilla

Little Lorikeet

FIW95

Platycercus eximius

Eastern Rosella

SWS87; ASSP93; FIS94; FOS94

Cuculus pyrrhophanus

Fan-tailed Cuckoo

ACSP93; ASSP93; ASS93; FIS94; FIS95; M78

Chrysococcyx lucidus

Shining Bronze Cuckoo

FIS94; FOW95?

Cacomantis variolosus

Brush Cuckoo

FIS94

Centropus phasianinus

Pheasant Coucal

HWS33

Scythrops novaehollandiae

Channel-billed Cuckoo

FOS94

Eudynamis scolopacea

Common Koel

FOS94; FOS95

Dacelo novaeguineae

Laughing Kookaburra

BBWW72-83: ACSP93; ASSP93; SWS87; FIS94; FIS95; FIW95; FOS94; FOS95; FOW95; M78

Ninox novaeseelandiae

Southern Boobook

SWS87

Podogargus strigoides
Tawny Frogmouth
FOS94;

Halcyon chloris
Sacred Kingfisher
FIS94; FOS94

Eurystomus orientalis
Dollarbird
FIS94; FWS94; FOS95

Hirundo neoxena
Welcome Swallow
ACS93; SWS87; FIS94; FIS95; FWS94; FOS94; FOS95; M78

Cecropis ariel
Fairy Martin
SWS87

Cinclorhamphus cruralis
Brown Songlark
BBWW72-83

Coracina novaehollandiae
Black-faced Cuckoo-shrike
ASS93; FIS94; FIS95; FOS94; FOS95; M78

Coracina tenuirostris
Cicadabird
FIS94; FOS95

Pycnonotus jocosus
Red-whiskered Bulbul*
BBWW72-83; ACSP93; ACS93; ASSP93; ASS93; SWS87; FIS94; FIS95; FWS94;
FOS94; FOS95; FIW95; M78

Psophodes olivaceus
Eastern Whipbird
FIS94; FIS95; FOS94; FOS95; FIW95; M78

Eopsaltria australis
Eastern Yellow Robin
BBWW72-83; FWS94; FIS94; FIS95; FOS95; FIW95

Pachycephala pectoralis
Golden Whistler
BBWW72-83; ASSP93; ASS93; FIW95; M78

Rhipidura fuliginosa

Grey Fantail

BBWW72-83; ACSP93; ACS93; ASS93; SWS87; FWS94; FIS94; FIS95; FIW95;
M78

Rhipidura rufifrons

Rufous Fantail

BBWW72-83; FIS95

Rhipidura leucophrys

Willy Wagtail

SWS87; FOS94; FIS95; FIW95; M78

Psophodes olivaceus

Eastern Whipbird

BBWW72-83; ACSP93; ACS93; ASSP93; ASS93; SWS87

Sericornis frontalis

White-browed Scrubwren

BBWW72-83; SWS87; ACSP93; ACS93; ASS93; FWS94; FIS94; FIS95; FIW95;
M78

Sericornis magnirostris

Largebilled Scrubwren

FIS95; FOW95

Arcrocephalus australis

Australian Reed Warbler

BBWW72-83

Megalurus timoriensis

Tawny Grassbird

BBWW72-83; SWS87

Megalurus gramineus

Little Grassbird

BBWW72-83; FWS94?; M78

Cisticola exilis

Golden-headed Cisticola

BBWW72-83; SWS87

Malurus cyaneus

Superb Blue Wren

BBWW72-83; M78; SWS87; ACSP93; ACS93; FIS94; FIS95; FOS94; FIW95.

Malurus assimilis

Variegated Wren

BBWW72-83; ASSP93; M78

Acanthiza nana
Yellow Thornbill
BBWW72-83; FWS94?; M78

Acanthiza pusilla
Brown Thornbill
BBWW72-83

Acanthiza lineata
Striated Thornbill
FIS94; FOS94;

Anthochaera carunculata
Little Wattlebird
BBWW72-83; SWS87; ACSP93; ACS93; ASSP93; FIS94; FOS94; FIS95; FIW95;
M78

Anthochaera paradoxa
Red Wattlebird
FIS94; FOS94; FWS94; FIS95; FIW95; FOW95

Philemon corniculatus
Noisy Friarbird
ASSP93; FOS94; FIS94; FWS94; FIW95; FOW95

Monarcha melanops
Black-faced Monarch
FIS94; FIS95; FWS94

Myiagra ruficollis
Leaden Flycatcher
FIS94; FIS95; FOS95; FWS94

Climacteris leucophaea
White-throated Treecreeper
FIS94; FIS95; FOS95; FIW95

Melithreptus gularis
Black-chinned Honeyeater
ACSP93 (vagrant)
Suspect record - possibly White - naped Honeyeater)

Meliphaga lewinii
Lewin's Honeyeater
BBWW72-83; FIS94; FIS95; FIW95

?*Lichenostomus melanops*

Yellow-eared Honeyeater
BBWW72-83

Lichenostomus chrysops
Yellow-faced Honeyeater
ASSP93; FIW95; FOW95; M78

Lichenostomus ornatus
Fuscous Honeyeater
BBWW72-83

Phylidonyris novaehollandiae
New Holland Honeyeater
BBWW72-83; FWS94; FIS95

Phylidonyris nigra
White-cheeked Honeyeater
ACSP93; ASSP93; ASS93; FIS94; FOS94; FIS95; FIW95; FOW95; M78

Myzomela sanguinolenta
Scarlet Honeyeater
ASSP93; FIW95; FOW95

M. elithreptus lunatus
White-naped Honeyeater
FIW95

Manorina melanocephala
Noisy Miner
FOS94; FIS95; FOS95; FIW95; FOW95

Acanthorhynchus tenuirostris
Eastern Spinebill
SWS87; ASSP93; FIS94; FOS94; FIS95; FOW95

Pardalotus punctatus
Spotted Pardalote
BBWW72-83; FIS94; FWS94; FOS94; FIS95; FIW95; FOW95

Zosterops lateralis
Silvereye
BBWW72-83; SWS87; ACSP93; ASS93; FWS94; FIS94; FIS95; FOS95; FIW95;
M78

Emblema temporalis
Red-browed Firetail
BBWW72-83; SWS87; ACS93; fis94; fws94; fis95; fiw95; M78

Lonchura castaneothorax

Chestnut-breasted Mannikin*
BBWW72-83

Carduelis carduelis
European Goldfinch*
BBWW72-83

Passer domesticus
House Sparrow*
BBWW72-83; ACS93; ASS93; FWS94; FIS94; FOS94; M78

Acridotheres tristis
Common Myna*
SWS87; ACSP93; ACS93; ASSP93 FWS94; FOS94; FIS95; FIW95; FOW95; M78

Dicrurus hottentotus
Spangled Drongo
BBWW72-83;

Strepera graculina
Pied Currawong
BBWW72-83; ACSP93; ACS93; FWS94; FOS94; FOS95; FIW95; FOW95; M78

Gymnorhina tibicen
Australian Magpie
SWS87; FOS94; FOS95; FIS95; FIW95; FOW95; M78

Corvus coronoides
Australian Raven
SWS87; ACSP93; ACS93; FWS94; FIS94; FOS94; FOS95; FIW95; FOW95; M78

Oriolus sagittatus
Olive-backed Oriole
FIS94; FOS94; FIS95?; FIW95; FOW95

Sternus vulgaris
Common Starling*
FWS94; FOS94; FIS95; FOS95; FIW95; FOW95; M78

Grallina cyanoleuca
Australian Magpie Lark
FOS94; FIS95; FOS95; FIW95; FOW95; M78

Cracticus torquatus
Grey Butcherbird
FOS94; FOS95; FOW95; FIW95

APPENDIX C NATIVE PLANT SPECIES - IRRAWONG RESERVE

KEY

LM - Species recorded by Lynn McDougall for this Plan of Management 1996.

RL - Species recorded by Roger Lembit 1996 including lists compiled by the Total Earth Care Company 1991.

SPECIES

COMMON NAME

RECORDED BY

FERNS

ADIANTACEAE

Adiantum aethiopicum

Common Maidenhair

RL LM

Adiantum hispidulum

Rough Maidenhair

LM

BLECHNACEAE

Blechnum cartilagineum

Gristle Fern

RL LM

Blechnum indicum

Bungwahl

RL

CYATHEACEAE

Cyathea australis

Rough Tree Fern

RL

Calochlaena dubia

Common Ground Fern

LM

DENNSTAEDTIACEAE

Pteridium esculentum

Bracken Fern

RL LM

Hypolepis muelleri

Harsh Ground Fern
LM

Histiopteris incisa

LM

GLEICHENIACEAE
Gleichenia microphylla
LM

OSMUNDACEAE
Todea barbara

LM

PSILOTACEAE
Psilotum nudum

LM

ANGIOSPERMS
MONOCOTYLEDONS

SPECIES
COMMON NAME
RECORDED BY

ARACEAE
Alocasia macrorrhizos
RL

ARECAEAE
Livistona australis
Cabbage Tree Palm
RL LM

COMMELINACEAE
Commelina cyanea
Native wandering jew
RL LM

CYPERACEAE
Carex appressa
RL LM

Gahnia clarkei
Cutting grass

RL LM

Gahnia melanocarpa
LM

Gahnia sieberiana

RL

Isolepis nodosus
RL

JUNCACEAE
Juncus usitatus
Common Rush
RL LM

LILIACEAE
Dianella caerulea
Dianella
RL LM

LOMANDRACEAE
Lomandra longifolia
Spiny Mat-rush
RL LM

LUZURIAGACEAE (PHILESIACEAE)
Eustrephus latifolius
Wombat Berry
LM RL

Geitonoplesium cymosum
Scrambling Lily
LM RL

POACEAE
Echinopogon caespitosus var. caespitosus
Tufted Hedgehog Grass
LM

Entolasia marginata
Bordered Panic
RL LM

Entolasia stricta
Wiry Panic
LM

Imperata cylindrica var. *major*
Blady Grass
RL LM

Oplismenus aemulus

RL

Oplismenus imbecillis

RL LM

Phragmites australis
Common Reed
RL LM

Themeda australis
Kangaroo grass
LM

SMILACACEA
Smilax australis
Lawyer vine
RL LM

Smilax glyciphylla
Sweet Sasparilla
RL LM

TYPHACEAE
Typha orientalis
Cumbungi
RL LM

DICOTYLEDONS
ARACEAE
Gymnostachys anceps
Settlers Flax
LM

AMARANTHACEAE
Alternanthera denticulata
Lesser Joyweed
RL LM

APIACEAE
Centella asiatica
Swamp pennywort

RL LM

Hydrocotyle laxiflora

Pennywort

RL

Hydrocotyle peduncularis

LM

Platysace lanceolata

LM

Xanthosia pilosa

LM

APOCYNACEAE

Parsonsia straminea var. *straminea*

Common silkpod

LM RL

ARALIACEAE

Astrotricha floccosa

LM

Astrotricha latifolia

LM

Polyscias sambucifolia

Elderberry Panax

LM RL

ASCLEPIADACEAE

Tylophora barbarta

Bearded Tylophora

LM

ASTERACEAE

Ozothamnus diosmifolius

Sago, White Dogwood

LM

Pseudognaphalium luteoalbum

Jersey Cudweed

RL

Sigesbeckia orientalis

Indian Weed

LM

BIGNOIACEAE

Pandorea pandorana
Wonga Vine
LM RL

CASUARINACEAE
Allocasuarina littoralis
Black Sheoak
RL LM

Allocasuarina torulosa
Forest Oak
RL LM

CELASTRACEAE
Maytenus silvestris
Narrow-leaved Orangebark
LM

CUNONIACEAE
Callicoma serratifolia
Black Wattle
RL LM

Ceratopetalum apetalum
Coachwood
RL LM

Ceratopetalum gummiferum
NSW Christmas Bush
RL

DILLENiaceae
Hibbertia dentata
Twining Guinea Flower

ELEOCARPACEAE
Elaeocarpus reticulatus
Blueberry Ash
LM

EPACRIACEAE
Epacris longifolia
Fuchsia Heath
LM

EUPHORBIACEAE
Breynia oblongifolia
Coffee Bush
LM

Glochidion ferdinandii
Cheese Tree
RL LM

Omalanthus populifolius
Bleeding Heart
RL LM

Phyllanthus gasstroemii
RL LM

EUPOMATIACEAE
Eupomatia laurina
Bolwarra
RL LM

FABACEAE
Acacia elata
Cedar Wattle
RL

Acacia floribunda
White Sally
LM

Acacia longifolia
Sydney Golden Wattle
RL LM

Acacia myrtifolia
RL

Acacia paramattensis
Parramatta Wattle
RL

Acacia terminalis
Sunshine Wattle
RL

Acacia ulicifolia
Prickly Moses
RL

Hardenbergia violacea
False sasparilla
LM

Glycine clandestina
Twining Glycine
RL LM

Kennedia rubicunda
Dusky Coral Pea
LM

Platylobium formosum
LM

Pultenaea flexilis
LM

LAURACEAE
Cassytha paniculata
RL

Endiandra sieberi
Corkwood
RL

LOBELIACEAE
Lobelia elata
Angled lobelia
LM

Pratia purpurascens
Whiteroot
LM

MELIACEAE
Synoum glandulosum
Bastard Rosewood
LM RL

MENISPERMACEAE
Sarcopetalum harveyanum
Pearl Vine
LM

Stephania japonica var. discolor
Snake Vine
LM RL

MORACEAE
Ficus rubiginosa
Port Jackson Fig
LM RL

MYRTACEAE

Acmena smithii

Lilly Pilly

LM RL

Angophora costata

Smooth-barked Angophora

LM RL

Angophora floribunda

Rough-barked Angophora

LM RL

Corymbia gummifera

Red Bloodwood

RL

Eucalyptus botryoides

Bangalay

LM

Eucalyptus piperita

Sydney Peppermint Gum

LM RL

Eucalyptus robusta

Swamp Mahogany

LM RL

Leptospermum trinervium

RL

Melaleuca ericifolia

Swamp Melaleuca

RL

Melaleuca lineariifolia

Snow in Summer

RL LM

Syncarpia glomulifera

Turpentine

LM RL

Syzygium paniculatum

Brush Cherry

RL

Syzygium sp.
LM

Tristania neriifolia
Water Gum
LM

Tristaniopsis laurina
Water Gum, Kanuka
LM

OLEACEAE
Notelaea longifolia
Mock Olive
RL LM

Notelaea venosa
RL

ONAGRACEAE
Epilobium billardierianum
LM

Ludwigia peploides subsp. montevidensis
Native water primrose
LM

PITTOSPORACEAE
Billardiera scandens var. scandens
Appleberry
LM

Pittosporum revolutum
Yellow Pittosporum
RL LM

Pittosporum undulatum
Sweet Pittosporum
RL LM

PLANTAGINACEAE
Plantago debilis
RL

POLYGONACEAE
Persicaria decipiens
Slender Knotwood

RL LM

Persicaria lapathifolia

Pale Knotweed

RL LM

Persicaria strigosa

Spotted Knotweed

RL LM

PROTACEAE

Persoonia linearis

Narrow-leaved Geebung

LM

Lomatia myricoides

River Lomatia

RL LM

RANUNCULACEAE

Ranunculus lappaceus

RL

RAMNACEAE

Pomaderris discolor

RL

RUBIACEAE

Morinda jasminoides

RL

Pomax umbellata

LM

RUTACEAE

Zieria smithii

LM

SAPINDACEAE

Dodonaea triquetra

Hopbush

RL LM

ULMACEAE

Trema aspera

Native Peach

LM RL

VIOLACEAE

Viola hederacea
Native violet
RL

VITACEAE
Cissus antarctica
Native Grape
RL LM

Cissus hypoglauca
Giant Water Vine
RL LM

WEED SPECIES - IRRAWONG RESERVE

KEY

LM - Species recorded by Lynn McDougall for this Plan of Management 1996.
RL - Species recorded by Roger Lembit 1996 including lists compiled by the Total Earth Care Company 1991.

SPECIES
COMMON NAME
RECORDED BY

FERNS
CYATHEACEAE
Cyathea cooperi
Straw Tree Fern
RL LM

DAVALLIACEAE
Nephrolepis cordifolia
Fishbone Fern
LM

ANGIOSPERMS
MONOCOTYLEDONS
ARACEAE
Arum italicum
Elephant's ear
RL

Colocasia esculenta
Taro

LM

Zantedeschia aethiopica

Calla Lily

RL LM

CANNACEAE

Canna indica

Canna Lily

RL

COMMELINACEAE

Tradescantia albiflora

Wandering Jew

RL LM

CYPERACEAE

Cyperus eragrostis

Umbrella sedge

LM

POACEAE

Bromus cartharticus

Prairie Grass

RL

Cortaderia selloana

Pampas Grass

RL LM

Cynodon dactylon

Bermuda Grass

RL LM

Echinochloa crus-galli

Barnyard Grass

RL LM

Elusine indica

Crowsfoot Grass

LM

Erharta erecta

Panic Veldtgrass

RL LM

Paspalum dilatatum

Paspalum

RL LM

Setaria geniculata
Slender Pidgeon Grass
RL

Sporobolus africanus
Parramatta Grass
RL

ZINGIBERACEAE
Hedychium garnerianum
Ginger Lily
RL LM

DICOTYLEDONS
ACANTHACEAE
Thunbergia alata
Black-eyed Susan
RL LM

ACERACEAE
Acer negundo
Box Elder
LM

AMARANTHACEAE
Amaranthus viridis
Green Amaranth
RL

APIACEAE
Ciclospermum leptophyllum (*Apium leptophyllum*)
Slender Celery
RL LM

Foeniculum vulgare
Fennel
LM

Hydrocotyle bonariensis
Kurnell Curse
RL LM

ASCLEPIADACEAE
Araujia hortorum
Moth Vine
RL LM

ASTERACEAE

Ageratina adenophora
Crofton Weed
RL LM

Ageratina houstonium
LM

Aster subulatus
Bushy Starwort
RL

Bidens pilosa
Cobbler's Peg
LM RL

Conyza albida
Tall Fleabane
LM

Conyza bonariensis
Flax-leaved Fleabane
RL

Conyza sp.
Fleabane
LM

Crassocephalum crepidioides
Thickhead
LM

Galinsoga parviflora
Potato Weed
RL LM

Hypochaeris radicata
Catsear
RL LM

Senecio mikanioides
Cape Ivy
RL

Sonchus oleraceus
Common Sow Thistle
RL LM

Tagetes minuta
Stinking Roger

LM

Taraxacum officinale

Dandelion

LM RL

BALSAMINACEAE

Impatiens walleriana

Dizzie Lizzie

LM

BASELLACEAE

Aneredera cordifolia

Madeira Vine

RL LM

BRASSICACEAE

Lepidium africanum

Peppercress

RL

Rorippa nastutium-aquaticum

Watercress

RL LM

CAPRIFOLIACEAE

Lonicera japonica

Japanese Honeysuckle

RL

CARYOPHYLLACEAE

Cerastium glomeratum

Mouse-eared Chickweed

RL LM

Stellaria media

Chickweed

RL

CHENOPODIACEAE

Chenopodium album

Fat Hen

LM

CONVOLVULACEAE

Ipomoea indica

Morning Glory

RL LM

EUPHORBIACEAE

Euphorbia peplus

Petty Spurge

RL LM

Ricinus communis

Castor Oil Plant

RL LM

FABACEAE

Caesalpinia sp.

RL

Erythrina Xsykesii

Coral Tree

RL

Erythrina crista-galli

Cockspur (Indian) Coral Tree

LM

Leucaena leucocephala

LM

Melilotus indica

Hexham Scent

RL LM

Senna X floribunda

Cassia

RL LM

Trifolium repens

White Clover

RL LM

Trifolium pratense

Red Clover

RL

Vicia tetrasperma

Vetch

RL

FUMARIACEAE

Fumaria sp.

Fumatory

RL

JUNCACEAE

Juncus articulatus

LM

LAURACEAE

Cinnamomum camphora

Camphor Laurel

LM

MALVACEAE

Modiola caroliniana

Red-flowered Mallow

RL

Sida rhombifolia

Paddy's Lucerne

RL LM

MORACEAE

Ficus elastica

Rubber Tree

RL LM

Morus alba

Mulberry

RL LM

OCHNACEAE

Ochna serrulata

LM

OLEACEAE

Ligustrum lucidum

Large-leaved Privet

RL LM

Ligustrum sinense

Small-leaved Privet

RL LM

ONAGRACEAE

Ludwigia peruviana

Water Primrose

RL LM

OXALIDACEAE

Oxalis purpurea

Large Flower Wood Sorrel

RL

PASSIFLORACEAE

Passiflora edulis

Passionfruit

RL LM

PHYTOLACCACEAE

Phytolacca octandra

Inkweed

RL LM

PLANTAGINACEAE

Plantago lanceolata

Lamb's Tongue

RL

Plantago major

Large Plantain

RL LM

POLYGONACEAE

Acetosa sagittata

Turkey Rhubarb

RL LM

PORTULACACEAE

Portulaca oleracea

Portulaca

RL LM

PRIMULACEAE

Angalis arvensis

Pimpernel

RL LM

RANUNCULACEAE

Ranunculus repens

Creeping buttercup

LM

ROSACEAE

Duchesnea indica

Wild Strawberry

RL

Rubus fruticosus

Blackberry

LM

SALICACEAE

Salix babylonica

Willow

RL LM

SOLANACEAE

Cestrum parqui

Green Cestrum

RL LM

Solanum mauritianum

Wild Tobacco

RL LM

Solanum nigrum

Black-berried nightshade

RL LM

TROPAEOLACEAE

Tropaeolum majus

Nasturtium

LM

VERBENACEAE

Lantana camara

Lantana

RL LM

Verbena bonariensis

Purpletop

RL LM

