DEPARTMENT OF
PRIMARY INDUSTRIES

Reedy Swamp
Environmental Management Plan

Final
2003

State Government Victoria
Departments of
Sustainability and Environment
Primary Industries

GOULBURN BROKEN
CATCHMENT MANAGEMENT AUTHORITY

Parks VICTORIA

Funded by the Department of Primary Industries, and the Shepparton Irrigation Region Implementation Committee of the Goulburn Broken Catchment Management Authority through the Shepparton Irrigation Region Catchment Strategy.

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Cover: Scenic aspect of Reedy Swamp (Photo: DPI).

Management Agreement

We the undersigned stakeholder representatives acknowledge this document as being the operative management plan for the wetland and accept our responsibilities in partnership as recommended for its ecological sustainability.

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- Constructive reviews of earlier drafts of this manuscript were received from members of Goulburn-Murray Water and from Bruce Wehner of Parks Victoria.

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Abbreviations

CA	Crown Allotment
CAMBA	Chinese and Australian Migratory Bird Agreement
COGS	Councils of Greater Shepparton
DPI	Department of Primary Industries
EC	Electrical Conductivity (unit measure of salinity)
EVC	Ecological Vegetation Class
EG 19/12	East Goulburn 19/12 Channel
EMP	Environmental Management Program (a unit within DPI)
EWA	Environmental Water Allocation
FGA	Field & Game Australia
FF	Flora and Fauna Division of DSE
FFG	Flora and Fauna Guarantee Act, 1988
GBCMA	Goulburn-Broken Catchment Management Authority
GMW	Goulburn-Murray Water
ha	Hectare
hr	Hour
JAMBA	Japanese and Australia Migratory Bird Agreement
km	Kilometre
MDBC	Murray-Darling Basin Commission
ML	Megalitre (one million litres)
ML/d	Megalitre per day (measure of flow)
NRE	Department of Natural Resources & Environment
PISC	Plan Implementation Support Committee
PV	Parks Victoria
SIR	Shepparton Irrigation Region
SKM	Sinclair Knight Mertz (consulting firm responsible for the arterial drain design)
SIR – PISC	Shepparton Irrigation Region – Plan Implementation Strategic Committee
SIRIC	Shepparton Irrigation Region Implementation Committee
SWMS	Surface Water Management Scheme
VROT	Victorian Rare of Threatened Species

Foreword

This Wetland Management Plan is the culmination of the effort of a number of dedicated people who share the vision of seeing Reedy Swamp remain as a viable and productive wetland ecosystem. It is intended that the plan will further foster the partnerships between the relevant stakeholders.

The Management Plan identifies the Key Stakeholders, including Government and non-government organisations who accept the management responsibilities assigned to them through the Actions defined in the Management Plan.

The Plan has been developed as an Adaptive Management Plan to enable management actions to be modified in response to the monitoring of the Key Ecological Indicator Species. The document should be updated as necessary with the implementation and/or amendments of Actions.

Therefore all works and actions which may impact on the implementation of the Plan will only be carried out after consultation/approval from the identified Key Stakeholders and signatories to the Plan.

The Plan has been developed in conjunction with existing infrastructure to provide for the flexibility required to manage this significant environmental feature in a regulated river environment subject to the vagaries of man and nature.

While implementation of the Plan is an adaptive process the Plan will be formally reviewed at five yearly intervals to ensure that it remains a living document. The review process will also be subject to consultation with, and sign off by, the identified Key Stakeholders.

I look forward to seeing the implementation of this Wetland Management Plan, which will be a prime model for partnerships in sustainable ecological management in the Goulburn-Broken Catchment.

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Kim Dyson
Management Plan Coordinator (Wetland Planner)
DPI Catchment and Agricultural Services

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Plate 1: Reedy Swamp after reinstatement of a dry cycle January 2002 (Photo: NRE).

Plate 2: Reedy Swamp after delivery of EWA September 2002 (Photo: NRE).

1. Summary

Reedy Swamp is a 130 ha marginal basin wetland located on the immediate outskirts of Shepparton's north-west urban area. Reedy Swamp is considered a high value wetland and an important component of the Goulburn River Floodplain.

Reedy Swamp provides valuable habitat and breeding sites for a large number of waterbirds including regionally, nationally and internationally significant species.

The wetland is utilised by the local duck hunting fraternity during declared seasons. Otherwise the wetland is highly regarded by local field naturalists for bird watching, local schools for science studies and by adjoining landholders for some minor stock and domestic water extraction.

The wetland has had a history of management actions that have altered its natural flooding regime. Over the last 70 to 80 years the site has experienced protracted flood regimes causing substantial tree loss, Water couch encroachment and a general decline in floristic diversity, and is considered to be under threat from eutrophication and prolonged inundation. However, recent structural works on an influencing drainage line now provides, for the first time, opportunities to impart a more natural flood regime on this valuable wetland.

This Management Plan presents the necessary biological, utilisation history, management history, and current landholder and stakeholder requirements to support the management recommendations as detailed. The reinstatement of a wetting and drying regime more representative of natural conditions is the key recommendation of this plan. Maintenance of wetland values, especially as a wetland bird breeding site, and the continued lawful utilisation activities associated with the wetland and surrounding reserve, form the basis of this plan.

Plate 3: Landscape view of Reedy Swamp, July 1997 (Photo: NRE)

2. Introduction

Reedy Swamp Wildlife Reserve supports 130 ha of deep freshwater marsh (Corrick and Norman 1980) and 94 ha of River Red Gum (*Eucalyptus camaldulensis*) grassy woodland and a small area of sandy rise box woodland. Both this wetland and vegetation type are considered depleted and endangered respectively in the Victoria Riverina Bioregion.

Reedy Swamp is an important wetland for colonial nesting waterbirds and threatened species such as; Great Egret (*Ardea alba*) and Royal Spoonbill (*Platalea regia*) which are classified as endangered and vulnerable respectively and listed under the Flora and Fauna Guarantee Act (1988); Latham's Snipe (*Gallinago hardwickii*), a migratory species protected under international agreements and, White-bellied Sea-eagles (*Haliaeetus leucogaster*), listed as endangered FFG (1998) and under international treaties, regularly nest at the wetland (NRE 1997). The site is host to a number of bird species listed under JAMB and CAMBA and State legislation.

Under pre-regulated river flow conditions, the wetland could have been annually inundated for up to 6 months of the year by floodwaters from the Goulburn River. In recent years (pre 1970) however, the wetland has been more akin to a permanent water body. The wetland is now primarily fed by irrigation runoff and inputs from outfall water from the East Goulburn 19/12 Channel (EG 19/12) and Drain No. 3 which discharges into the eastern side. The wetland now has a permanent average depth of approximately 0.4 to 0.5 m and is essentially a shallow body of open water (40-50%) (DNRE 2000) dotted with dead and fallen trees and tree stumps, beds and islands of tall reeds (55-60%) (DNRE 2000) and prolific growth of Water couch (*Paspalum distichum*) around its edges. Management of appropriate water regimes provides the greatest challenge for Reedy Swamp.

2.1 Purpose/Management Objectives

Parks Victoria (Nathalia) are the responsible management authority. The purpose of this plan is to provide direction for the future environmental management of Reedy Swamp Wildlife Reserve. The key objective of this plan being the protection, restoration and enhancement of the conservation value of this important wetland. The recommendations of the Reedy Swamp Environmental Management Plan specify management of the wetland and reserve for the following objectives:

- To maintain and enhance the diversity of indigenous flora and fauna species.
- To provide breeding habitat for a diversity of waterbird species, and particularly colonial nesting species such as ibis, spoonbills and egrets etc, where possible.
- To maintain a rushland area, with extensive fringing River Red Gum that is seasonally flooded.
- To provide for public recreation where consistent with the above objectives.
- To provide opportunities for duck shooting during open seasons where consistent with the above objectives.
- To provide for salinity and drainage protection:
  - protect Reedy Swamp from the adverse impacts of catchment drainage and run-off.

Objectives of this management plan have been developed in parallel with recommendations of the Land Conservation Council (1985).

2.2 Community Consultation

Stakeholders in the wetland have been identified from previous and existing forums, with broader public consultation involved where required. Two levels of interest have been generalised for main comment and input into this plan; those of Stakeholders such as the wider community and related interest groups, and Key Stakeholders that have a more direct management responsibility or interest in the site. A list of Stakeholders is provided in Table 1:

Table 1: Stakeholders for Reedy Swamp management consultation:

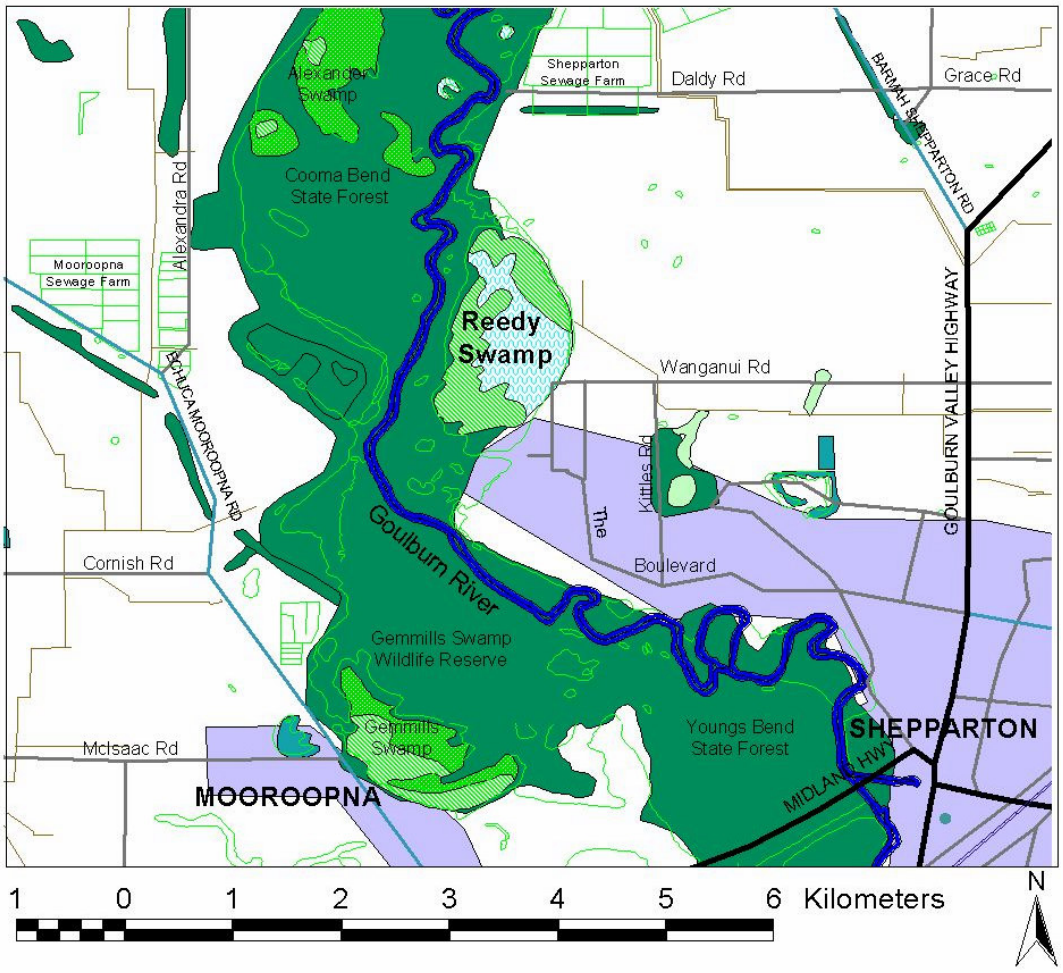
Name	Affiliation
Chris Norman (Manager)	Department of Primary Industries (Catchment and Agricultural Services)
Tony Long (Chief Ranger)	Parks Victoria
Merv McAliece (Manager)	Flora and Fauna (North East Region)
Justin Sheed (Waterways Manager)	Goulburn Broken Catchment Management Authority
Monica Morgan (Manager)	Yorta Yorta
Greg McKenzie (Mgr.Dev.Approvals)	City Of Greater Shepparton
Ross Plunkett (Assets Engineer)	Gouburn–Murray Water
Darren Nabbs (Shepp. Area Manager)	Goulburn–Murray Water
Russel Pell (Chair)	SIR–Implementation Committee
Dennis Patterson (Project Officer)	Field & Game Australia–Shepparton
Erin Reid (President)	Goulburn Valley Environment Group
Neil Webster	William Orr Campus–Shepparton TAFE; Landholder
Carmel Maguire (Team Leader)	Berry Street Victoria (Alternative Education Programs)
Pat Almond	Adjoining Landholder
Ken & Melva Threlfall	Adjoining Landholder
Chris Falla	Adjoining Landholder
Eric Kluge	Adjoining Landholder

2.3 Location and Access

Reedy Swamp Wildlife Reserve is located approximately 6 km north west of Shepparton on the urban fringe at the western end of Wanganui Road (Figure 1). Access to the Reserve is via Wanganui Road, Daldy Road and Golf Drive.

AMG Coordinates Zone 55, Easting 353 139, Northing 5 976 944, Crown Allotment Number 84C (No Section) and Crown Land Parcel Number P364187.

Figure 1: Location of Reedy Swamp



Waterways
Natural drainage line
Irrigation channel

Wetland Type
Open water
Herb
Reed
Red gum
Impoundment

Remnant vegetation
Urban

This map is based on publicly available data. The creator does not warrant that this map is definitive nor free of error and does not accept liability for loss arising from use of this product beyond its original purpose.

Produced by Keith Ward 20/10/99 Ph 03 5833 5947

2.4 Reservation Status and Management Authority

Reedy Swamp Wildlife Reserve (C18), previously reserved forest, was declared a temporary reservation for the management of wildlife by order in council of 26th April 1989 under the *Crown Lands (Reserves) Act* 1978. The Reserve is to be managed by the (now) Director of Parks, Flora and Fauna in accordance with the provisions of the Wildlife Act 1975 and Wildlife Reserve Regulations 1984. The site is managed by Parks Victoria, Nathalia.

A 30m section of land between the Reserve and the Goulburn River is a Permanent Public Purpose Reserve (Government Gazette 1881) and 2.343 ha of the Reserve area was proclaimed as a road on the 26th January 1993 (Government Gazette 1993).

2.5 Management History

Reedy Swamp Wildlife Reserve was part of an investigation by the Land Conservation Council in 1982/83 to make recommendations to the Minister for Planning and Environment with respect to the use of public land, in order to provide for the balanced use of land in the Murray Valley area. Recommendations for the use of Reedy Swamp Wildlife Reserve were published in 1985. The Land Conservation Council Recommendations (1985) for Reedy Swamp Wildlife Reserve (MV-C18) specify that it be used:

- Primarily to conserve the habitat of native animals, particularly water birds,
- For public recreation and education where this does not conflict with the primary aim, and
- That it be permanently reserved under section 4 of the *Crown Land (Reserves) Act* 1978 and be managed by the Department of Conservation, Forests and Lands.

Before European settlement, Reedy Swamp was dominated by River Red Gum and would have dried out most years during summer and autumn. Since the 1860s selective logging, cattle and sheep grazing, and fires have modified the wetland ecosystem. The addition of irrigation drainage water in the 1920s and introduction of a sewer drain in 1932 resulted in constant high water levels which caused the death of many River Red Gums and allowed rushes to dominate the wetland (Robinson 1990, Felton 1992). In addition to the constant high water level, the sewerage outfall added high nutrient loads to the wetland.

In 1977 concrete pipes and earthen banks were installed on the outlet creek to assist in minimising the effects of erosion and enable some management of water levels in the wetland. In 1979 this structure was upgraded to a concrete control structure which was funded by the Fisheries and Wildlife Department in conjunction with Shepparton branch of Field and Game Australia (FGA). Unauthorised operation/vandalism of this structure further contributed to the permanent inundation of Reedy Swamp.

Attempts were made to drain the wetland at the end of the 1993 duck season (Patterson 1995). Unfortunately, this was attempted during a wet season and water from the inlet drain refilled the wetland as quickly as it was drained (Patterson 1995). The culmination of a number of factors in the 1993 season saw the presence of blue-green alga in the wetland (Patterson 1995). The potential ramifications of blue-green alga entering the Goulburn River were recognised by the then Rural Water Corporation and spurred the installation of a channel that connected the inlet drain to the outlet creek to bypass the wetland, hence diverting all drain water supply away from Reedy Swamp. The channel facility was further developed by the Department of Conservation and Natural Resources in 1993-94 with the installation of a regulating structure and overflow sill and provided the ability to control drainage in-flows to Reedy Swamp (Patterson 1995).

At the end of the 1994 duck season, Reedy Swamp was drained by manipulating the outlet and inlet structures. This allowed the wetland to dry and facilitated the consolidation of sediments, proliferation of ephemeral wetland plants, regeneration of River Red Gum and alien weeds. The bed of the swamp comprises dispersive clays that shrink on drying to produce a columnar soil structure with deep cracks. Soil shrinkage is a response to water loss whilst soil air remains constant. Any accumulated organic material is exposed to the air, which will assist in its decomposition. The wetland was flooded again in April 1995, promoting the growth of aquatic plants and the release of nutrients in forms available for use by plants and animals (MDBC 2001). The native grasses and weeds that had germinated during the drying cycle died and large stands of Giant Rush (*Juncus ingens*) and Knotweed *Persicaria sp*. dominated. Knotweed declined over the years to return an open water area.

The wetland was again successfully dried in the summer - autumn of 2001/2002 through co-ordinated operation of the inlet and outlet structures. This was facilitated through the management plan process in consultation with stakeholders of the Reedy Swamp Environmental Management Plan.

2.6 Legislation, Strategies and Policy

The issues and directions for wetland management are outlined in a number of federal, basin, state, and catchment based legislation, strategies and policy. The primary emphasis of the strategies are to protect natural systems from degrading processes and, where possible, restore the natural functioning of degraded systems to enhance indigenous biodiversity.
Key legislation influencing the management of Reedy Swamp include:

STATE

- *Parks Victoria Act* 1998
- *Crown Lands (Reserves) Act* 1978
- *Catchment and Land Protection Act* 1994
- *Archaeological and Aboriginal Relics Preservation Act 1972*
- *Wildlife Act* 1975
- *Vermin and Noxious Weeds Act* 1958
- *Litter Act* 1964
- *Fences Act* 1968
- *Country Fire Authority Act* 1958
- *Local Government Act* 1989
- *Water Act* 1989
- *Flora and Fauna Guarantee Act* 1988
- *Heritage Rivers Act* 1992

COMMONWEALTH

- *Aboriginal and Torres Strait Islander Heritage Protection Act* 1984
- *Environmental Protection Biodiversity and Conservation (EPBC) Act* 1999

Key strategies and policies that influence the management of Reedy Swamp include:

STRATEGIES AND POLICIES

- 'The National Strategy for the Conservation of Australia's Biological Diversity' (CGoA 1996);
- 'Wetlands Policy of the Commonwealth of Australia' (CGoA 1997), including our international commitments via, JAMBA and CAMBA Agreements;
- 'Floodplain Wetlands Management Strategy for the Murray-Darling Basin' (MDBC 1998);
- 'Victoria's Biodiversity Strategy – Directions in Management' (DNRE 1997);
- 'The Goulburn-Broken Catchment Management Authority Catchment Strategy' (GBCMA 1998);
- 'Shepparton Irrigation Region Land and Water Salinity Management Plan' (GBCMA & NCCMA 1996).
- 'Draft Goulburn-Broken Native Vegetation Plan' (August 2000)
- 'Victoria's Draft Native Vegetation Management Framework' (August 2000)

3. Ecological Values

3.1 Reserve Significance

Victoria's deep freshwater marshes have declined by 70% in area since European settlement, with 10% of that loss occurring in the SIR (ARI 2000). Remaining deep freshwater marshes such as Reedy Swamp are therefore of very high value for their rarity of type. Its value for waterbird breeding habitat in particular makes it deserving of appropriate management to aid in returning this system to a more natural state and enhance indigenous biodiversity.

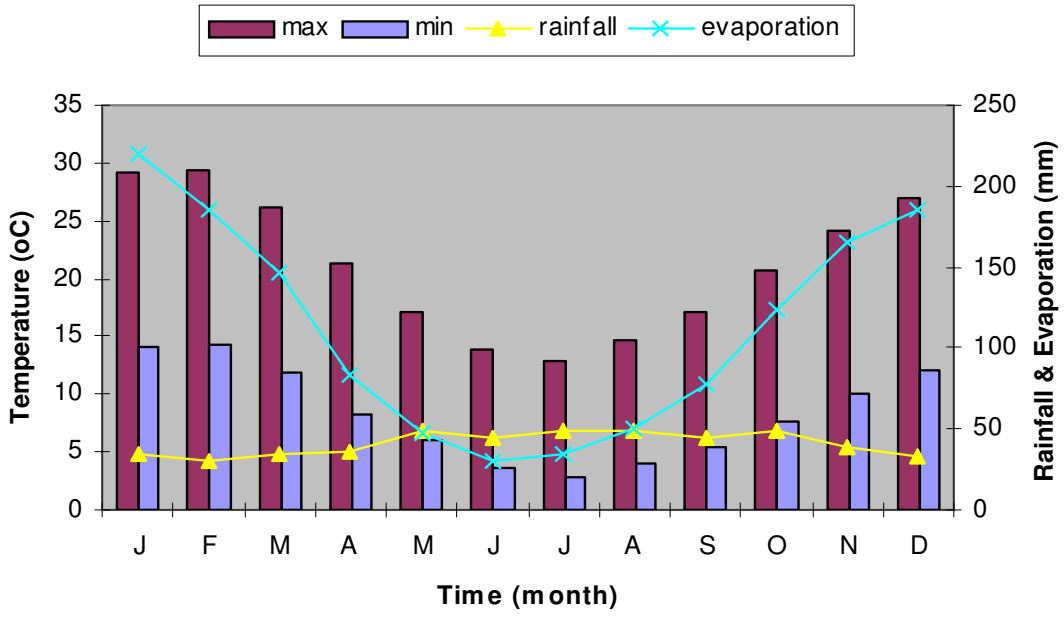
Reedy Swamp Wildlife Reserve is a component of the Lower Goulburn River forest reserve and floodplain. It is listed under the Directory of Important Wetlands (VIC052) as a high value wetland system for its ecological features. The Goulburn River itself is also one of 18 Victorian rivers protected under the *Heritage Rivers Act* 1992.

3.2 Physical Aspects

3.2.1 Climate

Reedy Swamp Wildlife Reserve is influenced by temperate climatic conditions characteristic of the Victorian Riverina Bioregion, with hot summers and mild winters. The Goulburn River floodplain receives an average annual rainfall of 450 mm, with monthly totals relatively evenly spread throughout the year with only a minor increase in winter and spring, and a total annual evaporation rate of 1349 mm strongly peaking in summer from a winter low (Figure 2).

Figure 2: Mean monthly climatic parameters at Tatura (nearest station to Reedy Swamp Wildlife Reserve).



3.2.2 Surface Water

Local rainfall contributes little to the natural flooding cycle, with the wetland dependent on high river flows or flooding from the Goulburn River. 60% of the natural flood events would nave occurred in the winter-spring months (July – October).

3.2.3 Water Quality

The effects of increased nutrient and salinity levels are primary degradative processes of particular concern in wetlands (National Parks 1996).

3.2.3.1 Nutrients

Elevated nutrients can cause alterations to botanical communities by modifying the competitive ability of different species and hence can be responsible for large shifts in the vegetation communities of a site. Unfortunately in Australia, where most plants have evolved to cope with low nutrient conditions, the shifts in vegetation communities often mean a shift to domination by exotic species and a corresponding decrease in indigenous diversity (Cottingham *et al*. 1994).

In addition, elevated nutrient conditions can lead to an algae dominated system as the main source of primary production within the wetland (Bowling 1994, GoV 1995). Major impacts can result if algal biomass reduces light penetration or otherwise smothers aquatic plants. Cyanobacteria, more commonly known as Blue Green Algae, can also bloom in very large numbers (as was observed in Reedy Swamp in 1993) and may be toxic to a range of organisms, particularly mammals (GoV 1995, Soranno 1997). A dying or decomposing algae bloom removes oxygen from the water, often reducing levels below that required for native fauna. Such a collapse in trophic levels can have negative impacts on the remainder of the ecosystem (Cottingham *et al*. 1994).

Nutrients, such as phosphorus and nitrogen, can potentially occur in high levels in drainage water and is therefore of concern to the wetland with respect to Drain No.3 as it is potentially the key source of water to the wetland, outside of natural Goulburn River events. There has been some monitoring of water quality (as per the major physico-chemical parameters) in Drain No.3 at the inlet to Reedy Swamp. Monitoring between April 1998 and June 2000 indicated the drain's water quality to be generally poor to degraded for turbidity. Reactive phosphorus levels were generally *good* to *fair*, however very high and high peaks of *degraded* levels were seen during Oct and Nov 1998 and a peak of *poor* was recorded in August 1999(Water Quality Report 2000).

There is the ability in this system to manipulate water inflows to the wetland and exclude those which are unacceptably rich in nutrients. Unfortunately, no specific guideline values are provided for Australian wetland systems for phosphorus and nitrogen. However, the *Environment Protection* Act (1970) states that 'waters shall be free of substances in concentration which cause nuisance plant growth or changes in species composition to the detriment of the protected beneficial uses'. Without background data for Reedy Swamp it is difficult to develop a reference condition from which to assess any change. Good background water quality data is therefore needed in order to develop a history of levels and variability in nitrogen and phosphorus concentrations to enable development of future management guidelines to minimise the impacts of extremes in these parameters on the wetland ecosystem.

Natural regular flushing from the Goulburn River will also assist in reducing the potential long-term effects of nutrients in Reedy Swamp.

3.2.3.2 Salinity

"Species diversity is significantly reduced as salinity increases, with more salt tolerant but less diverse taxa likely to become dominant" (Bailey & James 2000). Significant deleterious effects are observed in the biological communities of lowland wetland systems at salinities between 1500 and 3120 EC (Bailey & James 2000, Kelly 1993) with more indirect sublethal effects occurring below these concentrations (Bailey & James 2000). Some reduction in species diversity of macroinvertebrates has been observed at a salinity

of 1250 EC (Bailey & James 2000). Sublethal impacts of water salinities below 1000 EC have been recorded for some local wetland plants (Hart et al. 1990, James & Hart 1993, Warwick & Bailey 1997).

Salinity levels at the inlet and outlet of Reedy Swamp have been recorded between <100 EC and 400 EC (Clark 1996), which is indicative of excellent water quality under the Waterwatch water quality classification system developed from Australia & New Zealand Environment Conservation Council 2000 guidelines (Water Quality Report 2000).

Salinities monitored in Drain No.3 on a weekly to fortnightly basis between April 1998 and June 2000 indicate average salinity levels between 300 and 500 EC. However, some extreme influxes of up to 2000 EC are noted during this period (Water Quality Report 2000). Such fluctuations are significant considering this drain's importance to wetland inputs, however their impact is dependent on the volume and duration of flows and the internal dilution capacity of the wetland itself. Salinity levels in water downstream of the Goulburn Weir are generally less than 300 EC (Department of Water Resources 1989) and are not considered a threat to the wetland.

3.2.3.3 Turbidity

Turbidity is a measure of the light penetration through the water column and is affected by the amount of algae, other organic material and inorganic sediment (soil particles) suspended in the water (scattering the light).

High turbidity levels may reduce photosynthetic capacity of plants, eliminating them from deeper water; smother macroinvertebrates and fish eggs; limit the hunting success of waterbirds, fish and macroinvertebrates; and affect the respiratory systems of fish and macroinvertebrates.

High levels of turbidity are usually experienced in the lower reaches of major rivers in developed catchments and values may fluctuate significantly, peaking with high flow events.

Wetland vegetation can influence turbidity by binding the soil and reducing the re-suspension of sediments, excreting organic compounds that induce flocculation of suspended solids and reducing algal growth through competition for nutrients.

Turbidity at the inlet regulating structure at Reedy Swamp has been recorded at degraded levels of around 50 ntu with corresponding outlet regulator levels at 23 ntu (Clark 1996). There are insufficient measurements to identify any trends.

[1]Table 2: Criteria for assessing turbidity in the plains segment of river basins - National Tubidity Units (NTU)

Rating	NTU
excellent	<15.0
good	<17.5
moderate	<20.0
poor	<30.0
degraded	>30.0

The Goulburn Broken Catchment Management Authority's Regional Catchment addresses the management of stream turbidity.

[1] Table 2 taken from Victoria's Inland Waters, State of the Environment Report 1988; Office of the Commissioner for the Environment, Government of Victoria.

3.2.3.4 Suspended Solids

Suspended solids are a major influence of turbidity.

Elevated levels of suspended solids in the water entering wetlands is of concern as it will lead to a shallowing of the bed in the long-term, if there is not a corresponding re-suspension and flushing of wetland sediments.

The nutrient load in a wetland is also associated with the amount of suspended solids as much of the phosphorus is is adsorbed to soil particles.

There is not sufficient data at Reedy Swamp to determine sedimentation rates.

3.2.3.5 Lead

The use of lead shot for the hunting of waterfowl is now listed as a threatening process under the Flora and Fauna Guarantee Act 1988. By 2002 lead shot may no longer be used for duck hunting in Victoria wherever it occurs, including Reedy Swamp Wildlife Reserve.

3.2.4 Groundwater

Results of groundwater monitoring in the Shepparton area (1999) represent a recession in watertable levels since 1995. This recession is due to a successive series of dry winters (19950-2002) and shallow groundwater pumping supported by the Shepparton Irrigation Region Catchment Strategy (Draft Press Release February 1999).

Bore monitoring information indicates that the water table around the wetland is within 2.5 metres of the surface (refer Appendix 7 for bore locations). The groundwater salinity ranges between 4800 and 22200 EC in the vicinity of the wetland (SKM *in press*). This existing high groundwater and salinity trend could threaten the health of the wetland.

3.3 Wetland Classification

Reedy Swamp is identified under the statewide classification system (Corrick & Norman 1980) as a deep freshwater marsh dominated by reeds and open water (under irrigation conditions). This reflects the period of inundation rather than the depth.

In addition to this, the wetland has been further classified at a regional Shepparton Irrigation Region (SIR) level devised from the statewide process to describe wetlands in irrigated catchments by incorporating the characteristic descriptive elements of the wetland.

Under this regional classification system there are six basic wetland types, as defined for the SIR, ranging from intermittent (Type 1) to permanent open wetlands (Type 6). Descriptive classifications are based on aspects of topography, hydrology, soils and the composition of the vegetation and wildlife communities (Felton 1990). This is the system adopted by this management plan (Table 3).

Prior to the diversion of Drain No. 3 around the wetland, Reedy Swamp was unnaturally characteristic of a Type 6 or permanently inundated system. With the installation of the diversion drain and inlet regulating structure the wetland may be managed for a more natural Type 3/4 or a medium to prolonged duration seasonal wetland. However, the vandalism of the regulating structures in recent times has meant that the wetland has been functioning as a Type 5/6 or semi-permanent open wetland system (O'Connor 2000). The wetland's natural flood regime could typically be categorised as a Type 3 regime (medium duration seasonal wetland) and would experience a period of prolonged wet, approximately season to season (12 months to 2 years), once in every ten years. During a series of successively wet seasons however, Reedy Swamp would be more characteristic of a Type 4/5 wetland system with flooding seasonally extending for prolonged durations (O'Connor 2000).

Table 3: Approximate flood requirement definitions of Type 3 (medium duration seasonal wetland), Type 4 (prolonged duration seasonal open wetland), Type 5 (semi permanent open wetland) and Type 6 (permanent open water wetland).[2]

	Type 3	**Type 4**	**Type 5**	**Type 6**
Flooding frequency	Annual (most years)	Annual (most years)	Annual	Annual
Flooding period	Winter-spring	Winter-spring-summer	Winter-spring-summer- (autumn)	Winter-spring-summer-(autumn)
Flooding duration	4–6 months (120 – 180 days)	6–10 months (180 – 300 days)	Semi-permanent (>300 days)	Almost permanent
Flooding depth	0.4 – 1.0 m	0.6 – 1.5 m	<1.5 m	>1.5m
Drying frequency	Annual (most years)	3 – 5 years in 5	1 – 2 years in 5	<1 year in 5
Dry period	Summer-autumn	Summer-autumn	Occasional summer-autumn	Rarely summer-autumn
Other	Watertable >2m deep		Freshwater (<1500 EC max) Summer-autumn draw down by evaporation	Freshwater (<1500 EC max). Summer-autumn draw down by evaporation.

[2] Table 2 is an extract from the Community Surface Water Management Schemes: Guidelines for Design (Flooding Patterns and Resultant Wetlands, Shepparton Irrigation Region). Prepared by Sinclair Knight Merz for DNRE and G-MW of behalf of the Community Surface Drainage Program.

The values supported by Reedy Swamp as a Type 6 wetland, promoted through irrigation inputs, for waterbird breeding etc are considered important. However, the values this regime supports will eventually be degraded by persistence of continual/permanent flooding. Degrading will see the retraction of reed beds and expansion of Water Couch which decreases the overall biodiversity of the wetland by:

- Smothering biota,
- Decreasing feeding area available to macroinvertebrates, birds and fish,
- Increasing competition against other macrophytes,
- Reducing light availability,
- Promoting retraction of rush habitat which reduces the availability of tall emergent vegetation for waterbirds such as Ibis, Reed Warblers and Swans etc for nesting platforms and habitat for other species, and
- Creating oxygen reduced environments that promote methane and hydrogen sulphide production and follow on impacts from this.

The ability to manage Reedy Swamp as a Type 3 wetland exists through channel/drain supply and operation of infrastructure. However this is not considered appropriate because:

- Type 3 wetlands are quite common in the district,
- The wetland has developed values that are easier to maintain rather than recreate elsewhere,
- The ability to supply water to the wetland exists which is not possible for other sites developing Type 3 wetland characteristics,
- Type 3 wetland characteristics do not support conditions suitable for breeding of particular waterbirds ie: Ibis, and
- The current regime holds strong recreational values close to a public centre.

Therefore, in order to maintain and enhance the wetland's current values, it is considered most appropriate to emulate the natural flood characteristics through river regulation by managing for a Type 3 – 5 regime.

3.4 Flood Regime

Reedy Swamp Wildlife Reserve lies in the Goulburn River Basin, which covers 16191 km^2 in central Victoria and has an annual discharge of 3040GL (DWR 1989). Reedy Swamp was historically recharged annually by floodwaters flowing from the Goulburn River via a small depression (North Creek) to the north of the wetland. Occasional higher floods would overtop the river levee and flow into the wetland from the south-west. Floodwaters drain from the wetland back into the Goulburn River via North Creek.

Flood flow data since 1925 indicates that flooding of the wetland, as a result of river connection, would occur 6 years out of every 10 with ponded water for up to 6 months (Appendix 4a, 4b, 4c, 4d). One year in every 10 would experience a large flow event that would promote extended flooding where the wetland could be wet from one flood season to the next, holding water for 6 to 12 months (Appendix 4a, 4b, 4c, 4d). Ove Arup (1998), who identifies similar major flood peaks in the Goulburn River, supports this. However, this data is limited by its use of volume to ascertain flooding and does not consider duration of events or occurrence of intermediate events. Complete drying of the wetland could see maximum draw down of the wetland for up to 6 months in around 3 years out of every 10 (Appendix 4a, 4b, 4c, 4d).This may be protracted by drought as has been seen over the past ten years. In contrast, the wetland may also experience more frequent large events in a series of wet years that may increase the occurrence of extended flood duration.

The estimated watering regime has been devised on the following assumptions:

1) that breaching the threshold fills the wetland to maximum ponding depth (~ 0.5m).
2) that flood draw down/recession from approximately 0.5m ponding depth is estimated (in isolation from any external water inputs such as irrigation induced runoff) to be three to six months (based on regional rainfall and evaporation rates (Appendix 3) and assuming summer/autumn draw down).

Storms in the Great Dividing Range highlands used to govern the natural flood pattern of the Goulburn River, but has now been attenuated by the Eildon Dam and the Goulburn Weir, established for flood and irrigation control. Although flooding of the wetland may have occurred in intervening years, the extent and duration of floods has been significantly reduced. Goulburn River flows have been significantly impacted upon by the Goulburn Weir constructed upstream of Reedy Swamp (DWR 1989) to serve the Goulburn-Murray Irrigation District. Construction of the weir has seen greater than a 50% reduction in average monthly flows throughout the entire year downstream of the weir (Department of Water Resources 1989). The reduction in flows following regulation means that flooding of Reedy Swamp from the Goulburn River as a result of events upstream of the weir would be restricted to conditions exceeding regulated flows, such as those last seen in 1993. These factors could potentially restrict the natural extended flooding of Reedy Swamp.

The Goulburn River below the weir however, receives flood flows from a large unregulated section of the Strathbogie Ranges and as a result the frequency of flood flows impacting on Reedy Swamp is less altered. In 1995 for example Reedy Swamp was inundated for up to three months after the effects of the regional drainage network and catchment runoff from the Broken River, Honeysuckle, Pranjip, Castle and Sevens Creeks systems resulting from above average rainfall in the Strathbogies area over May, June and July (O'Connor). This was not a flood peak, but continuous input by these systems into the Broken River and then into Goulburn River above Reedy Swamp resulted in steady extended high water levels downstream of the weir.

Despite a reduction in the frequency and duration of forest and wetland flooding through river flows, the wetland has been filled consistently as a result of drainage inputs. However, the seasonality (summer/autumn) of these inflows is inappropriate. The summer/autumn flooding is occurring during the highest evaporation periods which precludes the wetland from drying (Appendix 3).

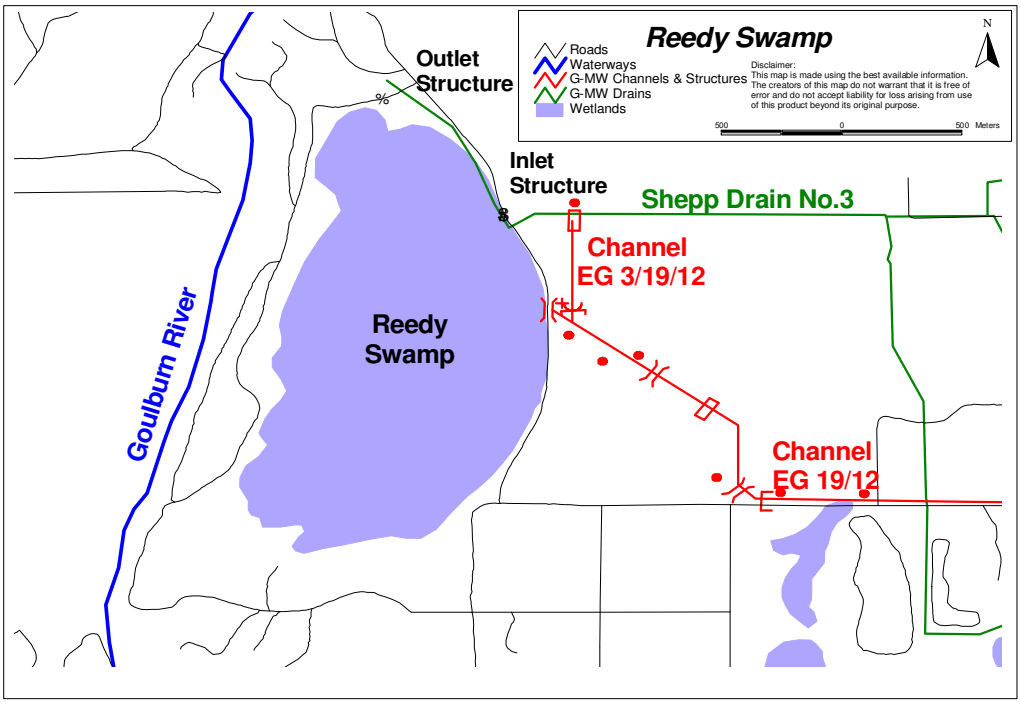
3.5 Surface Water Management

Surface Water Management Scheme (drainage) inflows over a long period of time have resulted in prolonged inundation and caused considerable alteration of Reedy Swamp. The outfall from irrigation drains and channels has changed this wetland from an ephemeral system to a semi-permanent lake. The EG 19/12 flows only during the irrigation season (August to May) and outfalls directly into Reedy Swamp (Nabbs 2001) and contributes to the unseasonal regime of the wetland. As a part of Goulburn-Murray Water's assets rationalisation process the channel outfall from EG 19/12 into Reedy Swamp will be decommissioned and all outfall will be directed into Drain No.3 above Reedy Swamp (Nabbs 2001). This will allow for the control of unseasonal channel flows into Reedy Swamp to be diverted around or into the wetland as required through manipulation of the inlet regulating structure (Figure 3 & Plate 5).

Goulburn–Murray Water (G-MW) and the City of Greater Shepparton (COGS) have submitted a joint proposal for Regional Infrastructure Development Funding to replace a section of EG 19/12 Channel from the off-take to Freemans Road with a pipeline (G-MW 2000). Establishment of this pipeline may directly affect potential for delivery of Environmental Water Allocation (EWA) from the channel.

Drain No.3 supplies water into the wetland via the inlet regulating structure (Figure 3 & Plate 5). The drain flows at seasonally variable rates due to inputs from irrigation/channel outfall and surface runoff. At some times of the year there may be no flow. It is predicted that Drain No.3, based on last season's data, could flow at approximately 4–5 ML/day (Allen *pers. comm* 2000). There are however no measuring devices installed on this drain to monitor flows but water quality is monitored as part of the Water Watch program (Allen *pers. comm* 2000).

Figure 3: Primary infrastructure associated with Reedy Swamp



A landholder east of Reedy Swamp Wildlife Reserve is a drainage diverter on Drain No. 3 approximately 300 metres upstream of the inlet regulating structure (Allen *pers. comm* 2000). It is proposed that EG 19/12 will outfall at this diversion site as part of the channel outfall realignment project (Nabbs 2001). The landholder has approached G-MW to have a low-level weir installed at the lower end of Drain No.3 to better utilise drain and outfall water during the summer months (Nabbs 2001). This could assist in minimising unseasonal flows which may enter into the wetland.

The installation of an outlet regulator on North Creek (Figure 3) in 1979 by the then, State Rivers and Water Supply Commission, provided greater control of wetland outflows. This structure replaced a number of inefficient small diameter pipes layed in an earth embankment in the outlet channel constructed in 1977 (Fisheries & Wildlife division files 1977). Unfortunately, the present structure is susceptible to tampering and flows are often obstructed to hold water up in the wetland.

An inlet regulating structure and overflow sill (Plates 4 & 5), and diversion drain were constructed in 1993/94 to provide control of flows outfalling from Drain No. 3 into the wetland. The inlet regulating structure can allow for diversion of outfall from EG 19/12 and/or Drain No.3, into or around the wetland (Figure 3) and therefore the reinstatement of annual drying.

The inlet regulating structure operates by backing up water in the drain to flow over the sill and into the wetland when the gate in the regulating structure is closed *ie* drop bars are in (Plate 5). Alternatively the gate can be opened to divert water around the wetland and into the Goulburn River. This structure has however been repeatedly vandalised and illegally operated in an attempt to manipulate water supply by blocking the gate structure (Allen). The protective locks on the drop bars have been vandalised and no longer function effectively (Allen).

Plate 4: Overflow sill at Reedy Swamp, 1994 (Photo: DNRE)

Plate 5: Inlet regulating structure and diversion drain at Reedy Swamp which backs water up in the drain and spills over the sill into the wetland when the gate is closed.

3.6 Biological Aspects

3.6.1 Flora

Ecological Vegetation Classes (EVCs) is a classification system developed by NRE for mapping and management planning of native vegetation in Victoria (Berwick). EVCs describe the variation in vegetation composition and structure, relative to local environmental variation in landscape position, drainage, soils, aspect and elevation, etc. Vegetation along the Goulburn River floodway, inclusive of Reedy Swamp Wildlife Reserve, has not been mapped at a small scale. Rather, a collective of particular vegetation units likely to occur at regular intervals along the river has been described as *complexes* or *mosaics*. Reedy Swamp Wildlife Reserve is a part of this mapped area and is described as a riverine grassy woodland/riverine sedgy forest/wetland mosaic, which is considered depleted at a bioregional level.

At ground level the wetland and reserve is comprised of areas of Riverine Grassy Woodland, Wetland and Sand Ridge Woodland vegetation units (Appendix 8). Of these, the Sand Ridge Woodland vegetation unit is classified as *endangered* within the GBCMA region.

Approximately 91 plant species (Appendix 1) have been identified in the Reedy Swamp Wildlife Reserve, 30 - 40% of which are introduced species. Of particular concern are the willow species infesting the body of the wetland.

Typical wetland vegetation consists of Giant rush (*Juncus ingens*), cumbungi and dead River Red Gum trees. The wetland is surrounded predominantly by healthy overstorey of River Red Gum (*Eucalyptus camaldulensis*), with Grey Box (*E. microcarpa*) and Yellow Box (*E. melliodora*) on the sandy rises. There is a sparse shrub layer of predominantly Silver wattle (*Acacia dealbata*) and isolated patches of Golden wattle (*Acacia pycnantha*) and Grey parrot pea (*Dillwynia cinerascens*). Ground layer vegetation consists of native grasses such as Tussock Grass (*Poa labillardieri*), Common Wheat–grass (*Elymus scaber*) and sedge (*Carex spp*).

Floods in 1974 washed out about two thirds of the Giant rush community from the wetland, and continuously high water levels prevented rushes from re-establishing (Felton 1992) until the wetland dried in 1994/95. High and stable water levels have promoted the growth of Water couch (*Paspalum distichum*) along the margins of the wetland.

3.6.1.1 Significant Species

The rare plant Jericho Wiregrass (*Aristida jerichoensis*) has recently been discovered in the sand dunes at Reedy Swamp Wildlife Reserve and is significant, as it is one of only three known sites in Victoria where the species is found (Weber *pers.comm* 2001).

Plate 6: Reedy Swamp vegetation and water level changes between 1997 and 2001 (Photos: Threlfall and DNRE).

Reedy Swamp 07/02/1997

Reedy Swamp 27/11/1997

Reedy Swamp 04/02/1998

Reedy Swamp 05/08/1998

Reedy Swamp 21/05/ 2001

Reedy Swamp 21/02/2002

3.6.2 Fauna

Reedy Swamp Wildlife Reserve provides an important refuge for native fauna in the SIR. The diverse range of habitats provided by the River Red Gum woodland, open water and rushland supports a range of native fauna, particularly waterbirds. The size of the Reserve, and its position along the Goulburn River corridor, enhance the conservation values of this site.

A total of 147 species (Appendix 2) have been recorded in or around Reedy Swamp Wildlife Reserve. It must be noted that the species listed in Appendix 2 are observed in the general area of Reedy Swamp Wildlife Reserve and although some species may appear on the list, they may not necessarily exist within the wetland and reserve area. For example, the degree of river connection will influence the presence of Murray Cod (*Maccullochella peeli peeli*).

3.6.1.1 Mammals

Mammal species identified for Reedy Swamp Wildlife Reserve include possums, gliders, bats, rodents and kangaroos. Many of these species are totally dependant on tree hollows for their survival.

Yellow–footed Antechinus (*Antechinus flavipes)* – hollow dependant
Common Brushtail Possum (*Trichosurus vulpecula*) – hollow dependant
Squirrel Glider (*Petaurus norfolcensis*) – endangered and hollow dependant
Sugar Glider (*Petaurus breviceps*) – hollow dependant
Feathertail Glider (*Acrobates pygmaeus*) – hollow dependant
Little Red Flying-fox (*Pteropus scapulatus*) – occasional vagrant
White-striped Freetail Bat (*Tadarida australis*) – hollow dependant
Southern Forest Bat (*Vespadelus regulus*) – hollow dependant
Little Forest Bat (*Vespadelus vulturnus*) – hollow dependant
Gould's Wattle Bat (*Chalinolobus gouldii*) – hollow dependant
Inland Broad-nosed Bat (*Scotorepens balstoni*) – hollow dependant
Large Forest Bat (*Vespadelus darlingtoni*) – hollow dependant
Water Rat (*Hydromys chrysogaster*)
Black Wallaby (*Wallabia bicolor*)
Eastern Grey Kangaroo (*Macropus giganteus*)

3.6.1.2 Birds

There are 72 species of birds recorded for Reedy Swamp (Appendix 2) includes colonial nesting waterbirds, water fowl and bushland bird species. The floating couch grass and giant rushes bordering the open water are the principal wildfowl refuges, along with the dead trees and logs which are the primary roosts.

As some of the recorded waterbirds are international migratory species the land manager has an obligation to protect their habitat under international agreements like China Australia Migratory Birds Agreement 1996 (CAMBA) and Japan Australia Migratory Birds Agreement 1996 (JAMBA). Latham's Snipe (*Gallinago hardwickii)* is listed under JAMBA and CAMBA, and the White-bellied Sea-eagle is listed under CAMBA (ANCA 1996). Both have been recorded at Reedy Swamp (Roberts 1981). Similarly, Great Egrets (*Ardea alba*) are now listed under the same international conventions.

Plate 7: One of the friendly inhabitants of Reedy Swamp, a juvenile Tawny Frogmouth (Photo: Melva Threlfall).

The wetland is an important breeding and nesting site for significant species such as Royal Spoonbills and Great Egrets, as well as Herons, and Sacred and Straw-necked Ibises. Sacred Ibis regularly breed in large numbers in the south-west of the wetland and counts of over 1000 birds have been regularly recorded (R. Weber *pers. comm* 1999). Many water birds require a flood event to begin breeding (Leslie 1995; Kingsford 1998) and as a result are vulnerable to the changing water levels and when water levels drop dramatically many species like Ibis, Swans and Pelicans desert their nests (Kingsford 1998). This highlights the need to be able to maintain periods of inundation at appropriate times of the year as part of a more controlled wetting regime.

3.6.1.3 Reptiles

Nine reptile species have been identified for Reedy Swamp Wildlife Reserve.

Common Long-necked Tortoise (*Chelodina longicollis*)
Murray River Tortoise (*Emydura macquarii*)
Marbled Gecko (*Phyllodactylus marmoratus*) – partially tree hollow dependant
Olive Legless Lizard (*Delma inornata*)
Tree Goanna (*Varanus varius*) – partially tree hollow dependant
Garden Skink (Lampropholis guichenoti)
Gray's Blind Snake (*Ramphotyphlops nigrescens*
Tiger Snake (*Notechis scutatus*)
Yellow-bellied Water Skink (*Euamprus heatwolei*)

3.6.1.4 Amphibians

Nine species of frog have been identified for Reedy Swamp Wildlife Reserve.

Southern Bullfrog (*Limnodynastes dumerilii*. ssp. Unknown)
Spotted Marsh Frog (*Limnodynastes tasmaniensis*)
Bibron's Toadlet (*Pseudophryne bibronii*)
Plains Froglet (*Crinia parinsignifera*)
Common Froglet (*Crinia signifera*)
Sloane's Froglet (*Crinia sloanei*)
Plains Brown Tree Frog (*Litoria paraewingi*)
Peron's Tree Frog (*Litoria peronii*) - partially dependant on tree hollows
Warty Bell Frog (*Litoria raniformis*) - vulnerable

3.6.1.5 Fish

The Crimson Spotted Rainbowfish (*Melanotaeniidae fluviatilis*) and the Flat-headed Galaxias (*Galaxias rostratus*) have been recorded as present for Reedy Swamp Wildlife Reserve. They are both classified as "*insufficiently known"* under the *Flora and Fauna Guarantee Act* (FFG) 1988.

The Crimson Spotted Rainbowfish (*Melanotaeniidae fluviatilis*) were last noted in 1991/92 during the conduction of an electrofishing equipment trial by field staff from the Kaiela Fisheries Research Station (Douglas *pers comm* 2001).

The Flat-headed Galaxias' (*Galaxias rostratus*) reproduces during August to September and spawns for up to one month (Native Fish 2000). Little more is known about this species' life history.

3.6.1.6 Significant species

There have been 34 significant species of birds and animals identified for Reedy Swamp Wildlife Reserve. A summary of classification status is seen below (refer Appendix 2 for more detailed information). Classifications used to describe the state, national and international conservation status of these species are from the Atlas of Victorian Wildlife, 2000 (Appendix 2).

- 2 critically endangered species, both of which are listed under the Flora and Fauna Guarantee Act, 1988 (FFG).
- 10 endangered species, all of which are listed under the FFG
- 14 vulnerable species, 6 of which are listed under the FFG
- 3 species classified as insufficiently known, of which 1 is listed under the FFG
- 5 species classified as lower risk near threatened, of which 1 is listed under the FFG
- 5 bird species are listed under both JAMBA and CAMBA
- 2 bird species listed only under CAMBA

3.7 Historical Land Use

3.7.1 Cultural Heritage

It is likely that Reedy Swamp and the reserve area was historically an important place for Aboriginal communities. Wetlands often provided a source of flora and fauna that would have been eaten or otherwise utilised by Aboriginal people (Gott 1999).

3.8 Land Use

The surrounding catchment comprises of agricultural, industrial and urban activities. The wetlands close proximity to the city of Shepparton has many ramifications for the site and site managers, Parks Victoria. Complaints to PV range from concerns about the amount of rubbish dumped to problems with motorbikes and vandalism. It is apparent from on-site inspection that the illegal dumping of household refuse and garden waste is a serious concern within the wetland and reserve area.

A number of penalty infringement offences have been issued in the Reedy Swamp Wildlife Reserve, however only two prosecutions against such offences has been attained in recent years (Wehner *pers comm* 2000*)*. These offences relate to the dumping of rubbish, which is the primary offence reported, closely followed by timber removal, reserve access by all terrain vehicles and motorbikes, deliberately lit fires and sand removal. The final noted offence, illegal grazing, is quite uncommon with only one noted in the last four years (Wehner *pers comm* 2000).

Reedy Swamp Wildlife Reserve is managed as a Game Reserve and is a significant wetland in the lower Goulburn Region for the hunting of waterfowl during the designated season. The site is utilised on a daily basis during duck season. On average, around 70-100 hunters utilise the wetland on duck opening (Norman *pers.comm* 2002) and shooting is usually conducted morning and evening, each day throughout the duck season, which occurs between March and June. There are no recently recorded complaints regarding the wetland or its use as a game reserve in consultation with COGS with only one shooting related offence recorded in the last 15 years (Trickey *pers.comm* 2000).

In the early 1970s, 504 acres was leased for grazing, although the actual area suitable for grazing is only about 126 acres (Robinson 1987). Grazing however would have undoubtedly commenced before the 1970's. There has been no legal grazing in the reserve since February 1995 when the last recorded grazing licence was terminated (Government Gazette).

The new Shepparton bypass route has been proposed to divert through traffic around Shepparton. A western route has been recommended by the Victorian Government. This preferred proposed route bypasses Shepparton and Mooroopna to the west and returns to the Goulburn Valley Highway north of Shepparton and passes south of the Reedy Swamp Wildlife Reserve along the same alignment as the powerline easement.

Housing development adjacent to the Reedy Swamp Wildlife Reserve is minimal. Plans held by COGS do not indicate any development or sub division activity on the fringes of the wetland. Because the wetland lies outside of the 'urban development' area, no further development would be expected there for at least ten years (Braslis *pers. comm* 2000).

The surrounding land on the east side of Reedy Swamp Wildlife Reserve is zoned as Rural. There are a number of possible uses for this land and most are subject to planning controls. Some of this land is also affected by flood and environmental significance overlays (Kalms *pers comm* 2002).

3.9 Monitoring

There is no monitoring program that feeds directly back to the manager, rather a number of adhoc programs have occurred. Monitoring programs that have been and are already undertaken at Reedy Swamp Wildlife Reserve include:

Mosquito monitoring
Mosquito monitoring started at Reedy Swamp before 1989. Both adult trapping and larval counts have been conducted. Adult trapping occurred in 1992/93 in the south east of the wetland. Larval counts have been conducted since 1989 where up to seven sites have been monitored each mosquito season.

Over the two mosquito breeding seasons (November – April, 1997/98 and 1998/99), there was very little mosquito breeding within the wetland (Wishart *pers. comm* 1999). Notably, only a small number of

mosquito (*Culex annulirostris*) has been found breeding in the wetland in recent years. This species is an efficient vector of arboviruses such as Murray Valley Encephalitis virus, Ross River virus, Barmah Forest virus and Kunjin (Wishart *pers. comm* 1999). This species of mosquito is found across the Murray Valley during the summer months.

The presence of predators in the wetland (fish and water-beetles) is thought to have maintained low levels of mosquito larvae throughout the wetland. The Crimson Spotted Rainbowfish is a mid water swimmer which feeds at the water's surface and is very efficient at preying on mosquito larvae. Wave action may also contribute to suppressing larvae numbers.

Floodplain Ecology Group Community Monitoring
Wanganui Secondary College conducted monitoring programs in 1995 on the water quality, salinity, pH and phosphate levels. Other monitoring programs included vegetation and macro-invertebrate surveys. These programs were conducted at the inlet (Drain No. 3 outfall) and outlet (North Creek) of Reedy Swamp (Clark 1996).

Environmental Management Group Monitoring
Reedy Swamp has been monitored annually since 1995 as part of the Victorian Statewide Salinity Monitoring Program which monitors the trends in catchment health, particularly salinity levels, in order to assess the impacts of the Salinity Management Program on wetlands and remnant vegetation (Cody 1998/99). This program includes monitoring of total phosphorus, reactive phosphorus, nitrate + nitrite, total Kjedahl nitrogen, salinity, pH, dissolved oxygen, temperature and turbidity. Biological monitoring involved surveying invertebrate community composition, weed invasion and regeneration, vegetation health, macrophyte and also the hydrological parameter of depth to groundwater.

Two sites were utilised for routine monitoring and include:
- near a pump site on the south-east boundary of the Reserve (AMG co-ordinates 533762), and
- adjacent the control structure on Drain No. 3 (AMG co-ordinates 535770).

All water quality parameters are sampled on a seasonal basis (ie: four times a year) along with vegetation health and depth to groundwater. All other biological parameters were monitored annually.

Waterwatch Monitoring
Water quality in Drain No. 3 is monitored regularly as part of the Waterwatch program. Water samples are taken just above the regulator on a weekly basis during irrigation season and once every fortnight outside of the irrigation season. These samples and the results from their analysis are collected by the Landcare network.

4. Management Issues

4.1 Cultural Heritage

There are records of numerous Aboriginal sites within the northern section of the broader Reedy Swamp floodplain (Moon *pers comm* 1999). Other important sites in the area are found along the nearby Goulburn River margins. A comprehensive archaeological survey recently conducted as part of the planning process for a proposed sewerage pipeline to run from Mooroopna to Shepparton resulted in the identification of a further two 'scatter' sites aside from those identified in desk top studies conducted by Aboriginal Affairs Victoria (Tyson *pers.comm* 2000).

Under the State *Archaeological and Aboriginal Relics Preservation Act* (1972) and the Commonwealth *Aboriginal and Torres Strait Islander Heritage Protection Act* (1984), all archaeological sites and relics are protected. Damage or disturbance, whether deliberate or inadvertent, without a permit is prohibited.

Any water management activity undertaken to maintain the natural flood regime of Reedy Swamp is unlikely to threaten important Aboriginal sites in the area.

4.2 Current Land Use

4.2.1 Recreation

Recreational usage of the wetland and reserve is moderate. Low impact activities such as bird watching, nature studies, walking, horse riding and game shooting are common. Less sensitive, higher impact activities include trail bike riding, bardi grubbing and sand extraction occur frequently.

4.2.1.1 Game hunting opportunities

The wetland is managed as a Game Reserve and is a significant wetland in the lower Goulburn Region for the hunting of water-fowl and there is an established history by shooters. The Shepparton branch of FGA in particular has developed a degree of custodianship of the site.

There is some opportunity to provide water to Reedy Swamp during duck season if it is considered to be complimentary with other management objectives and would be assessed on a seasonal basis. This may include the provision of inundated conditions during duck season or extending the duration of flooding in certain years.

4.2.1.2 Recreation facilities and opportunities

The further development of recreational facilities is considered inappropriate at Reedy. Visitation by bird life would provide an opportunity for the provision of a bird hide(s) by bird observers and nature studies groups. However, because of seasonal duck hunting use there is the potential to create a public danger between hunters and bird watchers. Some experience with bird hides has indicated that they are only viable at sites with permanent water to enable use throughout the whole year. Also impeccable security and full time guides or rangers present are essential. The establishment and use of such a structure therefore, would have to be carefully considered with respect to its maintenance and monitoring of its appropriate use, particularly because of the diversity of users to the area.

4.2.1.3 Rehabilitation, community awareness and education activities

There is an opportunity to promote the natural and botanic values of the reserve to the wider community. Possible activities include.

- erection of a sign at the main entrance to the Wildlife Reserve off Wanganui Road explaining the site's significance, managing authority and responsibilities of the public at this site
- promotion of field naturalist group activities to the wider public
- development of a flyer/brochure to promote the site for distribution to schools, universities, local community groups and government agencies
- increased monitoring and enforcement presence by PV

4.2.1.4 Tracks and Access

A number of tracks in Reedy Swamp Wildlife Reserve provide access to the Goulburn River. One of these tracks is a formal access road, running along the eastern boundary of the reserve, and is predominantly used by adjoining landholders. The track continues through the reserve and around the wetland and is used by the managing authority and general public. These tracks need to be maintained. The consequences of not maintaining existing tracks will be increased off road use of vehicles. Well maintained tracks serve to discourage off road use and preserve the botanical values of the site.

4.2.2 Mooroopna Pipeline

A pipeline to link the Mooroopna sewerage treatment plant and the Shepparton sewerage treatment plant has recently been laid by Goulburn Valley Water. The pipeline runs under the Goulburn River and through the northern section of the Reedy Swamp Reserve approximately 1m under the surface (Wehner *pers. comm* 2000 & Tyson *pers.comm* 2000). This section of cleared vegetation needs to be carefully monitored and maintained to prevent weed invasion.

4.2.3 Water Extraction

Reedy Swamp is also used as an opportunistic water extraction site for licensed G-MW diverters. The prolonged inundation of the wetland from channel and drainage outfalls has resulted in this supply being relatively secure for a number of years. Three unregulated stream licences, with diversion points directly from the wetland, are issued by G-MW. Under this licence agreement G-MW has no obligation to supply or to guarantee water quality or quantity (Gledhill *pers.comm* 2001). This means that, there is no legal obligation to provide water from Reedy Swamp (Hoare *pers. comm* 2001) that would conflict with the seasonal drying of the wetland. It is recommended that G-MW and PV liaise with relevant landholders to explore avenues for alternate supply arrangements.

4.2.4 Timber Extraction

Illegal timber/tree removal in the reserve has also been identified as a management issue. There has been no legal logging in the reserve for 38 years. Prior to this, selective logging for the production of sleepers took place (Weber *pers. comm* 2000). It is recommended that timber removal remain prohibited and that 'timber removal is prohibited' features on a sign at the reserve entrance. Increased vigilance in monitoring this activity in the reserve is required by the managing authority and community members.

4.2.5 Rubbish

The dumping of household rubbish, particularly garden waste, is a key issue within the Reserve. It is recommended that relevant actioning authorities (section 3.8) liaise with COGS to explore options to encourage responsible disposal of greenwaste at the local refuse disposal facility, which is also on Wanganui Road. Increased monitoring and enforcement (where possible) is required to discourage this activity.

The dumping and burning of car bodies is also a key concern at the site. Although this is very difficult to prevent and even more so to enforce through penalty infringement notices, increased monitoring by the managing authority will more frequently identify wrecks which need to be removed. An increased presence by the managing authority may also act to discourage some of this activity. Patrolling of the site during the evening may also be a consideration.

4.2.6 Community Involvement

It is recommended that a local committee/key contacts be established that can respond to specific issues associated with Reedy Swamp as the need arises, eg: friends of Reedy Swamp. Under the guidance of PV this group could be responsible for fostering a community ownership of the site, monitoring for rubbish dumping, site clean up days, monitoring of the site inlet and outlet structures, and to represent the local community at a regional level.

4.2.7 Monitoring Visitor Activities

Increased patrolling and enforcement presence by the managing authority is required to fulfil recommendations for many issues in the management plan. It is acknowledged that one site visit will address most recommendations of each of the issues. The intention of the plan is to identify the need for more regular site inspections. These inspections would then need to be built into the work schedules of the managing authority. This recommendation will be duplicated throughout section 6 of the plan and across many of the proposed management plans for wetlands areas.

4.3 Vegetation Management

4.3.1 Pest Plants

Pest plant species pose a significant threat to the biodiversity of Reedy Swamp Wildlife Reserve and the reserve area through increased competition with native species for nutrients and moisture. Woody weeds are a most recent introduction to the site and have the potential to become an infesting species. [The origin of their establishment is unknown but the few young olive trees present in the reserve should be removed/poisoned as soon as possible and complimented by an ongoing monitoring and response program. Cherry plum trees exist between the river and wetland and should also be removed/poisoned as soon as possible and actively monitored and managed].

Pattersons Curse
Pattersons Curse (*Echium plantagineum*) is a regionally controlled weed in Victoria. This plant can prove poisonous to some grazing animals and cause skin irritation in some animals and humans. This weed can be controlled by the use of herbicide when the plants are young. This weed should be addressed as soon as possible to prevent further establishment in the reserve or to near by farm land, and should be included in an ongoing monitoring and response program.

Arrowhead
Arrowhead (*Sagittaria graminea*) is an aquatic plant that is becoming an increasingly serious problem in aquatic systems and is generally found in water, in depths less than one metre. This weed poses significant problems in the irrigation network. There is an infestation of Arrowhead downstream of Reedy Swamp located in Drain No.3. This is treated annually as a part of G-MW's weed control program. This aquatic weed spreads quite rapidly due to its number of methods of reproduction. This weed poses a significant threat to both Reedy Swamp and the Goulburn River, into which the drain outfalls.

Wild mignionette
Wild mignionette (*Reseda luteola*) is a weed identified in the Reedy Swamp Wildlife Reserve. This plant can be controlled by the use of herbicide when plants are young. This plant should be controlled as soon as possible to prevent further establishment and included in an ongoing monitoring and response program.

Willows
Free seeding willow have recently been identified as becoming established in wetlands and drains in the SIR following the clearing of native vegetation (O'Connor 2000). Willows were initially introduced to Victorian waterways to aid in erosion prevention, particularly of riverbanks, but now pose a major threat to waterway health and the region's biodiversity as they are an aggressively invasive species. The adverse impacts of willow establishment and colonisation include threats to hydraulics and flooding due to interference in capacity levels and flows as a result of their root systems (NECMA). Also of concern are impacts on water quality, particularly dissolved oxygen, due to the impact of total leaf fall in autumn, compared with the year-round fall of the indigenous flora that the willows replace. Willows have been found to reduce macroinvertebrate diversity and density, therefore an overall reduction in food availability, and the reduction of habitat for native fauna such as honey eaters and hollow nesting birds (NECMA). However some evidence supports that there are no negative impacts (Yeates & Barmuta 1999).

The original introductions were established from cuttings from any vegetative part of the plant except the leaves. These plants were originally only either male or female trees which rarely or never produced seed (AANRM 1999). In recent years however, the introduction of opposite sex species and bisexual clones have allowed the establishment of free seeding populations (AANRM 1999). Willow seeds can germinate within 24 hours of contact with moisture, however their seeds have only a short lifespan of a few days and hence appropriate water management contrary to the willow's requirements may prove useful in their control (DNRE et al 1996).

The germination of willow species from free seeding sources was identified in Reedy Swamp in 1998 and is believed to be a cross with Tortured Willow (*Salix matsudana* 'Tortuosa') and White Willow (*Salix alba*) (O'Connor *pers. comm* 2000). These seedlings were eradicated via manual removal by agency staff, but recently further seedlings have been discovered, believed to be located in areas where the seeds would have been deposited when the ponding level of the wetland was low.

Should these seedlings be allowed to grow they would greatly reduce diversity and habitat within the wetland (DNRE et al 1996). These seedlings therefore need to be poisoned and/or manually removed immediately and if possible the source of the viable seed eradicated. Parent trees should be removed to prevent further seed dispersal and potential for contamination of other adjoining waterways. One willow tree located on the TAFE campus just a few hundred metres from the wetland was identified as a potential seed source and has been removed (O'Connor *pers.comm* 2000).

All existing adult trees should be killed insitu by scarf cutting and injecting a herbicide that is registered for use adjacent to aquatic environments. Poisoning should occur prior to autumn leaf fall and follow up treatments applied, repeatedly if necessary. The trees should not be removed nor any part of a disturbed living plant (broken branch), left in the wetland as these sections can easily regenerate into new plants.

Further education of the community, particularly adjacent landholders, regarding the ecological threats posed by willows and the manner in which they regenerate is required. This information needs to be extended to the nursery trade where initial supply of willow seedlings occurs.

Azolla

Azolla (*Azolla spp*) is a common native floating fern which supports nitrogen-fixing blue-green alga in the fronds of the plant. Dense mats of the floating fern, whilst common to low flow or lotic systems, have been identified as a potential indicator of nutrient conditions with blooms being observed at moderate and high levels of nutrient enrichment (Environment Australia & LWRRDC 2000). The combination of low flow and increased nutrients may favour proliferation of Azolla and/or algae which blanket the water surface, resulting in the marked reduction of light penetration through the water column, and is a precursor to deoxygenation and reduced wetland biodiversity. Low dissolved oxygen concentrations in turn cause loss of submerged plants, fish kills and liberation of phosphorus from the sediment (Environment Australia & LWRRDC 2000). Because nutrients may be a contributor to proliferation of the floating fern in this low flow system, the elimination or management of a potential nutrient point source may be a key management tool in controlling potential blanket formations of the plant.

Water couch

Water Couch (*Paspalum distichum*) provides valuable habitat and food for a number of wildlife. This plant can form dense mats and float over water from shallow fringes of wetlands. When prolific it can dominate the margin of a wetland and lead to the oxygen depletion of the water column under the floating mass. This chemical change to the water can be a problem to many freshwater lifeforms.

Water Couch grows and spreads rapidly in summer. Propagation is from seeds (flowering in mid-summer with seeds maturing late summer) or from pieces of rhizome (Sainty & Jacobs 1994). In many situations Water Couch is a major weed that can prove very difficult to eradicate (Sainty & Jacobs 1994). As Water Couch prefers damp to wet conditions, such as the margins of wetlands, drying may prove to be an effective management tool for the control of this species. However the extended dry period required would not be consistent with management for other wetland values at Reedy Swamp.

Water Couch used to be considered a cosmopolitan species (ie native to both Australia and many other countries of the world) (Willis 1970, Sainty & Jacobs 1981, Carr *et al*. 1992, Cunningham *et al*. 1992, Rowmanowski 1998), though more recently it is being regarded as introduced (Walsh & Entwisle 1994, Ross 1996). This document accepts the current exotic status and attempts to manage against the species, which the plan would intend to do, regardless of its exotic/native status because of its dominating colonisation ability within many wetlands throughout the SIR.

It is considered extremely difficult to eradicate this plant. The best management approach therefore is considered to be promotion of a mosaic distribution of the plant to inhibit development of a monoculture. The effectiveness of burning and/or fluctuating water levels associated with wetting and drying regime is not known for Reedy Swamp. Any trial burns after a draw down and drying should be monitored to ascertain the effectiveness of such a management tool in relation to Water couch.

Due to its status, some ecosystem value and difficulty of eradication, maintaining the species as part of a mosaic of the vegetation community should be aimed for. The re-introduction of a summer drying regime may assist in alleviating the dense biomass of Water Couch forming around the fringes of Reedy Swamp by eliminating water supply during the warmer months when it grows prolifically.

Although the burning of the Reedy Swamp wetland area is not recommended (Felton 1992), the controlled burning of Water Couch when dry in autumn-winter may assist with its control, and allow the removal of some of the high organic and nutrient loads (Felton 1992).

Blue-Green Algae

The excessive presence of blue-green algae (*Anabaena sp*.) was noted in Reedy Swamp in 1993 and prompted the diversion of nutrient rich irrigation runoff water from Drain No. 3 around the wetland. However, the primary source of water to the wetland continues to be derived from Drain No. 3, and therefore identifies the need to further address this point source of nutrients.

Blue-green alga occur naturally in most aquatic environments (State Government of Victoria 1995) without causing any noticeable problems, however blooms of these organisms may be promoted by a number of factors. These blooms may cause a number of problems such as the release of toxins which can be detrimental to humans and animals. They impart unpleasant tastes and odours, decrease recreational amenity, and remove oxygen from the water column which could prove detrimental to the ecology of an aquatic system (State Government of Victoria 1995). The most critical factors influencing occurrence and extent of blooms are water temperature, flow and turbulence, and the ratio of nitrogen levels to phosphorus levels (State Government of Victoria 1995). In a shallow, lotic system, such as Reedy Swamp, nutrient levels are potentially the most important factor in relation to algal blooms and hence the management of nutrient levels may provide the greatest potential for long-term control of blue-green algal blooms in the system.

Because Reedy Swamp is primarily supplied by water from Drain No. 3 it is a point source of nutrients to the wetland. It is recommended that a discrete management contingency should be considered for Reedy Swamp to prevent occurrence of blue-green algae blooms, including exclusion of drainage water with nutrient concentrations above that considered acceptable by DPI. Conversely, a response plan should also be devised to address an algal bloom occurrence.

4.3.2 Threatened Species Management

It is recommended that the Jericho Wiregrass (*Aristida jerichoensis*) be regularly monitored by PV and DSE – Flora and Fauna to identify any management activities required for its protection.

4.3.3 Giant Rush Community

Reedy Swamp hosts a Giant Rush (*Juncus ingens*) community which needs to be enhanced and preserved. Best management for the rush community would involve controlling its proliferation so as to allow Ibis to continue to use the species as a platform for its nests. The reinstatement of more natural wetting regimes has unpredictabele outcomes as it may allow the plant to proliferate or recede. The plant community needs to be monitored to determine the effects of the proposed wetting and drying regime on the Giant Rush and strategies assessed where possible. Should proliferation of the plant become a problem, burning followed by flooding is a management option for consideration.

4.3.4 Soil Disturbance

The sand dunes at the north eastern end of Reedy Swamp Wildlife Reserve are under threat from illegal sand extraction and disturbance from motorcycles. The recent discovery of the rare plant Jericho Wiregrass (*Aristida jerichoensis*) elevates the need to manage for the protection of the sand dunes. It is recommended that signs be established which identify the restricted access to the dunes to allow for establishment of revegetation and protection of a rare plant species. There may be a further need for some form of barricading around the base of the sand dunes to deter access by vehicles. Increased patrolling of the site is considered a high priority. Assistance by community members in monitoring the site is also considered to be a useful tool in managing against inappropriate activities in the area.

The Yellow Box (*Eucalyptus mellidora*) and understorey community which exists on the sand dune at the southern entrance of the reserve is under threat from soil disturbance and vegetation removal resulting from digging for bardi-grubs and sand removal. These issues were previously identified by Felton (1992) and supported by a recent field inspection. These activities involve overturning/removing the topsoil which creates a disturbance conducive to weed growth and resultant loss of native understorey and prevention of regeneration. This activity needs to be much more astutely monitored and it is recommended that regular patrols of the area be undertaken. It is also recommended that an educational program identifying the sand dune's significance and the damage that these activities can have on the natural regeneration of native flora should be developed. At this stage fencing of the sand dune is not recommended but may be a consideration should the degree of damage occurring as a result of bardi-grubbing continue after introduction of signs.

4.3.5 Tree Health

There has been a notable decline in the number of River Red Gums (*Eucalyptus camaldulensis*) within the main wetland body. Tree deaths in the deeper parts of the wetland have been caused by prolonged inundation due to unnatural wetland ponding as a result of contributions from channel and drainage outfall (Weber *pers. comm* 2000). Managing for a summer drying regime will ensure the health of the remaining River Red Gums. Of particular significance are two giant trees, a River Red Gum and a Grey Box tree (*Eucalyptus microcarpa*) still remain within the wetland reserve. They are fine examples of the large River Red Gums and Grey Box trees that were once common along the floodplains.

4.3.6 Grazing

Cattle grazing in river frontage forest was a historical practice throughout the lower Goulburn River. Many native plant species, especially some critical wetland macrophytes, became scarce or disappeared. Reeds and many other native plants sometimes flourish under occasional grazing, so long as they have a chance to recover (Mussared 1997). However, cattle grazing may have prevented the growth of the more palatable macrophytes such as Tall Spike-rush (*Eleocharis sphacelata*), Common Spike-rush (*E. acuta*), Marsh Club-rush (*Scirpus fluviatalis*) and River Club-rush (*Schoenoplectus validus*). The palatability of aquatic vegetation, the shade and shelter provided by fringing vegetation, and the presence of water, have generally made wetlands an attractive proposition for livestock grazing (Hull 1996).

Although grazing within the Reedy Swamp Reserve is currently withdrawn, illegal grazing is occasionally detected in the area and has been identified as a management issue.

4.3.7 Revegetation

The opportunity to encourage bush understorey within the reserve has been identified. On the higher, sandy ground it is recommended that a mixture of small trees and shrubs be planted to develop a diverse understorey. The following indigenous native species are recommended, in low densities:

- Yellow Box (*Eucalyptus melliodora*)
- Grey Box (*Eucalyptus microcarpa*)
- Lightwood (*Acacia implexa*)
- Silver Wattle (*Acacia dealbata*)
- Common Fringe-myrtle (*Calytrix tetragona*)
- Common Eutaxia (*Eutaxia microphylla*)
- Willow Wattle (*Acacia salicina*)
- Berrigan (*Eremophila longifolia*)
- Sweet Quondong (*Santalum acuminatum*)
- White Cypress-Pine (*Callitris glaucophylla*)
- Silver Banksia (*Banksia marginata*)
- Hooked Needlewood (*Hakea tephrosperma*)

Golden Wattles (*Acacia pycantha*) are present on lower ground, closer towards the wetland edge, but would potentially regenerate sufficiently without interference. Alien grasses dominate the lunette and a program of replacement with native species is desirable.

4.3.8 Fire Management

The effects of fire in wetlands result in changes in vegetation composition, reduction in the organic surface layer, exposure of roots and rhizomes and increased sedimentation (Hull 1996).

Fires that damage the vegetation before it has regenerated from the last fire may kill some plants, retard reproduction and eliminate seed stores. The recovery of wetland plants from fire depends on the fire frequency, intensity, community age, composition, and the post-fire weather conditions (Hull 1996). Fires are currently not perceived as a management tool for wetland vegetation management.

A number of fires are regularly recorded for Reedy Swamp Wildlife Reserve. These fires have sometimes been deliberate attacks, others are associated with dumped vehicles which have been burnt out, escaped campfires and also to self combustion of dumped greenwaste.

The ongoing maintenance of fire breaks and access tracks within and around the reserve are necessary for fire management.

4.4 Wildlife Management

The Goulburn River vegetation corridor, including Reedy Swamp Wildlife Reserve, is an important component of the Victorian Riverina Bioregion providing habitat for a great number of animal species and particularly breeding sites/conditions for many of the region's waterbirds. The frequency and duration of flooding are two of the major determinants of a wetland's species composition (Beilharz 1996).

See 'Fragments for the Future' (Bennett et al. 1998) for a comprehensive discussion of Victorian Riverina wildlife, their ecological requirements, and conservation issues. Bird surveys have been conducted over many years and all seasons.

4.4.1 Waterbirds

Regular waterbird counts have been completed as part of surveys conducted by Birds Australia. The adoption of Reedy Swamp Wildlife Reserve as a breeding site for colonial nesting birds appears to be a fairly recent phenomenon (since 1970). It is unlikely that natural flood events (from the regulated River) will be of sufficient duration to sustain nesting attempts on a consistent basis. Regular supplementation of flood water will be required.

It is possible to prescribe suitable watering regimes for particular species (Appendix 5). The proposed strategy for water management is to respond to any bird breeding attempts in order to ensure their success. This may include the delivery of environmental water to prolong inundation events. Any decisions regarding the manipulation of watering regimes for bird breeding should be done so in consultation with all stakeholders and key technical experts such as DSE Flora and Fauna branch.

4.4.2 Pest Animals

A large number of vertebrate and unknown number of invertebrate species have been introduced into the Victorian Riverina. The impacts of these species can be varied depending on site characteristics, seasonal conditions and population densities. The impacts of two key feral animal species, Fox (*Vulpes vulpes*) and Feral Cat (*Felis catus*), to the general faunal population are significant and well understood.

Predation by cats and foxes are listed as a threatening process for several Victorian native species. Of the feral animals identified for Reedy Swamp Wildlife Reserve, foxes and cats pose the most significant threat, particularly to the success of many ground-nesting birds. Control of these species would best be achieved through a coordinated cat caging and 'fox off' baiting program both in the reserve and adjoining properties. Coordinated fox drives can assist control, but are also a disturbance to wildlife.

Brown Hares (*Lepus capensis)* can have an impact by selective browsing of some flora. Their population densities and impacts should be monitored.

Control of rabbits (*Oryctologus cuniculus*) would also need to be undertaken by trapping implosion, gassing, ripping or release of biological control agents. Poisoning would have to be undertaken only under stringent guidelines to minimise impact on non-target species.

Carp (*Cyprinus carpio*) are also seen to be an issue for the future management of Reedy Swamp.

4.4.3 Threatened Wildlife Management

A number of significant species are noted for, or in the vicinity of, Reedy Swamp Wildlife Reserve. In particular a number of regional, national and internationally significant waterbirds utilise the site for habitat, refuge and breeding. Little information regarding population numbers, distribution or habitat requirements is available.

These details are extremely important with regard to the long-term management of Reedy Swamp Wildlife Reserve, particularly the hydrological management of the wetland. Unfortunately this type of research and information gathering is potentially beyond the resources of Parks Victoria and the Goulburn Broken Catchment Management Authority (GBCMA). It is therefore recommended that Universities, education institutions and other departments be encouraged to conduct research within the reserve area. This information would then be utilised to further refine the management action of this management plan.

4.5 Salinity and Nutrients

The management of water quality to prevent eutrophication and salinisation of wetlands would best be controlled or mitigated by controlling or influencing landuse and landuse practices within the catchment (National Parks 1996). Such control may be best facilitated through the development of whole catchment management plans and whole farm planning (National Parks 1996).

The current Catchment Strategy addresses the majority of these issues and includes development of drain management plans. The progress of the Catchment Strategy may need to be assessed in future to ascertain whether its programs require acceleration. It is recommended that a draft management plan be developed (possibly on a sub-catchment basis) to coordinate efforts of current programs and identify potential new programs to combat salinity and nutrient problems. Increased community awareness through further education programs regarding the impacts of landuse practices on wetlands and waterways is also considered appropriate and may be included as part of a draft management plan.

Ongoing monitoring of water quality in Reedy Swamp and in Drain No.3 should continue as part of the Mandatory Environmental Monitoring Program being undertaken by the Environmental Management Program of DPI and with Waterwatch. Intensified monitoring of water quality in Reedy Swamp is required if no riverine influxes have occurred over an extended period. If at any time this monitoring indicated salinities rising above around 1000 EC (the lowest acceptable upper limit for some species) then artificial flushing or dilution of the wetland may be necessary. In addition, intensified monitoring of water quality in Drain No.3 by managing stakeholders (DPI, DSE, PV & FGA) is required before and during closing of the inlet structure during delivery of water from the Surface Water Management System. The control structure should not be closed if Drain No.3 flows are in excess 1000 EC unless it is deemed appropriate that the dilution capacity of the wetland is able to negate its effects.

The potential nutrient input from large flocks of nesting birds eg: >1000 Ibis observed in 1986 and 2001 could be substantial. If nutrients from this source was identified as a problem, drying would have to be implemented to promote breakdown of the organic material.

Should conditions necessitate water supply to the wetland, for topping up, priming and/or flushing, and suitable volumes or quality of water are not available from the drainage system then it may be necessary to supplement or replace drainage supply water with an EWA.

Another water quality concern associated with Reedy Swamp Wildlife Reserve is the existence of a re-use outfall from an adjoining property. The operation of this re-use is not understood however the potential impacts of it on water quality entering Reedy Swamp or the Goulburn River is significant. It is recommended that this system's existence and operation is further investigated to ensure it is appropriately managed.

Plate 8: Re-use outfall drain into the Reedy Swamp Reserve (Photo: DPI)

4.6 Groundwater

Groundwater monitoring data recorded in the vicinity of Reedy Swamp Wildlife Reserve is inadequate to determine how groundwater impacts on the Wetland. Only two sites are regularly monitored for water levels and salinity (SKM *in press*).

An observation bore installed on the western margin of the wetland, near the Goulburn River, would assist in determining the local direction of groundwater flow and the interaction between groundwater, Reedy Swamp and the Goulburn River. Groundwater levels should also be monitored north of the wetland with the installation of an observation bore (SKM *in press*).

The installation of nested bores within Reedy Swamp would permit the vertical groundwater gradient to be determined. The number of bores required is yet to be ascertained. The practicality of installing and monitoring these bores is an issue due to the nature of the wetland bed. The installation of a gauge board may be an alternative to monitor water depth if bores are not possible. All observation bores should be regularly monitored and surveyed to AHD to assist in the interpretation of the impact of groundwater on the wetland.

4.7 Powerline

A powerline easement with large high voltage powerlines runs south of Reedy Swamp Wildlife Reserve and represents the preferred alignment for the proposed Shepparton Bypass. Electric powerlines are known to be a cause of bird mortality through collision as they are often not visible to birds in their flight path (Alonso *et al* 1994). This poses some threat to birds, particularly 'large flight' birds such as Ibis which can visit Reedy Swamp in their hundreds, Great Egrets (endangered) and Royal Spoonbill (vulnerable). Birds are particularly vulnerable during low light periods at dawn and dusk when most species would be entering or exiting the wetland.

The necessity to minimise the risk to birds associated with these powerlines is highlighted as a management issue because of the potential frequency and numbers of large birds utilising the wetland. The marking of power lines with large/bright visual markers (balls) is recommended as the best way to reduce bird mortality at power lines (Alonso *et al* 1994). It is also recommended that consideration be given to underground cabling of these powerlines in conjunction with the construction of the proposed Shepparton Bypass.

4.8 Flood Regime

Management recommendations for the flooding regime of Reedy Swamp have been based around the determination of natural and current conditions, the distribution of vegetation communities and their requirements and on previous work undertaken by Felton (1992). The recommendations are intended to be simplistic and adaptive. In essence they attempt to emulate key aspects of the natural flood regime with management dictated by seasonal conditions. Managing for wetland biodiversity will see some emphasis of colonial nesting waterbids and habitat which will pick up on requirements of other species. The proposed management is not an exact science and as such no specific determining factors ie specific levels (AHD) or dates, will be used. Rather, natural events such as wets, dries and bird breeding will be used as cues to initiate the appropriate management mechanisms in conjunction with the following guidelines;

Complete Dry
- mimic/maintain dry conditions in Reedy Swamp when they are naturally dry.
- draw down until the majority of the basin is dry with only a small area of water remaining.
- 3 out of every 10 years exclude drain inflows between November and April (6 months).
- manages for seedling establishment of the rushland.
- manages against water couch, cumbungi, algae and azolla.

Prolonged Wet
- mimic/maintain wet conditions in Reedy Swamp when they are naturally wet.
- wet from season to season (ie autumn to autumn), at full supply level .
- 3 out of every 10 years spent inundated.
- manages for bird breeding, aquatic habitat, aquatic plant health and provision of duck shooting conditions.

Draw Down
- in between extreme wet and dry conditions provide water level fluctuations to mimic/maintain intermediate seasonal conditions.
- reduction of water level to below the River Red Gum zone allowing it to dry completely whilst still providing water in the rushland area with some small areas of open water.
- 4 out of every 10 years spent dry from December to March (4 months).
- manages for the health of River Red Gum.
- manages against water couch, cumbungi, algae, azolla, willows and mosquitoes.
- provision of breeding/bird habitat.
- provision of conditions for duck shooting.

The Plan Implementation Support Committee (PISC) forum is recommended as the most appropriate foundation group to establish a regional process to oversee annual water management activities and allocations to a range of SIR wetlands, which includes Reedy Swamp. The committee would be expanded to include PV and community / stakeholder representatives when appropriate. This expanded forum would be responsible for subjectively reviewing water requirements of the wetlands within its charter, and make considered and coordinated recommendations to the relevant management authorities (DPI, PV and Forests Victoria for public lands) based upon the guidelines in wetland environmental management plans.

4.8.1 Regulating Structure Management

In order to secure a more natural watering regime to the wetland both structures need to be protected from tampering. Installation of an under shot gate structures (screw down locked gate) is recommended because it eliminates the requirement for removal and replacement of drop bars. The inlet regulating structure would be owned and maintained by G-MW. This structure would also be operated by G-MW under direction from Parks Victoria as advised by DPI and in consultation with Wetland Plan Key Stakeholders.

The outlet regulating structure would be owned, maintained and operated by PV as required on advice from DPI and in consultation with the Wetland Plan Key Stakeholders.

An operational agreement governing the operation of the inlet and outlet regulating structures for implementation of the watering regime recommendations of the Management Plan should be developed (Appendix 9). These guidelines should provide for flexibility in management to cater for any number of the potential scenarios which may arise. The agreement is directly linked to the Management Plan and all signatories to the plan are expected to observe the 'agreements' obligations.

Increased vigilance on behalf of all stakeholders will be required upon implementation of the Management Plan, with regard to monitoring of both the inlet and outlet structures to ensure they are free of obstruction and operating effectively. The erection of signs at both structures, identifying their purpose and to educate the public about their operation and importance, may assist in discouraging further vandalism. The implementation of a public education program is recommended to assist in alleviating this problem.

4.9 Surface Water Management

Ongoing monitoring of water quality in Drain No.3 is recommended in conjunction with the operation of the inlet control structure to ensure satisfactory water quality when inflows to the wetland are required (monitoring is specifically for water quality before allowing it to be diverted directly into wetland).

It is recommended that a set of guidelines be developed and agreed upon by PV, G-MW, DPI and the landholder east of Reedy Swamp (section 3.5) with regard to the operation of a proposed weir pool proposed on Drain No. 3. It would be important to ensure that the operation of any proposed structure(s) does not compromise the ability to deliver Environmental Water Allocation (EWA) or channel outfall into Drain No.3 and into the wetland should it be required. These guidelines must also take into consideration the amount of water in the catchment which may be associated with summer rainfall events to ensure that these flows enter the wetland. It is further recommended that a modified diversion agreement is put in place with landholder(s) who divert from Drain No.3 to ensure that EWA delivery via the channel and drainage network, is not compromised by diversion.

4.10 Environmental Water Allocations

An EWA is seen as a distinct management tool to address many issues within Reedy Swamp. This includes provision of water for the ecological purposes (Appendix 8) of indirectly providing drought refuge for waterbirds, ensuring waterbird breeding conditions and the ability to control giant rush community. Practicable community based considerations include irrigation supply and conditions appropriate to game shooting in certain years when conditions are suitable.

Such an allocation is considered imperative in this system and further research to determine the exact volume of such an entitlement is required. It is suggested that the EWA volume determined be sufficient to fill the entire wetland from dry and for situations such as topping up the wetland to ensure waterbird breeding cycles or to maintain conditions for duck hunting.

The volume required to fill the wetland to 1.0m in depth is calculated to be approximately 650 ML (Appendix 3). This figure is doubled to give a volume of 1300 ML to allow for potential absorption effects by the wetland basin should it undergo a significant drying and evaporation phase. Such a volume may be required to fill the wetland from dry to maintain seasonal regimes as specified. It may also be necessary at times to permanently inundate the giant rush population as a means of preventing its proliferation. The minimum volume required is 325 ML, that volume required to fill the wetland to an average depth of 0.5 m. This minimum figure would still need to be multiplied to allow for absorption effects if the wetland was being filled from dry. It is therefore necessary to secure a minimum 650 ML EWA for Reedy Swamp in order to meet the requirements of the wetland in all years, should it be necessary.

An EWA could potentially be delivered via the EG 19/12 and Drain No. 3 system without the need for any further infrastructure. The new EG 19/12 outfall structure into Drain No.3 is designed to cater for flows up to 20 ML/d but is not sufficient to deliver the volumes to the wetland in the time required. It may however be possible to deliver a cumulative volume from a number of channels which outfall into Drain No. 3.

The cumulative capacity of the outfall system can cater for 99 ML/d (optimum channel capacity) delivered into Drain No.3 (Table 4 & Figure 4). At optimum efficiency (not considering transfer losses) this system could deliver 1300 ML in approximately 26.5 days. However, restrictions on this delivery will apply during the irrigation season with supply demand impacting on water available to be outfalled. This may mean that outfall volumes are restricted during an irrigation season, but may still be possible to some degree. It may be necessary to restrict supply to the end of the irrigation season ie outfalled at reduced rates over May, to be boosted in capacity on shut down of irrigation supply. Both the inlet and outlet structures should be monitored regularly with increased vigilance during EWA delivery period ie at least every two days, including weekends.

Table 4: Channel outfalls into Drain No.3 (refer to figure 4).

Channel	Capacity (ML)	Outfall Capacity (ML)
2/11	20	10
3/11	15	15
4/11	30	5
6/11	5	5
7/11	15	10
2/12/12	30	5
3/12/12	40	5
12/12	75	4
17/12	30	20
19/12	25	20
		Total: 99

Site managers must remain mindful of the status of the drainage system during a desired delivery period in regard to a heavy rain event. It is recommended that EWA delivery be shut down should a rainfall event equivalent to the maximum capacity of the drainage system occur. These flows should in turn be allowed to enter the wetland.

Conversely, consideration must also be given to ceasing or delaying EWA delivery should evaporation rates become higher than delivery rates can cater for in order to prevent unnecessary water losses.

Another consideration to be made during EWA delivery involves the monitoring of diversion from channel systems and Drain No.3. It is recommended that diversion sites be monitored as best as possible to ensure successful delivery of the full environmental allocation. G-MW would be responsible for informing customers of delivery requirements and the timeline demands on the system. It may prove more simplified to modify existing diversion agreements with landholder(s) who divert from Drain No.3 to ensure that EWA delivery via the channel and drainage network, is not compromised by diversion.

The EWA is not intended for use every year, nor is the full allocation likely to be used, but the ability to provide for the above ecological purposes must be achieved as best as possible to protect the system's current values. This allocation would be used to achieve the recommended flooding regimes already discussed in section 3.4, based on the ecological requirements of the wetland.

4.11 Monitoring for the Implementation of Wetland Management

4.11.1 Effectiveness of Existing Monitoring Programs

The suite of current monitoring programs (Section 3.9) are considered appropriate for this site's requirements however it is necessary for the information from each program needs to be amalgamated to be of use to the land manager in interpreting apparent trends. This information also needs to be made accessible/available in a greater catchment context.

The mandatory monitoring program in particular is important for the site and needs to continue. However there is a need to refine the monitoring process to ensure it is consistent and statistically rigorous and that the information collected and outcomes recorded are disseminated effectively. This program could easily be integrated/expanded into a more site-specific program.

4.11.2 Monitoring the Effectiveness of Management Programs

A monitoring program needs to be conducted over the life of the management plan, at which stage, patterns can be evaluated, and management strategies reviewed. It is beyond the scope of this management plan to set criteria for such a program. These would need to be developed in accordance with a regional monitoring program which would investigate specific attributes of biodiversity performance, related to both wetland and terrestrial sites.

An interim monitoring program is however required to allow for adaptive on-ground management. The program needs to be coordinated and include water quality issues, wetland hydrology and biological response of management based on the key attributes and/or indicator species outlined in the plan. This monitoring program should be incorporated into the existing monitoring framework where possible eg expansion of the current mandatory monitoring program or inclusion of a new component.

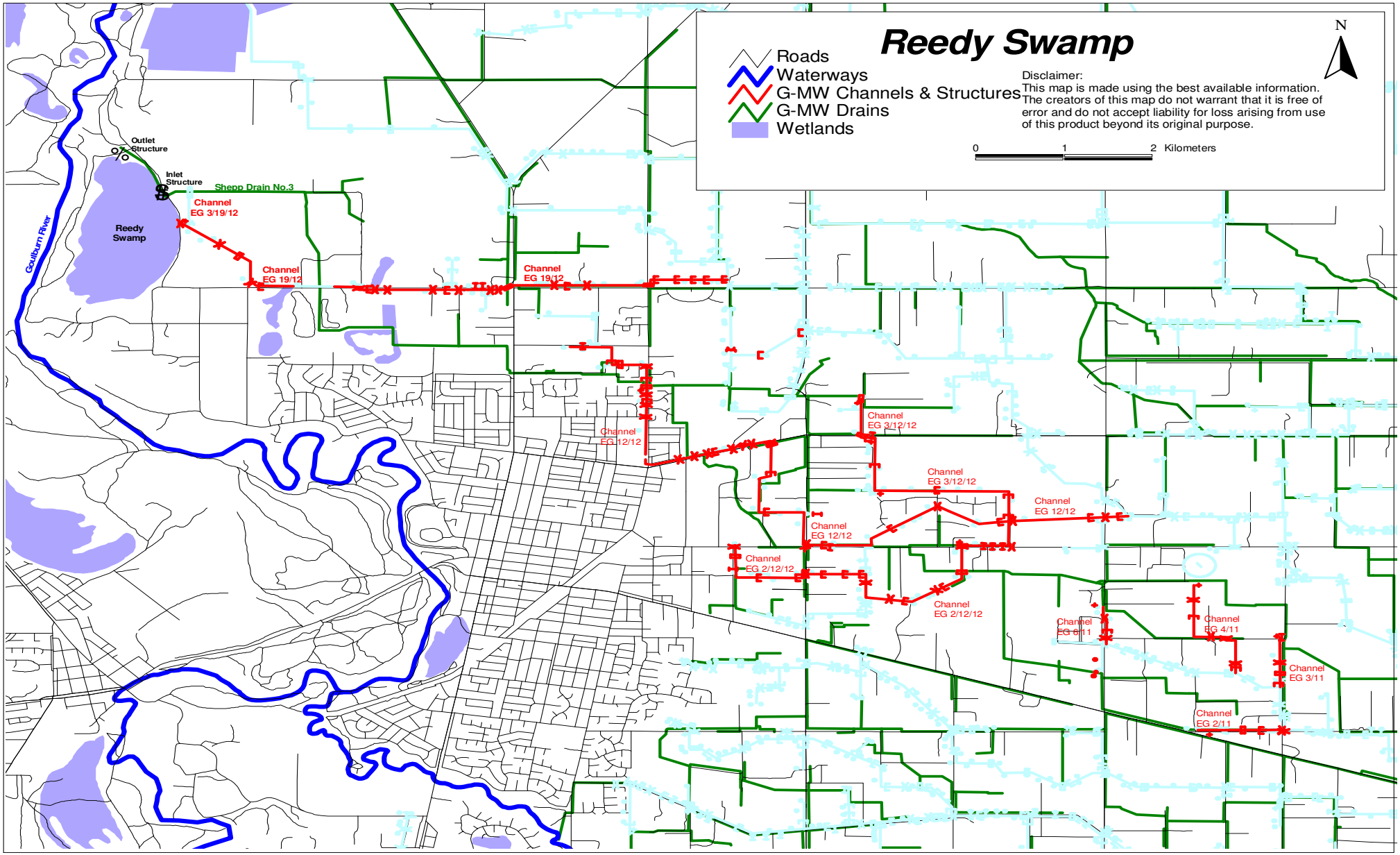
The following attributes are considered important for inclusion in a monitoring program for Reedy Swamp Wildlife Reserve:

- population status and distribution of rare and threatened plant species,
- population status and distribution of potential weed species,
- weed invasion patterns and impacts and the effectiveness of strategies,
- localised groundwater levels,
- drainage patterns and impacts,
- river regulation patterns and impacts, and
- water quality – both in the wetland and of drainage inflows.

Key indicator species that could be used in monitoring during adaptive management of the wetland include:

- River Red Gum health – to observe any regeneration in the wetland basin and that trees around the wetland are not stressed with a reinstated drying regime
- Giant Rush – attempt expansion of distribution and abundance whilst ensuring that it does not become threateningly dominant
- Spike-sedge – attempt expansion of distribution and abundance
- Willows – attempt to eradicate
- Patterson's Curse – attempt to eradicate identified noxious weeds
- Water Couch – attempt contraction in distribution and abundance
- Azolla – attempt to avoid any proliferation in distribution and abundance
- Blue-Green Algae – attempt to avoid any proliferation in distribution and abundance
- Arrowhead – ensure the infestation remain isolated
- Colonial nesting waterbird – breeding, wetland utilisation and to ensure for their protection
- Sea Eagles – breeding, wetland utilisation and to ensure for their protection
- General waterbird breeding and utilisation of the wetland

Figure 4: Summary of channel system for delivery to Reedy Swamp



5.0 Recommendations

The management plan identifies issues related to the site and a series of management recommendations and associated actions developed to address these issues. The recommendations are presented on the basis of priority. These actions are developed with a view to returning ecological balance to the Mansfield Swamp Wildlife Reserve.

It is understood that the issues identified in this plan may not accord with the regional priorities of individual organisations. It is acknowledged that the responsible organisation or group will address individual actions as opportunities and / or funds arise.

It is however the intention of the plan to provide a tool for managers to identify new priorities and opportunities, and to support application for funding to support plan implementation.

The following table provides the list of recommendations, a description of required management actions and the agency or groups responsible for implementing each action.

PRIORITY	**MANAGEMENT RECOMMENDATIONS**
High	Actions of high priority should be implemented as soon as possible but within the first year of the life of this plan. These management actions may or may not require the most resources and commitment.
On-going	On-going action to be implemented over the life of the plan. Unless otherwise specified, on-going actions are to be considered the same priority as high priority actions.
Medium	Actions of medium priority should also be implemented as soon as possible, but focus should be turned to these actions after high priority actions have been addressed.
Low	Actions of low priority should be considered after high and medium priority actions have been addressed.
As needed	Management issues or opportunities that may need to be addressed on an infrequent occasion or when a situation or opportunity develops. To be determined by the appropriate management authority in consultation with other stakeholders.

5.1 Current Land Use

5.1.1 Recreation

5.1.1.1 Game hunting opportunities

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
Provision of water from drainage supply to the wetland to provide inundation conditions or to extend the duration of flooding in certain years during duck season where it does not conflict with other management objectives.	ℜ	Seasonal	PV & G-MW	In consultation with key stakeholders	As needed	4.2.1.1 (p. 23)

5.1.1.2 Recreation facilities and opportunities

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
Due to the size and significance of the reserve and the unknown association with groundwater the construction of toilet facilities is not recommended.	No cost		PV	DPI		4.2.1.2 (p 23)
Explore the opportunity for construction of a bird hide for bird observers and nature studies groups.	No cost	As needed	PV	DPI	As needed	4.2.1.2 (p23)

5.1.1.3 Rehabilitation, community awareness and education activities

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
Promote the natural and botanic values of the reserve to the wider community:		As soon as possible	PV	DPI	High	4.2.1.3 (p24)
• erect a sign at the Wanganui Road entrance.	$500					
• promotion of field naturalist group activities.	No capital cost	As needed	PV & GVEG	DPI	As needed	4.2.1.3 (p24)
• develop and distribute a flyer or brochure to promote the site to schools, universities, local community groups and government agencies	ℜ		PV & DPI	DPI	Low	4.2.1.3 (p24)
• increased patrolling and enforcement presence.	No capital cost	Fortnightly to monthly	PV	DPI & PV	High	4.2.1.3 4.2.7 (p25)

5.1.1.4 Tracks and Access

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
The formal access track into and around the wetland should be maintained.	$200	As needed	PV	DPI & PV	As needed	4.2.1.4 (p24)
No further tracks should be established in the reserve due to the number of small ones already present.	No capital cost	On-going	PV	DPI	On-going	4.2.1.4 (p24)

5.1.2 Mooroopna Pipeline

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
The section of cleared vegetation traversing the new pipeline alignment should be monitored and maintained for weed growth to prevent further invasion. Particular attention should be given to the inlet access point at the Goulburn River.	No capital cost	Monthly	PV	DPI	On-going	4.2.2 (p24) 5.2.1 (p43)

5.1.3 Water Extraction

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
PV and G-MW to liase with relevant adjoining landholders to explore avenues for alternate supply arrangements.	No capital cost	As soon as possible	PV & G-MW	DPI	High **Complete Nov 2002**	4.2.3 (p24)

5.1.4 Timber Extraction

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
Timber extraction to remain prohibited: • Inclusion of 'timber removal is prohibited' on entrance sign.	Refer 5.1.1.3	On-going	PV	DPI	Medium / On-going	4.2.4 (p24)
Increased monitoring and enforcement presence.	No capital cost	On-going	PV	DPI	On-going	4.2.4 (p24) 4.2.7 (p25)

5.1.5 Rubbish

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
Liase with COGS to explore options to encourage responsible disposal of greenwaste at the refuse disposal facility ie: making disposal of greenwaste free.	No capital cost	As soon as possible	PV & COGS	DPI	Medium	4.2.5 (p25)
Increased monitoring and enforcement (where possible) presence.	$500	Fortnightly	PV	DPI	On-going	4.2.5 (p25)

5.1.6 Community Involvement

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
Establishment of a local committee or 'Friends of Reedy Swamp' group.	No capital cost	As soon as possible	PV & DPI	DPI	Low	4.2.6 (p25)

5.2 Vegetation Management

5.2.1 Pest Plants

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
Noxious weeds within the reserve to be controlled include Patterson's Curse (*Echium plantagineum*).		Immediate / On-going	PV	DPI	High	4.3.1 (p25)
Invasive and controllable species requiring particular attention include: • Willow (*Salix* sp) • Wild mignionette (*Reseda lutela*) • Olives • Water couch (*Paspalum distichum*)	$ variable	Immediate / On-going	PV	DPI	High	4.3.1 (p25)
• Cherry plum	$ variable	Immediate / On-going	GBCMA	DPI	High	4.3.1 (p25)
• Arrowhead (*Sagittaria graminea*)	$ variable		G-MW	PV & DPI	High	4.3.1 (p25)
Eradication of Willows in the wetland: • hand removal of any seedlings (>0.5m) • in-situ poisoning • monitoring and follow up poisoning • plant disturbance or removal is not recommended	$2000	Immediate	PV	DPI	High	4.3.1 (p25)
The introduction or further enhancement of education programs to increase community awareness of the risks and problems associated with will and their introduction to the Australian environment through GBCMA (Waterways), Landcare and FGA.	$ variable	On-going	PV, DPI, GBCMA, Landcare & FGA	DPI	Low	4.3.1 (p25)
Educating nursery owners would prove a beneficial point source to either prevent sale of willows or promote appropriate use of the plant.	$ variable	On-going	PV, DPI & GBCMA	DPI	Low	4.3.1 (p25)
Promote mosaic distribution of Water couch and reduction of wetland organic load through: • reinstatement of wetting and drying • mosaic burning when draw down has promoted drying of the couch • monitoring response	$ variable	On-going	PV	DPI	On-going	4.3.1 (p25)

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
Plants requiring long term management include: Camel Thorn (*Alhagi maurorum*) Aster-weed (*Aster subulatus*) Trifid Burr-marigold (*Bidens tripartita*) Fat Hen (*Chenopodium album*) Fleabane (*Conyza albida*) Drain Flat-sedge (*Cyperus eragrostis*) Willow-leaf Lettuce (*Lactuca slaigna*) Prickly Lettuce (*Lactuca serriola*) Common Pepper-cress (*Lepidium africanum*) Wimmera Rye-grass (*Lolium rigidum*)	$500	On-going	PV	DPI	Medium	4.3.1 (p25)
Plant requiring long term management include: Paradoxical Canary-grass (*Phalaris paradoxa*) Wireweed (*Polygonium aviculare s.*l) Curled Dock (*Rumex crispus*) Broad-leaf Dock (*Rumex obtusifolius ssp*) Black Nightshade (*Solanum nigrum s.l*) Common Sow Thistle (*Sonchus oleraceus*) Cluster Clover (*Trifolium glomeratum*)	$500	On-going	PV	DPI	Medium	4.3.1 (p25)
The prevention of Blue-Green Algal and Azolla blooms through monitoring and controlled releases of drainage water into Reedy Swamp.	ℜ	On-going	PV, DPI	G-MW	On-going	4.3.1 (p25)
Development of a response plan to be implemented in the event of Blue-Green Algal bloom.	ℜ	As soon as possible	PV & G-MW	DPI	Medium	4.3.1 (p25)

5.2.2 Threatened Species Management

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
Monitoring and protection of Jericho Wiregrass *(Aristida jerichoensis*).	No capital cost	On-going	PV & DSE	DPI	On-going	4.3.2 (p28)

5.2.3 Giant Rush Community

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting	Priority	Section Reference
Promote the mosaic habitat of Giant Rush (*Juncus ingens*) but avoid creating a monoculture of the species through: • reinstating wetting and drying regime. • controlled burning during late autumn to early summer in a mosaic fashion.	ℜ ↑ ~$1070	Annual As required	PV & DPI	DPI	On-going	4.3.3 (p28)
On-going assessment of the strategy through monitoring the response of the community.	ℜ	On-going	PV & DPI	DPI	On-going	4.3.3 (p28)

5.2.4 Soil Disturbance

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
Minimise the level of disturbance to the sand dunes from sand extraction and motorcycle riding: • erection of a sign identifying restricted access to the area. • obstruct access to discourage vehicular access.	$500 ℜ	As soon as possible	PV	DPI	Medium	4.3.4 (p28)
Assessment of the need to establish barricading around the base of the sand dune to deter motorcycle access to the sand dune.	No capital cost	As required	PV	DPI	Low	4.3.4 (p28)

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
Encourage the regeneration of indigenous vegetation on the sand dune near the Wanganui Road entrance to the reserve through: • the erection of a sign near the Wanganui Road entrance detailing the destructive nature of bardi-grubbing and requesting the public's • cooperation in preserving this valuable site.	$ 500	As soon as possible	PV	DPI	Medium	4.3.4 (p28)
consideration given to fencing the site if further action is required.	No capital cost	As required	PV	DPI	Low	4.3.4 (p28)
Increased monitoring and enforcement presence.	No capital cost	Fortnightly / Monthly	PV	DPI	High	4.3.4 (p28) 4.2.7 (p25)

5.2.5 Tree Health

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
Promote the health of River Red Gums (*Eucalyptus camaldulensis*) surrounding the rim of the wetland.	ℜ ℑ	Annual / On-going	PV	DPI	On-going	4.3.5 (p29)

5.2.6 Grazing

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
Grazing of the wetland and reserve to remain prohibited.	No capital cost	On-going	PV	PV & DPI	On-going	4.3.6 (p29)
Increased monitoring and enforcement presence.	No capital cost	Fortnightly / Monthly	PV	DPI	High	4.3.6 (p29) 4.2.7 (p25)

5.2.7 Revegetation

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
Revegetation of the northern sand dune is recommended, in low densities, with the following species: Yellow Box (*Eucalyptus melliodora*) Grey Box (*Eucalyptus microcarpa*) Lightwood (*Acacia implexa*) Silver Wattle (*Acacia dealbata*) Common Fringe-myrtle (*Calytrix tetragona*) Common Eutaxia (*Eutaxia microphylla*)	$600	As soon as possible	PV & DPI	DPI	Low	4.3.7 (p29)
Further revegetation of the reserve of wetland area is not recommended.	No capital cost	As required	PV	DPI	Low	4.3.7 (p29)

5.2.8 Fire Management

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
The on-going maintenance of fire break and access tracks is necessary	$200	Annually	PV	DPI	Low	4.3.8 (p30)

5.3 Wildlife Management

5.3.1 Waterbirds

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
Seasonal assessment of waterbird utilisation of Reedy Swamp for habitat, breeding and attempt to provide suitable water regime for successful fledging (provided that this does not conflict with habitat maintenance or that the significance of the breeding attempt is warranted).	$200	Annually	PV & DSE	DPI	Medium	4.4.1 (p30)

5.3.2 Pest Animals

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
Encourage on-going fox, hare a cat control throughout the Wildlife Reserve and neighbouring districts, especially prior to waterbird breeding season (spring and early summer). Fox control is to be actively managed through:						
• implementing a targeted Fox-off baiting program	$500	Annual / Seasonal	PV	DPI	On-going	4.4.2 (p30)
• implementing a cat control program	ℜ	Annual / Seasonal	PV, COGS, FGA	DPI	On-going	4.4.2 (p30)
• encouraging appropriately managed community fox drives and cat caging programs	$500	Annual / Seasonal	PV & FGA	DPI	On-going	4.4.2 (p30)

5.3.3 Threatened Wildlife Management

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
Encourage research by universities, educational institutions and other departments regarding the requirements of significant waterbird species.	No capital cost	On-going	PV, GBCMA & DPI	DPI	Low	4.4.3 (p31)
Maintain a pro-active management approach, which enable reactive response to any situation eg: closing of reserve during duck season if a breeding attempt occurs.	No capital cost	Annually	PV	DPI	On-going	4.4.3 (p31)

5.4 Salinity and Nutrients

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
The control or mitigation of increasing nutrient and salinity problems associated with contributions from Drain No.3 through: • On-going assessment of the progress of the Catchment Strategy in addressing salinity and nutrients issues related to Reedy Swamp Wildlife Reserve.	$30 000	Annually	PV, GBCMA, SIR IC, DPI & G-MW	DPI	On-going	4.5 (p31)
• Consideration of the development of a sub-catchment draft management plan to: - accelerate programs of the current Catchment Strategy - promote already existing government incentives/programs - identify potential new programs - enhance education programs.	$30 000	As needed	GBCMA, PV, DPI & SIRIC	DPI	As needed	4.5 (p31)
• Increased monitoring of water quality in Drain No.3 during delivery periods: - monitor salinities before closing inlet regulating structure - monitor salinities during delivery - assess requirement to delay water deliver if Drain No. 3 flows are in excess of 1000 EC ie: dependant of season, volume and quality of water in wetland	$ variable	As needed	PV & DPI	DPI	On-going	4.5 (p31)
• Assessment of nutrient conditions and characteristics to create a benchmark for management of phosphorus and nitrogen	ℜ					
• Increased monitoring of water quality in Reedy Swamp during dry periods: - if >1000EC the regional committee should convene to discuss ecological requirements of the system and options for management - consider the topping up or flushing the wetland with drainage water or EWA if internal wetland salinities rise above 1000 EC	$variable ℑ	As needed	PV & DPI	DPI	On-going	4.5 (p31)
Monitoring/assessment of salinity and nutrient concentrations in Reedy Swamp and Drain No.3 should continue or be included as part of the Mandatory Environmental Monitoring Program. This may involve	$10 000	Quarterly	DPI	DPI	On-going	4.5 (p31)

promotion/facilitation of better utilisation of available water quality resources ie: attempt to compile all available data into one entity.						
Investigate the status and operational guidelines of the re-use outfall drain into the Reedy Swamp Wildlife Reserve and assess action required based on its outcomes.	No capital cost	As soon as possible	PV, DPI & G-MW	DPI	High	4.5 (p31)

5.5 Groundwater

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
Determine the impact of groundwater on the wetland : • Install observation bores: - on western margin of wetland to monitor groundwater flow and interaction between groundwater, Reedy Swamp and the Goulburn River. - north of the wetland to monitor groundwater levels. • Assess the ability to install and monitor nested bores in the wetland to monitor vertical groundwater gradients. - consider install a gauge board to monitor water depth.	 ~$750 ~$750 ℜ	 As soon as possible As soon as possible As soon as possible	 PV & G-MW PV & G-MW PV & G-MW	 DPI DPI DPI	 Medium Medium Medium	4.6 (p32) 4.6 (p32)
All observation bores should be monitored regularly and surveyed to AHD.	ℜ	As required	G-MW & DPI	DPI	Medium	4.6 (p32)

5.6 Powerlines

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
Explore the potential to install visual aids, such as large bright orange balls, to the powerlines to allow the birds to identify them in their flight path.	ℜ	As soon as possible	PV & Origin Energy	DPI	Medium	4.7 (p33)
Consider the potential for underground cabling of powerlines in conjunction with the construction of the proposed Shepparton Bypass.	ℜ	As needed	PV, Origin Energy & Vic Roads	DPI	Medium	4.7 (p33)

5.7 Flood Regime

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
Over the short term, there is a strong need to establish a regular annual cycle of flooding and drawdown to maintain River Red Gum and seasonal wetland species around the fringe of the swamp, and to reduce the dominance of Water Couch and Willows. Occasional complete drying of the wetland is necessary to encourage the regeneration of rushland in the central area of the wetland and to allow organic decomposition and nutrient recycling and reduced potential for mosquito breeding. • Open gate on inflow control structure and make sure outlet structure is free of obstructions during mid to late spring to allow for draw down and drying of the main wetland area by mid/late summer (January). • Maintain the site dry with inlet and outlet gates remaining open over summer to early/mid autumn (February to May) in most years. • Close the inlet and outlet structures to allow for a late autumn, winter/spring flooding from river and before channel and drain flows commence (May 15th). • Flooding period should extend approximately 6-9 months in duration in most years to a depth of 0.5–1.0m. • Maintain flooded status to near full supply level through winter spring (June to November).	$ variable ℑ	Annual	PV & DPI	On advice from DPI	High	4.8 (p33)
Aim to have a complete dry (December – March) 3 years out of every 10.	No capital cost	3 out of 10 years	PV & DPI	On advice from DPI	High	4.8 (p33)
Aim to have significant draw down or significant drying 4 years out of every 10.	No capital cost	4 out of 10 years	PV & DPI	On advice from DPI	High	4.8 (p33)
Aim to have the wetland flooded continuously between yearly flood events at least 3 occasions in every 10 year period.	ℑ	5 – 10 years	PV & DPI	On advice from DPI	High	4.8 (p33)
Utilisation of PISC forum to allocated distribution of environmental water to wetlands in the SIR. Expansion of the forum to include PV and other relevant stakeholders when appropriate to this topic.	ℜ	Annual	PV, DPI, G-MW, GBCMA, FGA & Stakeholders	PV & DPI	On-going	4.8 (p33)

5.7.1 Regulating Structure Management

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
Secure ability to control water inflows from Drain No.3 by: • upgrade of the inlet regulating structure on Drain No 3 to an under shot gate with a screw down lockable gate.(screw down locked gate). • key is to be held only by G-MW, to be operated under the direction of PV under advise from DPI and in consultation with identified stakeholders.	$5800	Immediate	PV, G-MW & SIR IC	DPI	High **Complete July 2003 (50% cost share G-MW & SIRIC**	4.8.1 (p34)
Develop an operational agreement between governing management of both the inlet and outlet regulating structures.	$200	As soon as possible	PV, DPI & G-MW	DPI	High **Complete May 2003**	4.8.1 (p.34)
Secure ability to maintain water level in wetland by: • upgrade of the outlet regulating structure on North Creek to an undershot gate with a screw down lockable gate. • key is to be held only by PV, to be operated on advice from DPI and in consultation with identified stakeholders.	$10000	Immediate	PV & FGA	DPI	High	4.8.1 (p34)
Increased vigilance in monitoring both regulating structures particularly during summer or dry periods.	ℜ	On-going	G-MW, PV & FGA	DPI	On-going	4.8.1 (p34) 4.2.7 (p25)
Attempt to alleviate vandalism pressure on the inlet and outlet regulating structures: • maintain sign at the inlet regulating structure identifying its purpose to educate the public as to its operational value and discourage further vandalism.	~$400	As soon as possible.	PV	DPI	On-going	4.8.1 (p34)
• install and maintain a sign at the outlet regulating structure explaining its purpose to educate the public as to its operational value and discourage vandalism.	~$400	As soon as possible	PV	DPI	Medium / On-going	4.8.1 (p34)
• news releases informing the public when structures are going to be operated and for what purposes (as determined by flood regime guidelines).	$ variable	As required	PV	DPI	As needed **EWA delivery 2002/2003**	4.8.1 (p34)

5.8 Surface Water Management

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
Development of operational guidelines for proposed weir pool or any structure on Drain No.3 to ensure security of EWA delivery.	ℜ	As needed	G-MW & PV	DPI	Medium	4.9 (p34)
Modification of existing diversion agreements with landholder(s) who divert from Drain No.3 to ensure that EWA deliver via the channel and drainage network is not compromised by diversion.	ℜ	As needed	G-MW	DPI & PV	Medium	4.9 (p34)

5.9 Environmental Water Allocation

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
Formalise a share of Environmental Water Allocation to supply a minimum of 650 ML and up to 1300 ML. To be delivered in accordance with requirement of sections 4.6 and 3.?.	ℜ ℑ	As soon as possible. To be used as needed	PV, GBCMA, DPI & G-MW	DPI	High / On-going	4.10 (p35) 4.8 (p33)
Delivery of EWA via the East Goulburn channel system: • cumulative delivery.	~$195000	As needed	PV, GBCMA, DPI & G-MW	DPI	On-going	4.10 (p35)
Ensure security and efficiency of delivery of EWA: • modification of existing diversion agreements with landholder(s) that divert from Drain No.3 to ensure that EWA delivery via the channel and drainage network is not compromised by diversion. • inform all diversion customers of EWA delivery and restriction on diversions. - monitoring of outfall and diversion sites during delivery.	ℜ ℜ	As needed As needed	G-MW	PV & DPI	High On-going / As needed	4.10 (p35)

• automatic shut down of EWA delivery is a rainfall event the equivalent to the maximum capacity of the drain occurs.	No capital cost	As needed	G-MW & PV	DPI	As needed	4.10 (p35)
• cease or delay EWA delivery should evaporation rates be in excess of the delivery rates.	No capital cost	As needed	G-MW & PV	DPI	As needed	4.10 (p35)
• monitoring of both inlet and outlet structures during EWA delivery period. - every second day including weekends.	ℜ	As needed	G-MW & PV	DPI	As needed	4.10 (p35)

5.10 Monitoring and Implementation of Wetland Management

5.10.1 Effectiveness of Existing Monitoring Programs

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
Continuation of the existing mandatory monitoring program: • refine monitoring process to ensure accurate and consistent data collection. • data is recorded and disseminated effectively ie: made accessible on a catchment scale. • consider expansion or modification of program to include an exclusive wetland monitoring component.	ℜ	As soon as possible	DPI	DPI	High	4.11.1 (p36)
The amalgamation of all existing data / information from previous and current programs into one entity which can be accessed on a catchment basis and particularly by the land manager.	ℜ	As soon as possible	DPI	DPI	High	4.11.1 (p36)

5.10.2 Monitoring and Effectiveness of Management Programs

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
Develop a regional monitoring program for wetlands to monitor the success of implemented strategies.		As soon as possible	DPI & GBCMA		Medium	4.11 (p36)
Develop an interim monitoring program for Reedy Swamp Wildlife Reserve, which could be incorporated into a regional wetlands monitoring program, to allow for adaptive management. The program should consider monitoring of the following attributes:						4.11 (p36)
• population status and distribution of rare and threatened plant species		Annual	PV, DPI & DSE	DPI	On-going	4.11.2 (p36)
• population status and distribution of potential weed species		Annual	PV & DPI	DPI	On-going	4.11.2 (p36)
• weed invasion patterns and impacts		On-going	PV	DPI	On-going	4.11.2 (p36)
• localised groundwater levels and interactions		Annual / Seasonal	PV, DPI & G-MW	DPI	On-going	4.11.2 (p36) 4.6 (p32)
• drainage patterns and impacts		On-going	PV, DPI & G-MW	DPI	On-going	4.11.2 (p36) 4.8 (p33) 4.9 (p34)
• river regulation patterns and impacts		On-going / Seasonal	PV, DPI & G-MW	DPI	On-going	4.11.2 (p36) 4.8 (p33)
• Water quality (salinity and nutrients) – both in the wetland and of drainage inflows		On-going / Seasonal	PV & DPI	DPI	On-going	4.11.2 (p36)

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
The monitoring program should include the following key indicator species as a method of assessing short term conditions/trends and strategy effectiveness and allow for management adaptations: • River Red Gum health • Giant Rush community • Spike-sedge community • Willows • Patterson's Curse • Water Couch • Azolla • Blue-Green Algae • Arrowhead • Colonial nesting waterbirds • White-Bellied Sea Eagles • General waterbird breeding and utilisation	ℜ	On-going	DPI	DPI	On-going	4.11.2 (p36)

5.11 Ecological Research and Surveys

To achieve best environmental outcomes for Reedy Swamp Wildlife Reserve, an adequate understanding of the ecology and conservation status of resident, seasonal, nomadic and migratory species is required. The co-ordination or implementation of such programs however, is presently beyond the scope of PV. Many of the programs outlined below would make ideal projects for tertiary students in the fields of ecology, biology or natural resource management, and research institutions.

5.11.1 Co-ordination of Ecological Research and Surveys

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
Send letters to all relevant institutions informing them of opportunities that exist in the SIR. The following topics relate to Reedy Swamp Wildlife Reserve:	No capital cost	As appropriate	PV, SIR IC	DPI	On-going	None

Action	Estimated Cost 2002	Frequency	Responsibility	Supporting Authority	Priority	Section Reference
• Vegetation mapping and description - determine the populations status and distribution of significant plant taxa. - determine the ecological requirements and appropriate management regime for rare/particular plant taxa eg: Giant Rush. - monitor the response of aquatic vegetation to controlled watering regimes. • Studies of the faunal composition of Reedy Swamp Wildlife Reserve - determine the populations status and distribution of significant fauna within the reserve and wetland. - determine the population status, ecological requirements and appropriate management regime for waterbird species eg: Great Egret. • Study the physicochemical relationships between wetland water quality and drainage supply. • Wetland productivity and its relationship with controlled watering regimes and water quality.						

ℵ Steering Committee costs will be dependent on frequency required, issues to be resolved, site inspection required etc.

ℑ May be EWA inclusive.

ℜ Not determined.

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Appendix 1: Flora of Reedy Swamp

Note: * Introduced Species
r - rare

Species (scientific name)	Common name	
Agrostis avenacea var. *avenacea*	Common Blown-grass	
Agrostis avenacea	Common Blown-grass	
Alhagi maurorum	Camel Thorn	*
Alternanthera denticulata-nodiflora group		
Alisma plantago-aquatica	Water Plantain	
Aristida jerichoensis var. *subspinilifera*	Jericho Wire Grass	r
Aster subulatus	Aster-weed	*
Austrodanthonia duttoniana	Brown-back Wallaby-grass	
Austrodanthonia caespitosa	Common Wallaby-grass	
Austrodanthonia duttoniana	Brown-back Wallaby-grass	
Austrodanthonia setacea	Bristly Wallaby-grass	
Austrostipa scabra spp. *falcata*	Rough Spear Grass	
Azolla filiculoides	Pacific Azolla	
Bidens tripartita	Trifid Burr-marigold	*
Briza minor	Lesser Quaking-grass	
Calotis scapigera	Tufted Burr-daisy	
Carex inversa	Common Sedge	
Carex tereticaulis	Rush Sedge	
Centaurium tenuiflorum	Branched Centaury	
Centipeda cunninghamii	Common Sneezeweed	
Chenopodium album	Fat Hen	*
Conyza albida	Fleabane	*
Craspedia paludicola	Swamp Billy-buttons	
Cynodon dactylon	Couch	
Cyperus eragrostis	Drain Flat-sedge	*
Deyeuxia quadriseta	Reed Bent-grass	
Deyeuxia rodwayi	Tasman Bent Grass	
Dichondra repens	Kidney-weed	
Digitaria sanguinalis	Summer Grass	
Dillwynia cinerascens	Grey Parrot-pea	
Echinocloa crus galli	Common Barnyard Grass	*
Eleocharis acuta	Common Spike-sedge	
Eleocharis pusilla	Small Spike-sedge	
Elymus scaber	Common Wheat Grass	
Epilobium billardierianum ssp. *cinereum*	Grey Willow-herb	
Epilobium ciliatum	Glandular Willow-herb	
Eryngium ovinum	Blue Devil	
Eucalyptus camaldulensis	River Red-gum	
Eucalyptus microcarpa	Grey Box	
Goodenia gracilis	Slender Goodenia	
Hemarthria uncinata var. *uncinata*	Mat Grass	
Hypochoeris radicata	Cat's Ear	
Juncus amabilis	Hollow Rush	
Juncus bufonius	Toad Rush	
Juncus flavidus	Yellow Rush	
Juncus holoschoenus	Jointed Leaf Rush.	
Juncus ingens	Giant Rush	
Juncus sarophorus	Broom Rush	
Lactuca saligna	Willow-leaf Lettuce	*
Lactuca serriola	Prickly Lettuce	*
Lemna dispersa	Common Duckweed	
Leontodon taraxacoides	Hairy Hawkbit	*
Lepidium africanum	Common Pepper-cress	*

Linum marginale	Native Flax	
Lolium rigidum	Wimmera Rye-grass	*
Ludwigia	Water Primrose	
Ludwidgia peploides ssp. *Montevidensis*	Clove Strip	
Lythrum hyssopifolia	Small Loosestrife	
Marsilea costulifera	Narrow-leaf Nardoo	
Myriophylum spp.	Water Milfoil	
Oxalis perennans	Grassland Wood-sorrel	
Paspalum distichum	Water Couch	*
Paspalum dilatatum	Paspalum	*
Persicaria decipiens	Slender Knotweed	
Persicaria hydropiper	Water-pepper	
Persicaria prostrata	Creeping Knotweed	
Phalaris paradoxa	Paradoxical Canary-grass	*
Poa labillardierei	Common Tussock-grass	
Polygonum arenastrum	Wireweed	*
Polygonium aviculare s.l.	Prostrate Knotweed	
Pseudognaphalium luteoalbum	Jersey cudweed	
Ranunculus lappaceus	Australian Buttercup	
Ranunculus scelaeratus	Celery Buttercup	
Romulea rosea	Onion Grass	*
Rorippa nasturtium	Water Cress	
Rumex brownii	Slender Dock	
Rumex crispus	Curled Dock	*
Rumex obtusifolius ssp. *obtusifolius*	Broad-leaf Dock	*
Salix spp.	Willow	*
Setaria jubiflora	Warrego Summer-grass	
Solanum nigrum s.l.	Black Nightshade	*
Solenogyne dominii	Smooth Solenogyne	
Sonchus oleraceus	Common Sow-thistle	*
Spirodela punctata	Thin Duckweed	
Trifolium glomeratum	Cluster Clover	*
Triglochin multifractum	Water-ribbons	
Typha domingensis	Cumbungi	
Ulricularia australis	Yellow Bladderwort	
Verbena officinalis s.l.	Common Verbena	
Wahlenbergia fluminalis	River Bluebell	
Wahlenbergia gracilis s.l.	Sprawling Bluebell	

Appendix 2: Fauna of Reedy Swamp

Note:

(CST) Conservation Status in Victoria

CEn	Critically Endangered
End	Endangered
Vul	Vulnerable
R/R	Rare
LR	Lower Risk Near Threatened
R/C	Restricted colonial, breeding or roosting sites
Ins	Insufficiently known, suspected of being in one of the above categories
Ext	Extinct
*	Alien
Cmp	Comprising several taxa
Ssp	Sub-species

FFG Status under the Flora and Fauna Guarantee Act

L	Listed under FFG
T	Listed as a threatening process

HDP Dependence upon tree hollows

T	Total Dependence
P	Partial Dependence

INT Species listed on international Treaty

C	China Australia Migratory Bird Agreement
J	Japan Australia Migratory Bird Agreement

NOTE: This species list includes some species observed in the general area of Reedy Swamp and although some species may appear on the list, they may not have been recorded within the swamp. For example, due to the elimination of natural flooding from the Goulburn River, Murray Cod and Silver Perch are unlikely to be present.

CST	FFG	HDP	INT	Species	
Ins				Brown Quail	*Coturnix australis*
				Peaceful Dove	*Geopelia striata*
				Crested Pigeon	*Ocyphaps lophotes*
				Buff-banded Rail	*Gallirallus philippensis*
				Australian Spotted Crake	*Porzana fluminea*
Vul	L			Baillon's Crake	*Porzana pusilla*
				Black-tailed Native-hen	*Gallinula ventratis*
				Dusky Moorhen	*Gallinula tenebrosa*
				Purple Swamphen	*Porphyrio porphyrio*
				Eurasian Coot	*Fulica atra*
				Great Crested Grebe	*Podiceps cristatus*
				Australasian Grebe	*Tachybaptus novaehollandiae*
				Hoary-headed Grebe	*Potiocephalus potiocephalus*
				Great Cormorant	*Phalacrocorax carbo*
				Little Black Cormorant	*Phalacrocorax sulcirostris*
LR				Pied Cormorant	*Phalacrocorax varius*
				Little Pied Cormorant	*Phalacrocorax melanoleucos*
				Darter	*Anhinga melanogaster*
				Australian Pelican	*Pelecanus conspicillatus*
				Silver Gull	*Larus novaehollandiae*
				Red-kneed Dotterel	*Erythrogonys cinctus*
				Masked Lapwing	*Vanellus miles*
				Black-fronted Dotterel	*Elseyornis melanops*
				Black-winged Stilt	*Himantopus himantopus*
			CJ	Marsh Sandpiper	*Tringa stagnatilis*
			CJ	Sharp-tailed Sandpiper	*Calidris acuminata*
LR			CJ	Latham's Snipe	*Gallinago hardwickii*
End	L			Bush Stone-curlew	*Burhinus grallarius*
LR			C	Glossy Ibis	*Plegadis falcinellus*
				Australian White Ibis	*Threskiornis molucca*
				Straw-necked Ibis	*Threskiornis spinicollis*
Vul				Royal Spoonbill	*Platalea regia*
				Yellow-billed Spoonbill	*Platalea flavipes*
End	L			Little Egret	*Egretta garzetta*
CEn	L			Intermediate Egret	*Ardea intermedia*
Vul	L		CJ	Great Egret	*Ardea alba*

				White-faced Heron	*Egretta novaehollandiae*
				White-necked Heron	*Ardea pacifica*
LR				Nankeen Night Heron	*Nycticorax caledonicus*
End	L			Little Bittern	*Ixobrychus minutus*
Vul				Magpie Goose	*Anseranas semipalmata*
	T			Australian Wood Duck	*Chenonetta jubata*
				Black Swan	*Cygnus atratus*
	T			Australian Shelduck	*Tadorna tadormoides*
				Pacific Black Duck	*Anas superciliosa*
		T		Chestnut Teal	*Anas castanea*
		T		Grey Teal	*Anas gracilis*
Vul				Australasian Shoveler	*Anas rhynchotis*
		P		Pink-eared Duck	*Malacorhynchus membranaceus*
End	L			Freckled Duck	*Stictonetta naevosa*
Vul				Hardhead	*Aythya australis*
End	L			Blue-billed Duck	*Oxyura australis*
Vul				Musk Duck	*Biziura lobata*
				Swamp Harrier	*Circus approximans*
				Brown Goshawk	*Accipiter fasciatus*
				Collared Sparrowhawk	*Accipiter cirrhocephatus*
Vul	L		C	White-bellied Sea-Eagle	*Haliaeetus leucogaster*
				Whistling Kite	*Haliastur sphenurus*
				Stack-shouldered Kite	*Elanus axillaris*
		P		Peregrine Falcon	*Falco peregrinus*
				Brown Falcon	*Falco berigora*
		P		Nankeen Kestrel	*Falco cenchroldes*
		T		Southern Boobook	*Ninox novaeseelandiae*
End	L	T		Barking Owl	*Ninox connivens*
Vul	L	T		Powerful owl	*Ninox strenua*
		T		Rainbow Lorikeet	*Trichoglossus haematodus*
		T		Musk Lorikeet	*Glossopsitta concinna*
		T		Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*
		T		Little Lorikeet	*Glossopsitta pusilla*
		T		Sulphur-crested Cockatoo	*Cacatua galerita*
		T		Little Corella	*Cacatua sanquinea*
		T		Long-billed Corella	*Cacatua tenuirostris*
		T		Galah	*Cacatua roseicapilla*
		T		Cockatiel	*Nymphicus hollandicus*
		T		Crimson Rosella	*Platycercus elegans*
		T		Yellow Rosetta	*Platycercus elegans flaveolus*
		T		Eastern Rosella	*Platycercus eximius*
		T		Red-rumped Parrot	*Psephotus haematonotus*
LR	L	P		Turquoise Parrot	*Neophema pulchella*
End	L	T		Swift Parrot	*Lathamus discolor*
				Tawny Frogmouth	*Podargus strigoides*
		T		Dollarbird	*Eurystomus orientalis*
				Azure Kingfisher	*Alcedo azurea*
		T		Laughing Kookaburra	*Dacelo novaegulneae*
		P		Sacred Kingfisher	*Todiramphus sanctus*
				Rainbow Bee-eater	*Merops ornatus*
			CJ	Fork-tailed Swift	*Apus pacificus*
				Pallid Cuckoo	*Cuculus pallidus*
				Fan-tailed Cuckoo	*Cacomantis flabelliformis*
				Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*
		P		Welcome Swallow	*Hirundo neoxena*
		T		Tree Martin	*Hirundo nigricans*
		P		Fairy Martin	*Hirundo ariel*
				Grey Fantail	*Rhipidura fuliginosa*
				Willie Wagtail	*Rhipidura leucophrys*
				Restless Flycatcher	*Myiagra inquieta*
				Scarlet Robin	*Petroica multicolor*
				Pink Robin	*Petroica rodinogaster*
				Rose Robin	*Petroica rosea*
				Golden Whistler	*Pachycephala pectoralis*
				Rufous Whistler	*Pachycephala rufiventris*
		P		Grey Shrike-thrush	*Colluricincla harmonica*
				Magpie-Lark	*Grallina cyanoleuca*
				Crested Shrike-tit	*Falcunculus frontatus*
				Black-faced Cuckoo-shrike	*Coracina novaehollandiae*
				White-winged Triller	*Lalage sueurii*
End	L			Grey-crowned Babbler	*Pomatostomus temporalis*
				White-throated Gerygone	*Gerygone olivacea*
				Western Gerygone	*Gerygone fusca*
				Weebill	*Smicrornis brevirostris*
				Striated Thornbill	*Acanthiza lineata*
				Yellow Thornbill	*Acanthiza nana*
				Buff-rumped Thornbill	*Acanthiza reguloides*
				Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*

Vul	L		Speckled Warbler	*Chthonicola sagittata*
			Rufous Songlark	*Cincloramphus mathewsi*
			Little Grassbird	*Megalurus gramineus*
			Clamorous Reed Warbler	*Acrocephalus stentoreus*
			Superb Fairy-wren	*Malurus cyaneus*
			White-breasted Woodswallow	*Artamus leucorynchus*
			Masked Woodswallow	*Artamus personatus*
		P	Dusky Woodswallow	*Artamus cyanopterus*
			Varied Sittella	*Daphoenositta chrysoptera*
		T	Brown Treecreeper	*Climacteris picumnus*
		T	White-throated Treecreeper	*Cormobates leucophaeus*
			Mistletoebird	*Dicaeum hirundinaceum*
			Spotted Pardalote	*Pardalotus punctatus*
			Black-chinned Honeyeater	*Melithreptus gularis*
			Eastern Spinebill	*Acanthorhynchus tenuirostris*
Vul	L		Painted Honeyeater	*Grantiella picta*
			Yellow-faced Honeyeater	*Lichenostomus chrysops*
			White-plumed Honeyeater	*Lichenostomus penicillatus*
			Noisy Miner	*Manorina melanocephala*
			Red Wattlebird	*Anthochaera carunculata*
			Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*
			Noisy Friarbird	*Philemon corniculatus*
			Little Friarbird	*Philemon citreogularis*
			Red-browed Finch	*Neochmia temporalis*
			Olive-backed oriole	*Oriolus sagittatus*
			White-winged Chough	*Corcorax melanorhamphos*
			Pied Currawong	*Strepera graculina*
			Australian Magpie	*Gymnorhina tibicen*
			Australian Raven	*Corvus coronoides*
			Mallard	*Anas platyrhynchos*
			Little Raven	*Corvus mellori*
		P	Striated Pardalote	*Pardalotus striatus*
*			Common Blackbird	*Turdus merula*
*			House Sparrow	*Passer domesticus*
*			European Goldfinch	*Carduells carduelis*
*		P	Common Starling	*Sturnus vulgaris*
			Platypus	*Ornithorhynchus anatinus*
			Short-beaked Echidna	*Tachyglossus aculeatus*
			Yellow-footed Antechinus	*Antechinus flavipes*
		T	Common Brushtail Possum	*Trichosurus vulpecula*
End	L	T	Squirrel Glider	*Petaurus norfolcensis*
		T	Sugar Glider	*Petaurus breviceps*
		T	Feathertail Glider	*Acrobates pygmaeus*
			Koala	*Phascolarctos cinereus*
			Common Wombat	*Vombatus ursinus*
			Black Wallaby	*Wallabia bicolor*
			Eastern Grey Kangaroo	*Macropus giganteus*
			Little Red Flying-fox	*Pteropus scapulatus*
		T	White-striped Freetail Bat	*Tadarida australis*
		T	Southern Forest Bat	*Vespadelus regulus*
		T	Little Forest Bat	*Vespadelus vulturnus*
		T	Gould's Wattled Bat	*Chalinolobus gouldii*
		T	Inland Broad-nosed Bat	*Scotorepens balstoni*
		T	Large Forest Bat	*Vespadelus darlingtoni*
*			Black Rat	*Rattus rattus*
*			House Mouse	*Mus musculus*
			Water Rat	*Hydromys chrysogaster*
*			European Rabbit	*Oryctolagus cuniculus*
*			Brown Hare	*Lepus capensis*
*	T		Red Fox	*Canis vulpes*
*			Dog	*Canis familaris*
			Common Long-necked Tortoise	*Chelodina longicollis*
			Murray River Tortoise	*Emydura macquarii*
		P	Marbled Gecko	*PhyllodactyLus marmoratus*
			Olive Legless Lizard	*Delma inornata*
Vul		P	Tree Goanna	*Varanus varius*
			Garden Skink	*Lampropholis guichenoti*
			Gray’s Blind Snake	*Ramphotyphlops nigrescens*
			Tiger Snake	*Notechis scutatus*
			Yellow-bellied Water Skink	*Euamprus heatwolei* (WTF)
			Southern Bullfrog (ssp. unknown)	*Limnodynastes dumerilii*
			Spotted Marsh Frog (race unknown)	*Limnodynastes tasmaniensis*
			Bibron's Toadlet	*Pseudophryne bibronii*
			Plains Froglet	*Crinia parinsignifera*
			Common Froglet	*Crinia signifera*
			Stoane's Froglet	*Crinia sloanei*
			Plains Brown Tree Frog	*Litoria paraewingi*
		P	Peron's Tree Frog	*Litoria peronii*

Vul		Warty Bell Frog	*Litoria raniformis*
Ins		Flat-headed Galaxias	*Galaxias rostratus*
Ins	L	Crimson-spotted Rainbowfish	*Melanotaenia fluviatilis*
End	L	Murray Cod	*Maccullochella peelii peelii*
Vul		Golden Perch	*Macquaria ambiqua*
CEn	L	Silver Perch	*Bidyanus bidyanus*
Cmp		Carp Gudgeon (1 species)	*Hypseleotris* sp.

* The final fauna species list is compiled from site specific and surrounding area searches.

Appendix 3: Reedy Swamp Volume Determination

Area of Reedy Swamp = 130 **ha** Maximum depth = 1.0 m
Average depth = 0.5 m

As 1 ha = 100 x 100 = 10,000m^2

Then 130 ha = 1,300,000 m^2 @ 1.0 m maximum depth x 0.5 m

= 650,000 m^3

= 65**0 ML** (as 1 ML = 1,000 m^3)

Hence:
Maximum volume = 650 ML
Average volume = 325 ML

Therefore, loss via evaporation is calculated as follows (assuming the wetland is full):

Evaporation (eg: 7mm/d) x 1m^2 x 1,300,000m^2 = 0.007m^3 x 130x$10^4$$m^2$

= 7L/m^2/d x 130x$10^4$$m^2$ (where 1 m^3 = 100 L)

= 9100000 L/d

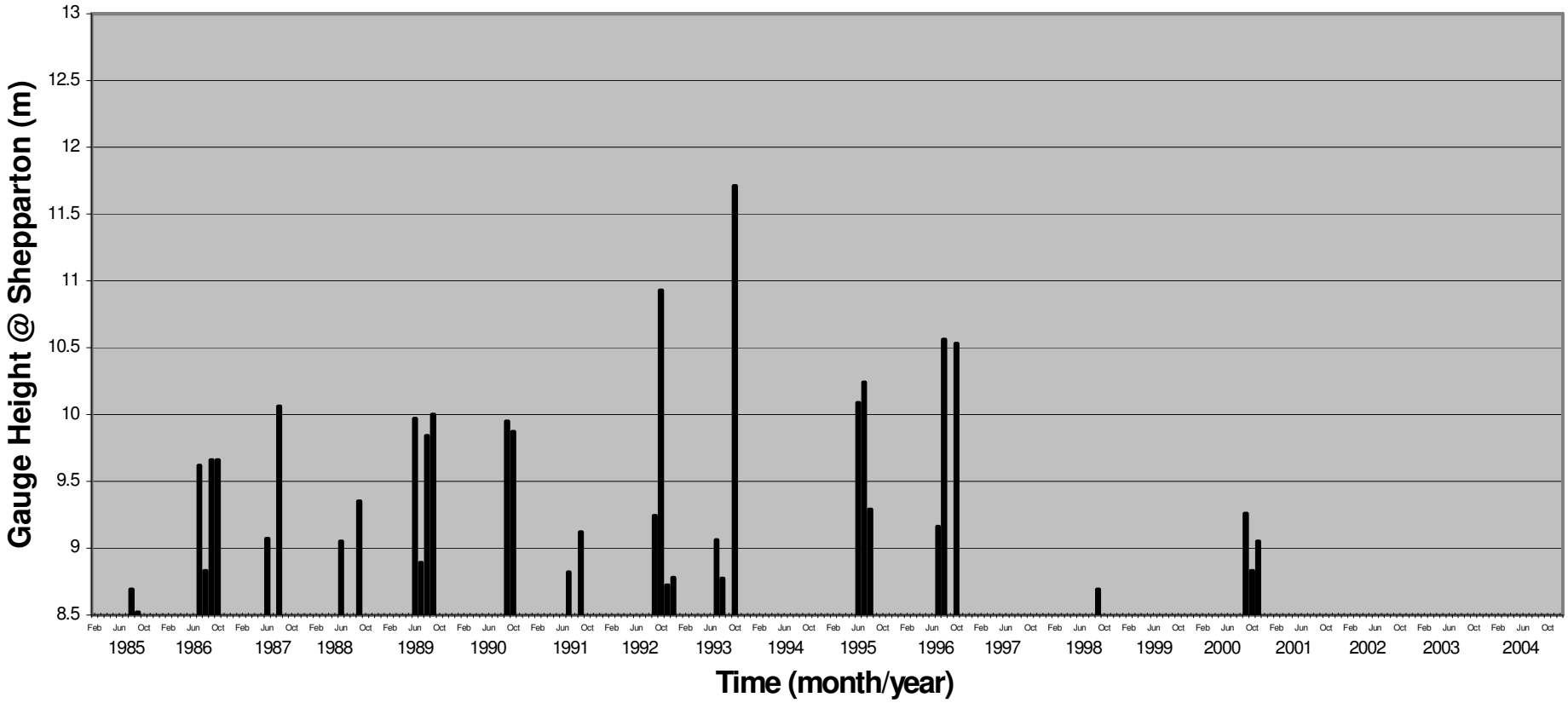
= 9.1ML/d

Average monthly and daily evaporation losses from Reedy Swamp [3].

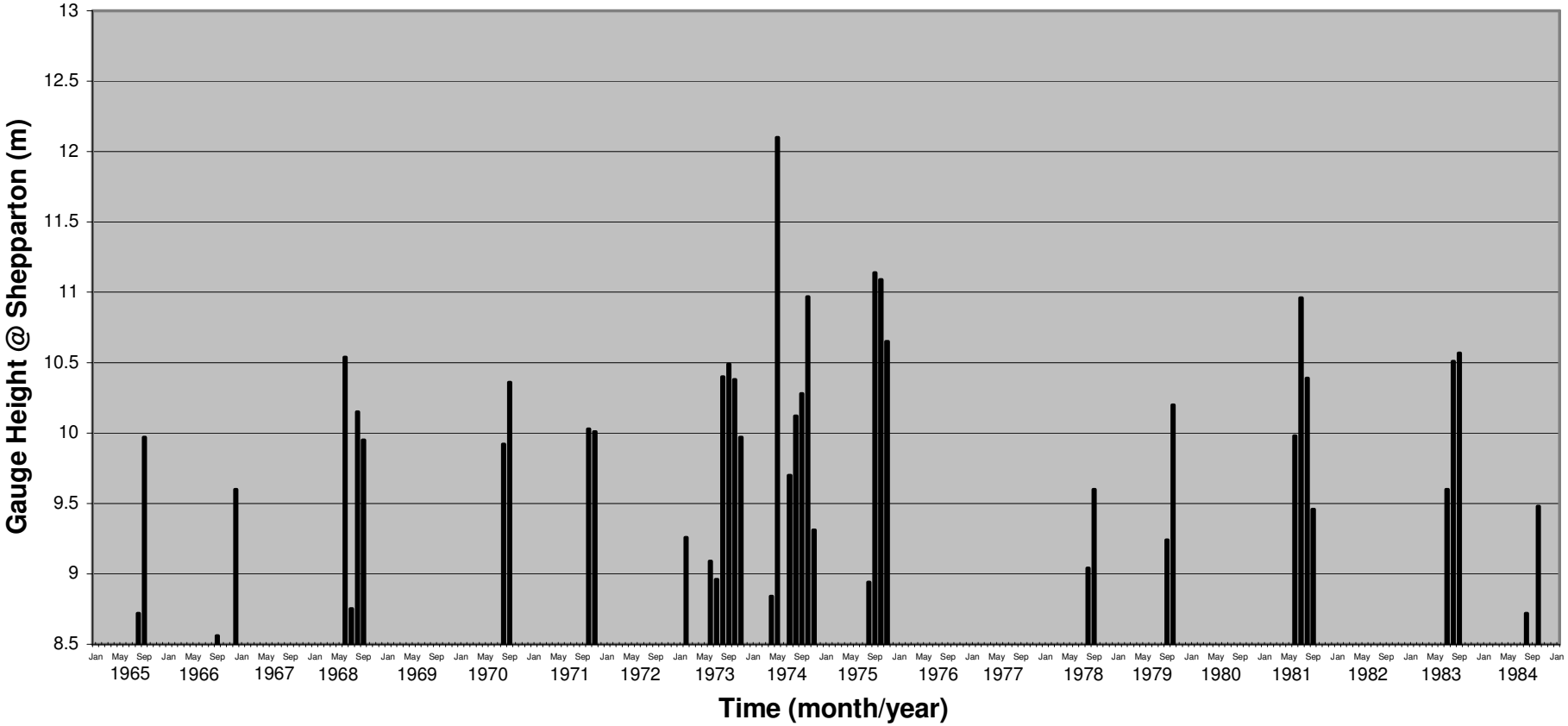
Month	Evaporation (mm/d)	Evaporation (mm/mth)	Daily Loss (ML/d)	Monthly Loss (ML/mth)
Jan	7.1	220	9.1	282
Feb	6.6	185	8.5	238
March	4.7	146	6.1	189
April	2.8	84	3.6	108
May	1.5	47	1.9	58
June	1.0	30	1.3	39
July	1.1	341	1.4	43
Aug	1.6	50	2.0	62
Sept	2.6	78	3.4	102
Oct	4.0	124	5.2	161
Nov	5.5	165	7.1	213
Dec	6.0	186	7.8	241

[3] Data extracted from the Bureau of Meteorology Australia website: site number 081049.

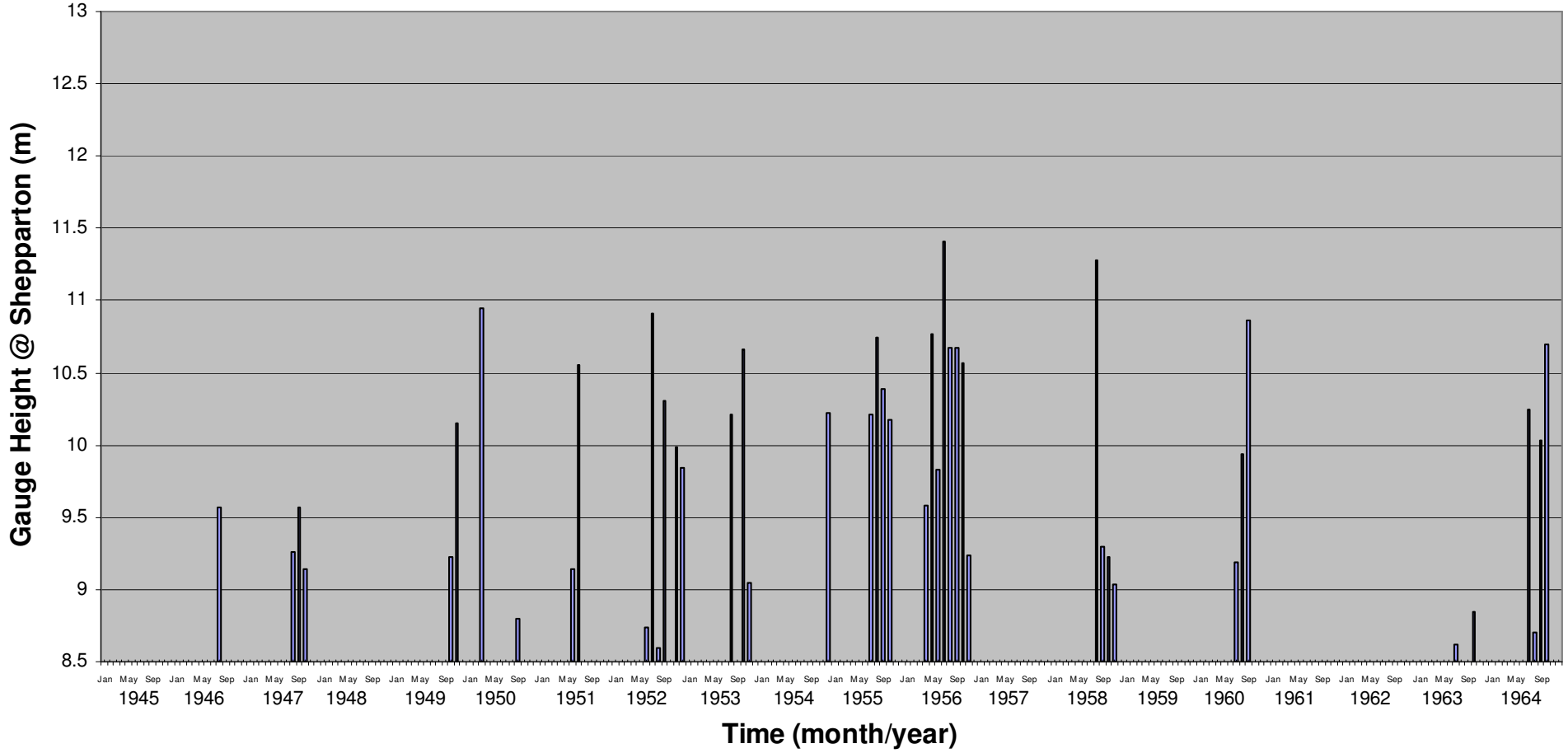
Appendix 4a: Flows exceeding Loch Gary Commence-to-Flow threshold 1985 to 2004.



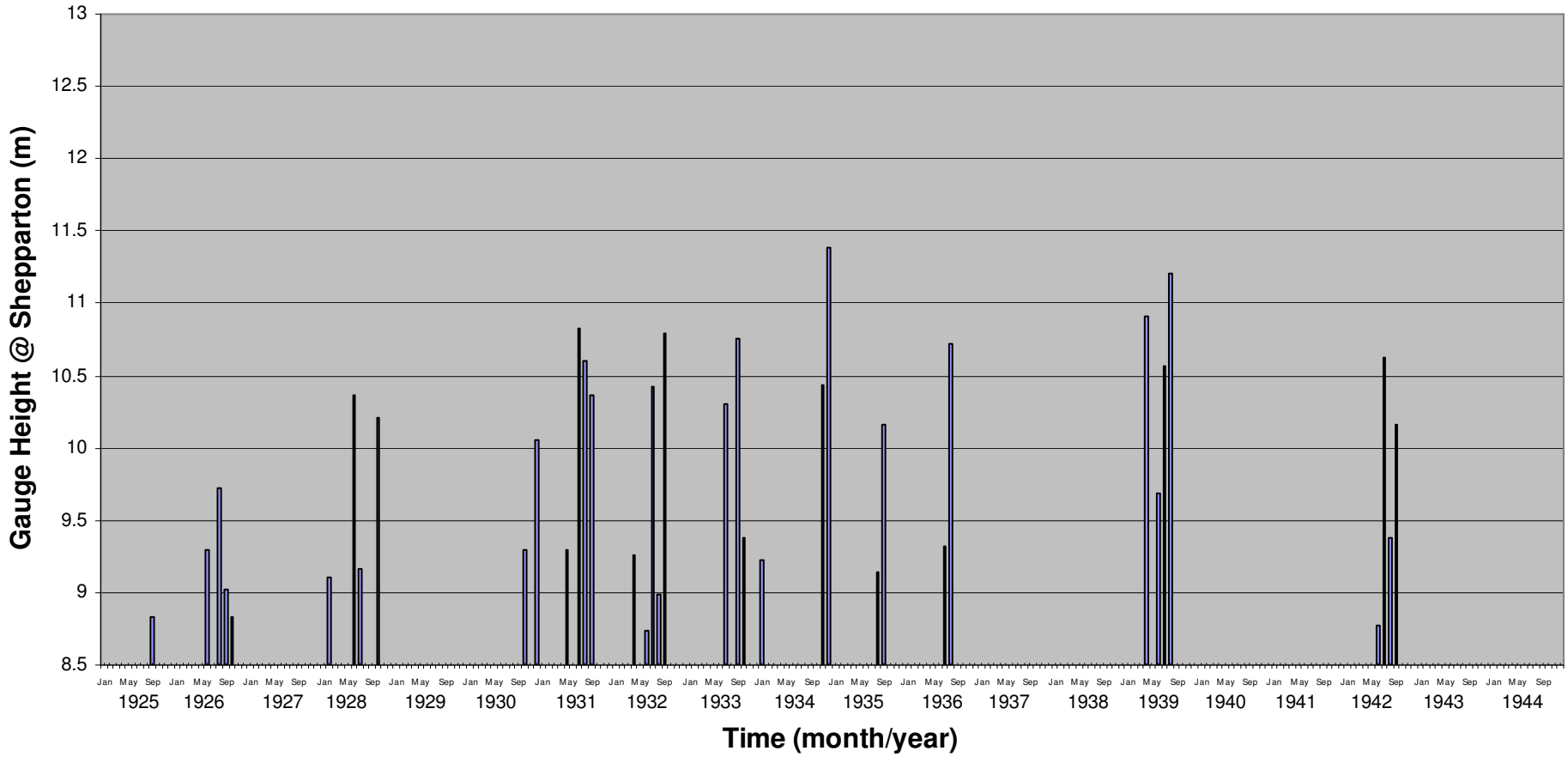
Appendix 4b: Flows exceeding Loch Gary Commence-to-Flow threshold 1965 to 1984



Appendix 4c: Flows exceeding Loch Gary Commence-to-Flow threshold 1945 to 1964



Appendix 4d: Flows exceeding Loch Gary Commence-to-Flow threshold 1925 to 1944



Appendix 5: Water requirements for successful breeding of waterbirds.

Periodic monitoring of the development in the ibis population during the breeding season at Reedy Swamp will be required.

Background information:
White ibis are not well synchronised in their egg-laying.
The colony will build up over a period of time with nests containing eggs and young at different stages of development.
The group that layed eggs on 6 October will have fleglings not dependent on the swamp by 10 December.

This group of nesters should be tolerant of a slow draw down (loss by evaporation) in water level 62 days after egglaying.
The water control operation would include:
Close off the inlet to allow drainage water to by-pass the swamp 62 days after egglaying.
Open outlet to draw down ponded water 93 days after egglaying (after 10 December if required).

Ibis development stage	Egg laying	Hatching	Communal care	Fledged
Normal Duration of life stage	21 days incubation	At 21 days age chicks become mobile	21 days chicks congregate on nest platform	Training flights at 5 weeks, fledged at 6 weeks
Date 2003	6 October	29 October	19 November	10 December
Management response	Maintain high water level	Maintain high water level	Stop inflows	Drain

An inspection is desirable to estimate the percentage of nests that were commenced after the initial group commenced and that may require protection for a longer period.

It is not possible to save every nest.

The strategy would provide ideal water conditions for 60 % of the nesting population (as described above), a number of later nesters will still succeed in the sub-optimal conditions, bringing the success rate above 80 %.

Sacred Ibis:

- Initial response is to flooding of the wetland.
- Nests are constructed on beds of *Juncus ingens* and *Schoenoplectu tabernaemontani* when the water has settled to full supply level (0.5 m). Floods higher than this do not provide sufficient vegetation and flood events subsequent to nest initiation will drown nests.
- The birds gradually build up in numbers with small groups (10 pairs) progressively joining the colony and initiating nesting. The first nests may appear in late August and peak numbers are most frequently seen in October. Second clutches are suspected when nesting extends into February in suitable seasons.
- Nests containing eggs and fledglings are abandoned when water levels become low.
- Some nesting losses are likely to occur in any year that water levels are not artificially maintained (planned drying cycle).
- For successful nesting of Ibis the duration of flooding will need to extend from Sept into Jan (5 months). This is unlikely to occur regularly without supplementation from channel supply.

Straw-necked Ibis:

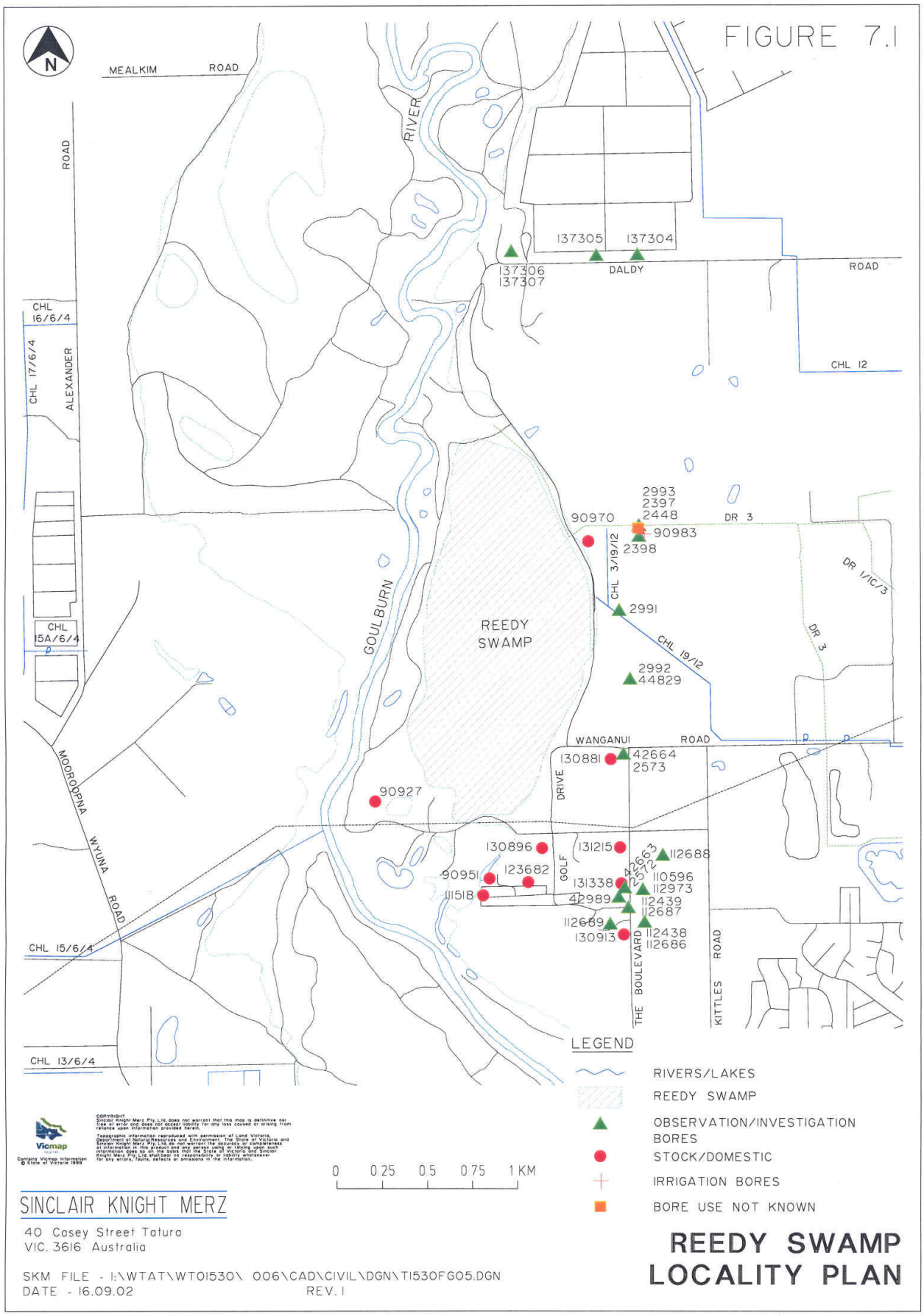
- Nesting is highly synchronised with a large group (>300 pairs) commencing egg-laying on the same day. The colony may expand during the season and this will also be by large synchronised groups.
- Nesting usually follows some 4 weeks after the first white ibis eggs are layed and often commences in October, but eggs in January are not unusual.

- Nests may be abandoned at any stage of development of the young if water levels become low.

Royal and Yellow-billed Spoonbills:

- Nests are constructed in trees at Reedy Swamp but have nested near Ibis on Lignum.
- Up to 12 nests have been observed at Reedy Swamp.
- The timing of nesting is similar to the Straw-necked Ibis but is not as highly synchronised.
- For successful nesting of Spoonbills the duration of flooding will need to extend from Sept into Jan (5 months). This is unlikely to occur regularly without supplementation from channel supply.

Appendix 6: Locations of groundwater bores



Appendix 7: Vegetation Units

EVC 264 : Sand Ridge Woodland

All Bioregions

Description:
Open pine-box woodland to15 m tall with a small or medium shrub layer of variable density and including a range of annual herbs, grasses and geophytes, in the dense ground layer. Occupies distinctive sandy rises (or sand mounts) adjacent to, or inland of, major rivers and wetlands. Very sandy, deep, free draining, moderately fertile soil, developed on sand blown up by wind action from a prior stream bed.

Large trees:

Species	DBH(cm)	#/ha
Eucalyptus spp.	70 cm	15 / ha
Callitris spp.	50 cm	
Allocasuarina spp.	50 cm	

Tree Canopy Cover:

%cover	Character Species	Common Name
15%	*Eucalyptus melliodora*	Yellow Box
	Eucalyptus leucoxylon	Yellow Gum
	Callitris glaucophylla	WhiteCypress-pine
	Allocasuarina luehmannii	Buloke

Understorey:

Life form	#Spp	%Cover	LF code
Immature Canopy Tree		5%	IT
Medium Shrub	4	20%	MS
Small Shrub	3	10%	SS
Prostrate Shrub	2	5%	PS
Large Herb	2	5%	LH
Medium Herb	10	15%	MH
Small or Prostrate Herb*	5	5%	SH
Large Tufted Graminoid	3	10%	LTG
Medium to Small Tufted Graminoid	8	15%	MTG
Ground Fern	1	5%	GF
Scrambler or Climber	1	5%	SC
Bryophytes/Lichens	na	10%	BL
Soil Crust	na	10%	S/C

* Largely seasonal life form

LF Code	Character Species	Common Name
MS	*Dodonaea viscosa s.l.*	Sticky Hop-bush
MS	*Banksia marginata*	Silver Banksia
SS	*Pultenaea tenuifolia*	Slender Bush-pea
SS	*Hibbertia riparia*	Erect Guinea-flower
PS	*Kennedia prostrata*	Running Postman
LH	*Senecio quadridentatus*	Cottony Fireweed
LH	*Senecio tenuiflorus*	Narrow-leaf Groundsel
MH	*Wahlenbergia gracilis*	Sprawling Bluebell
MH	*Wahlenbergia communis*	Tufted Bluebell
MH	*Gonocrpus tetragynus*	Common Raspwort
SH	*Crassula sieberiana*	Sieber Crassula
SH	*Millotia tenuifolia var. tenuifolia*	Soft Millotia
SH	*Euchiton sphaericus*	Annual Cudweed
SH	*Stuartina muelleri*	Spoon Cudweed
LTG	*Austrostipa mollis*	Supple Spear-grass
LTG	*Dichlachne crinita*	Long-hair Plume-grass
MTG	*Poa sieberiana*	Grey Tussock-grass
MTG	*Elymus scaber*	Common Wheat-grass
MTG	*Dianella revoluta s.l.*	Black-anther Flax-lily
GF	*Pteridium esculentum*	Austral Bracken
SC	*Cassytha pubescens*	Downy Dodder-laurel

Recruitment:
Continuous

Organic Litter:
10 % cover

Logs:
15 m/0.1 ha.

Weediness:

LF Code	Typical Weed Species	Common Name	Invasive	Impact
MS	*Chrysanthemoides monilifera*	Boneseed	high	high
MH	*Hypochoeris glabra*	Smooth Cat's-ear	high	low
MH	*Hypochoeris radicata*	Cat's Ear	high	low
MTG	*Bromus diandrus*	Great Brome	high	low
MNG	*Vulpia bromoides*	Rat's-tail Fescue	high	low
MNG	*Vulpia muralis*	Wall Fescue	high	low
MNG	*Vulpia myuros f. myuros*	Rat's-tail Fescue	high	low
MNG	*Aira elegantissima*	Delicate Hair-grass	high	low
MNG	*Aira caryophyllea*	Silvery Hair-grass	high	low
MNG	*Ehrharta calycina*	Perennial Veldt-grass	high	high

EVC 295 : Riverine Grassy Woodland

Victorian Riverina Bioregion

Description:
Occurs on the floodplain of major rivers, in a slightly elevated position where floods are infrequent, on deposited silts and sands, forming fertile alluvial soils. River Red Gum woodland to 15 m tall with a groundlayer dominated by graminoids. Occasional tall shrubs present.

Large trees:

Species	DBH(cm)	#/ha
Eucalyptus spp.	80 cm	15 / ha

Tree Canopy Cover:

%cover	Character Species	Common Name
15%	*Eucalyptus camaldulensis*	River Red-gum

Understorey:

Life form	#Spp	%Cover	LF code
Immature Canopy Tree		5%	IT
Understorey Tree or Large Shrub	1	5%	T
Small Shrub	1	1%	SS
Medium Herb	2	1%	MH
Small or Prostrate Herb	2	1%	SH
Large Tufted Graminoid	2	5%	LTG
Medium to Small Tufted Graminoid	5	20%	MTG
Medium to Tiny Non-tufted Graminoid	2	20%	MNG
Bryophytes/Lichens	na	10%	BL

LF Code	Character Species	Common Name
T	*Acacia dealbata*	Silver Wattle
MH	*Sida corrugata*	Variable Sida
MH	*Oxalis perennans*	Grassland Wood-sorrel
SH	*Chamaesyce drummondii*	Flat Spurge
SH	*Azolla filiculoides*	Pacific Azolla
LTG	*Austrostipa gibbosa*	Spurred Spear-grass
LTG	*Carex tereticaulis*	Hollow Sedge
MTG	*Chloris truncata*	Windmill Grass
MTG	*Themeda triandra*	Kangaroo Grass
MTG	*Aristida behriana*	Brush Wire-grass
MTG	*Elymus scaber var. scaber*	Common Wheat-grass
MNG	*Pseudoraphis spinescens*	Spiny Mud-grass
MNG	*Eleocharis acuta*	Common Spike-sedge

Recruitment:
Continuous

Organic Litter:
10 % cover

Logs:
20 m/0.1 ha.

Weediness:

LF Code	Typical Weed Species	Common Name	Invasive	Impact
LH	*Cirsium vulgare*	Spear Thistle	high	high
MTG	*Lolium rigidum*	Wimmera Rye-grass	high	low

EVC 298 : Riverine Sedgy Forest

Victorian Riverina Bioregion

Description:

Riverine Sedgey Forest occurs on the floodplain of major rivers in areas of frequent flooding. The overstorey is a tall forest of River Red Gum to 20 m tall. The groundlayer is dominated by flood-related grass and sedge species. Depending on time or year and flooding level associated water plants may be present.

Large trees:

Species	DBH(cm)	#/ha
Eucalyptus spp.	90 cm	20 / ha

Tree Canopy Cover:

%cover	Character Species	Common Name
25%	*Eucalyptus camaldulensis*	River Red-gum

Understorey:

Life form	#Spp	%Cover	LF code
Immature Canopy Tree		5%	IT
Understorey Tree or Large Shrub	1	5%	T
Large Herb	2	5%	LH
Medium Herb	7	10%	MH
Small or Prostrate Herb	3	10%	SH
Large Tufted Graminoid	2	10%	LTG
Medium to Small Tufted Graminoid	4	5%	MTG
Medium to Tiny Non-tufted Graminoid	3	45%	MNG
Bryophytes/Lichens	na	10%	BL

LF Code	Character Species	Common Name
LH	*Epilobium billardierianum ssp. cinereum*	Grey Willow-herb
MH	*Myriophyllum crispatum*	Upright Water-milfoil
MH	*Goodenia gracilis*	Slender Goodenia
MH	*Lythrum hyssopifolia*	Small Loosestrife
MH	*Marsilea drummondii*	Common Nardoo
SH	*Azolla filiculoides*	Pacific Azolla
SH	*Ludwigia peploides ssp. montevidensis*	Clove-strip
SH	*Lobelia concolor*	Poison Pratia
SH	*Elatine gratioloides*	Waterwort
LTG	*Amphibromus nervosus*	Common Swamp Wallaby-grass
LTG	*Juncus aridicola*	Tussock Rush
MTG	*Triglochin procerum s.l.*	Water Ribbons
MTG	*Carex inversa*	Knob Sedge
MTG	*Setaria jubiflora*	Warrego Summer-grass
MTG	*Austrodanthonia duttoniana*	Brown-back Wallaby-grass
MNG	*Eleocharis pusilla*	Small Spike-sedge
MNG	*Eleocharis acuta*	Common Spike-sedge
MNG	*Cynodon dactylon*	Couch
EP	*Muellerina eucalyptoides*	Creeping Mistletoe

Recruitment:

Continuous

Organic Litter:

10 % cover

Logs:

20 m/0.1 ha.

Weediness:

LF Code	Typical Weed Species	Common Name	Invasive	Impact
LH	*Cirsium vulgare*	Spear Thistle	high	high
MTG	*Lolium rigidum*	Wimmera Rye-grass	high	low

Appendix 8: Environmental Water Allocation – nesting ibis

To ensure the successful fledging of colonial nesting ibis the aim is to maintain full supply as long as possible and control the draw down to provide a minimum of 300 mm of ponded water some 3 months from the initiation of breeding.

Assuming the wetland is filled by natural Goulburn River inflows or discharge from Drain Number 3 at 30 th September. Then about 260 ML of additional water will be required to complete the nesting cycle.

Month	**Target AHD (bed 107.00)**	**Evaporation Losses (mm)**	**Replaced Volume (mm)**	**Replaced Volume (ML)**
August				
September	107.57			
October	107.57	124	124	161
November	107.48	165	75	98
December	107.3	180	0	
Total				259

It is anticipated that Drain Number 3 may deliver 4 ML/day to Reedy Swamp. Certainly in the past the inflows have matched evaporation losses to maintain adequate water levels through December.

Month	**Evap Losses (ML/month**	**Drain 3 inflow @ 4ML/d**	**Shortfall (ML/month)**	**Net Evap Loss (mm/month)**	**AHD (bed 107.00)**
Sept	102	120	-18	-14	107.57
Oct	161	124	37	28	107.54
Nov	213	120	93	72	107.47
Dec	241	124	117	90	107.38
Jan	282	124	158	122	107.26
Feb	238	112	126	97	107.16
March	189	124	65	50	107.11

Changes to Drain Number 3 catchment conditions that reduce the outfalls to Reedy Swamp my need to be replaced with an allocation from the irrigation supply system.

When recovery of the wetland from a drying cycle is planned but the river height has not induced flooding then additional (650ML) water will be required.

It is anticipated that rainfall will swell the soils of Reedy Swamp and seal the bed of the wetland. If this is not the case then it is not appropriate to flood the wetland.

Appendix 9: Reedy Swamp Operational Agreement

INTRODUCTION

This document outlines the functional guidelines for operation of the Reedy Swamp inlet regulating structure and the outlet regulating structure to enable delivery of drain/channel flows to Reedy Swamp. It provides the necessary detail for applying recommendations of the Reedy Swamp Environmental Management Plan.

The guidelines governing operation of both Reedy Swamp regulators will alter with time. The aim is to increase the frequency of drying cycles, to counteract the prolonged wet sequence experienced in the past, and promoting a Type 3 – 5 regime flood regime (Table 1). However, water management to this wetland is reactive as it is essentially governed by climatic conditions.

Table 1: Approximate flood requirement definitions of Type 3 (medium duration seasonal wetland), Type 4 (prolonged duration seasonal open wetland), and Type 5 (semi permanent open wetland).[4]

	Type 3	**Type 4**	**Type 5**
Flooding frequency	Annual (most years)	Annual (most years)	Annual
Flooding period	Winter-spring	Winter-spring-summer	Winter-spring-summer-(autumn)
Flooding duration	4–6 months (120 – 180 days)	6–10 months (180 – 300 days)	Semi-permanent (>300 days)
Flooding depth	0.4 – 1.0 m	0.6 – 1.5 m	<1.5 m
Drying frequency	Annual (most years)	3 – 5 years in 5	1 – 2 years in 5
Dry period	Summer-autumn	Summer-autumn	Occasional summer-autumn
Other	Watertable >2m deep		Freshwater (<1500 EC max) Summer-autumn draw down by evaporation

It is agreed that no actions will be taken with regard to operation of either regulating structure without consultation between the three relevant parties. Those parties and relevant contacts responsible for regulator and wetland management are:

- Goulburn-Murray Water – Shepparton Drainage Officer (operation and maintenance of the inlet regulating structure on Shepparton Drain No. 3, monitoring/reporting of EG 19/12 flows and salinity). Currently Barry Russel. Ph. (03) 58329966.
- Parks Victoria – Wetland Planner (operation and maintenance of the inlet/outlet regulating structure and monitoring salinity).
  Currently Bruce Wehner. Ph. (03) 58222288.
- DPI – Wetland Ecology Planner (responsible for provision of technical advice). Currently Kim Dyson. Ph. (03) 58335961.

[4] Table 1 is an extract from the Community Surface Water Management Schemes: Guidelines for Design (Flooding Patterns and Resultant Wetlands, Shepparton Irrigation Region). Prepared by Sinclair Knight Merz for DNRE and G-MW of behalf of the Community Surface Drainage Program.

It is considered ideal for Goulburn-Murray Water to act as the key party responsible for operating the inlet regulating structure. It is the responsibility of PV and DPI to decide on how the structure is to be operated. PV and/or DPI will provide advice to G-MW regarding the operational requirements of the structure as required. This could possibly be on a reactive basis. G-MW may be called upon to provide information regarding drain flows because to the Drainage Officer's proximity and regular presence in the area.

It is necessary to monitor salinity levels of water in Shepparton Drain No. 3 before it enters the wetland. This is the responsibility of both PV and G-MW. If levels are >1000 EC:

- Shepparton Drain No. 3 inlet regulating structure is to be open.

INITIAL MANAGEMENT

The gradual reinstatement of a drying regime is highest priority for initial management. Management must be cautious not to promote a negative response after prolonged wet conditions. Drying should therefore be promoted only when re-flooding is possible. In order to "ween" the wetland back into a drying regime initial management will involve annual drying for short periods progressing into extended dries less often. Controlled flooding will therefore be dependent on irrigation season and/or Environmental Water Allocation (EWA).

Conditions under which the inlet and outlet regulating structures are closed:

- to reinstate wet conditions after a dry cycle.
- if the duration of drying cycle causes or is anticipated to cause a negative ecological response.
- if EWA is to be delivered.

Conditions under which both regulating structures should be open:

- if a 1 in 10/11 year flood event, or greater, occurs and the capacity of Shepparton Drain No. 3 and the regulating structure is compromised by having the regulating structure closed.
- if sufficient wetland filling has occurred and it is necessary to drain the wetland via the outlet structure to avoid promoting water stress.
- if the capacity of the Shepparton Drain No. 3 is compromised.
- if the duration and level of flood is sufficient and rapid draw down to promote drying is required.
- to promote seasonal wetland drying.

ESTABLISHED TYPE 3-5 GUIDELINES

Once a drying cycle this has been achieved it will be possible to establish conditions more prescriptive of a Type 3-5 system. Climatic factors, ecological responses, and availability of environmental water will again dictate this regime and therefore management will need to remain flexible. In particular, the floodplain connection with Reedy Swamp and the Goulburn River necessitates that management be synchronous with or reactive to natural river flood events.

Complete Dry

Annual winter/spring/summer (autumn) flooding with complete basin drying for 2-6 months between November-April around 3 years in every 10:

- inlet and outlet regulating structures open between November-April.
- inlet and outlet regulating structure closed between April-November.

Consecutive dry years are not highly favourable but may follow a natural dry spell, if possible however dry periods should not persist beyond one two-year dry cycle:

- Inlet and outlet regulating structures closed between November-April.

Intermediate Event

Winter/spring/summer (autumn) flooding to overflow and/or ponding for 6-10 months with significant draw down or drying between December-March (4 months) around 4 years in every ten:

- inlet and outlet regulating structures closed between March-December.
- inlet and outlet regulating structures open between December-March.

If consecutive wet seasons promote inundation beyond a season to season duration ie wet for greater than 12 months without any drying or significant draw down, that is not in alignment with a 4 in 10 year regime then wetland drying should be established:

- inlet and outlet regulating structures open.

If consecutive wet seasons coincide with a significant bird breeding event and negative ecological response is not observed, promotion of extended flooding may be considered.

- inlet and outlet regulating structures closed as required.

Prolonged Wet (1 in 10 year event)

Continuous flooding from flood season to flood season 4 years in every 10. This may be triggered by natural high flow events, consecutive wet seasons, or drain/channel flow conditions:

- inlet and outlet regulating structures closed

If a consecutive number of wet years occur and the wetland does not get the opportunity to undergo complete drying or draw down in alignment with conditions specified, and does not correlate with a 1 in 10 year event it will be necessary to promote drying as much as possible:

- inlet and outlet regulating structures open.

Other Scenarios

If a significant water bird breeding event forms an ecological trigger, the flooding cycle may alter in order to sustain suitable duration and depth of flooding to ensure successful fledging:

- inlet and outlet regulating structures closed.

In all flooding situations it is favourable to promote filling to spill level and sustain flushing of the wetland for as long as possible within seasonal/cyclic timelines or until an ecological trigger event:

- inlet regulating structure closed and outlet regulating structure open.

If seasonal and ecological conditions are suitable and the wetland could be supplemented to support a duck season:

- inlet and outlet regulating structures closed.

To provide delivery of an EWA in alignment with recommendations of the Reedy Swamp Environmental Management Plan:

- inlet and outlet regulating structures closed.

If the level of ponding is below that of overflow there is a need to maintain an open flow path or river connection in potential high flows. NB: the outlet flow path to the Goulburn River is also the inlet flow path from the river to the wetland.

- inlet regulating structure closed and outlet regulating structure open.

If a number of dry years persist and protracted wetland drying occurs, regulating structures should be operated to allow for capturing potential summer storm events:

- inlet and outlet regulating structures closed for delivery from drain infrastructure.
- inlet regulating structure closed and outlet regulating structure open if delivery is from the Goulburn River.

If ponding level is below that of the overflow but there is a need to maintain an open flow path for river connection in anticipated high flow conditions. NB: the outlet flow path to the river is also the inlet flow path from the Goulburn River to Reedy Swamp:

- inlet regulating structure closed and outlet regulating structure open.

If sufficient wetland filling has occurred and inflows are substantial enough to promote flushing:

- inlet regulating structure closed and outlet regulating structure open.

Further scenarios are likely to occur. A number of critical events may occur at once and the sequence in which they occur will govern the final management outcome. One overarching factor influencing the final management outcome for any of these scenarios is however the ecological response, particularly.

The attached flow chart attempts to provide for these scenarios but in all situations the technical expertise of PV, G-MW and DPI will be required to govern sound management actions.

CONCLUSION

This document is an attachment to the Reedy Swamp Environmental Management Plan and as such all signatories to the Management Plan are expected to observe the “agreement’s” obligations.