

OFFICIAL



Reedy Swamp Environmental Water Management Plan 2011

Goulburn Broken Catchment
Management Authority



**GOULBURN
BROKEN**
CATCHMENT
MANAGEMENT
AUTHORITY



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EXECUTIVE SUMMARY

This plan outlines the water regimes required to protect and enhance the water dependent environmental values of Reedy Swamp. This information will inform the management of the wetlands and the development of seasonal watering proposal for wetlands in the Goulburn Broken Catchment for consideration by the VEWH.

Reedy Swamp is a deep open water tall marsh wetland. It is located on the outskirts of Shepparton Township in northern Victoria. The wetland provides important breeding habitat for Royal Spoonbill, Yellow Spoonbill and Ibis in the Goulburn Broken Catchment. The wetland is managed by Parks Victoria under the Lower Goulburn National Park and is listed under the Directory of important Wetlands in Australia as part of the Goulburn River listing. It is valued for its size, rarity, species diversity and waterbird habitat.

In the plan the following four ecological objectives have been established for the wetlands:

- Improve the diversity of wetland flora species consistent with the applicable Ecological Vegetation Class benchmarks;
- reduce the cover and diversity of exotic flora species;
- maintain habitat for colonial waterbird refuge and breeding;
- maintain or increase diversity and abundance of native frog species supported by the wetland during flood events; and
- provide feeding habitat for significant waterbird species.

To achieve these ecological objectives minimum, optimum and maximum watering regimes are recommended. These are summarised in the table below. The ecological objectives and watering regimes were developed by a Scientific Technical Committee.

Watering regime for Reedy Swamp

Minimum – Provide four flooding events every ten years filling the wetland to variable depths to provide habitat for colonial waterbirds and maintain existing vegetation communities.

Optimum – Provide six flooding events every ten years filling the wetland to variable depths to provide habitat for colonial waterbirds and to allow regeneration and recruitment of vegetation communities.

Maximum – Provide an annual flooding event over a ten year period, filling the wetland to variable depths to provide habitat for breeding waterbirds and maintain vegetation communities.

The plan also details potential risks associated with the delivery of environmental water to the wetland, opportunities to improve the environmental water delivery efficiency to the wetland, and key environmental water management knowledge gaps including the flood regime tolerances of aquatic dependent ecological vegetation classes and their associated flora species.

TABLE OF CONTENTS

DOCUMENT CONTROL.....	i
EXECUTIVE SUMMARY.....	ii
TABLE OF CONTENTS.....	iii
ACKNOWLEDGEMENTS	viii
ABBREVIATIONS	ix
1. INTRODUCTION	1
1.1 Background	1
1.2 Purpose.....	1
1.3 Region.....	2
1.4 Consultation	6
1.5 Information Sources	6
1.6 Limitations.....	7
2. SITE OVERVIEW	8
2.1 Catchment history	8
2.2 Land status and management.....	9
2.3 Wetland Characteristics	10
2.4 Environmental Water Sources	12
2.5 Legislative and policy framework.....	13
2.6 Related Plans and Activities.....	15
3. WATER DEPENDENT VALUES.....	16
3.1 Environmental - Fauna	16
3.1.1 Fauna listings and significance.....	16
3.1.2 Significant Fauna.....	20
3.2 Environmental – Flora vegetation communities.....	22
3.2.1 Flora – Species listings and significance	23

3.3 Wetland depletion and rarity.....	24
3.3.1 Ecosystem functions.....	25
3.4 Social.....	26
3.4.1 Cultural heritage.....	26
3.4.2 Recreation.....	27
3.5 Economic.....	27
4. HYDROLOGY AND SYSTEM OPERATIONS.....	28
4.1 Water management and delivery.....	28
4.1.1 Pre-Regulation.....	28
4.1.2 Post-Regulation.....	29
4.1.3 Wetland Volume.....	31
4.1.4 Environmental Water.....	31
5. THREATS AND CONDITION.....	32
5.1 Water dependent threats.....	32
5.2 Current Condition.....	34
5.3 Condition trajectory.....	34
6. MANAGEMENT OBJECTIVES AND ADAPTIVE APPROACHES.....	35
6.1 Management Goal.....	35
6.2 Ecological and Hydrological Objectives.....	35
6.2.1 Ecological Objectives.....	35
6.2.2 Hydrological Objectives.....	37
6.2.3 Watering Regime.....	39
6.3 Implementation: seasonally adaptive approach.....	40
7. POTENTIAL RISKS AND MITIGATION MEASURES.....	43
8. ENVIRONMENTAL WATER DELIVERY INFRASTRUCTURE.....	46
8.1 Constraints.....	46

8.2 Irrigation modernisation.....	46
8.3 Infrastructure recommendations	47
9. KNOWLEDGE GAPS AND RECOMMENDATIONS	48
10. GLOSSARY	49
11. REFERENCES	50
12. APPENDICES.....	53
Appendix 1: Workshop Notes	53
Appendix 2: Corrick and Norman Classification of wetland categories.....	54
Appendix 3: Environmental Water Sources	55
Appendix 4: Legislative Framework.....	57
Appendix 5: Fauna Species List	61
Appendix 6: Ecological Vegetation Classes.....	66
Appendix 7: Flora Species List	68
Appendix 8: Index of Wetland Condition Method.....	75
Appendix 9: EVC Benchmarks for Reedy Swamp.....	78
Appendix 10: Frog breeding events.....	85

Figure 1: Location of Reedy Swamp within the Goulburn Broken Catchment..... 4

Figure 2: Reedy Swamp location and connection to Goulburn River..... 5

Figure 3: Reedy Swamp and surrounding land use. 8

Figure 4: Sharp-tailed sandpipers observed at Reedy Swamp in 2008. 18

Figure 5: Straw-necked Ibis breeding at Reedy Swamp in 2008..... 18

Figure 6: Royal Spoonbill nesting at Reedy Swamp in 2010. 21

Figure 7: Cultural sensitive areas within and around Reedy Swamp complex 26

Figure 8: Goulburn River (left of image) flowing into the North Creek July 2011..... 28

Figure 9: The outlet structure on North Creek at Reedy Swamp, constructed in 1979. 29

Figure 10: Regulating Structure and overflow sill at Reedy Swamp to allow drainage water in the wetland as required. 30

Figure 11: Reedy Swamp on 30th April 2008, the day of the environmental water delivery 31

Figure 12: Reedy Swamp 17th September 2008, five months after the delivery of environmental water 31

Figure 13: Flow chart for Environmental water planning 41

Figure 14: Potential direct connection from East Goulburn 12 47

Table 1: Lead government agencies and their responsibilities at Reedy Swamp.....	9
Table 2: Summary of site characteristics.....	11
Table 3: Responsible Agencies for Environmental Water Allocations.....	12
Table 4: Conservation status of water dependant fauna species recorded in the study area.	17
Table 5: Breeding requirements of Ibis and Spoonbills (Rogers and Ralph, 2011).....	20
Table 6: Conservation status of Ecological Vegetation Classes recorded within Reedy Swamp	22
Table 7: List of water-dependent plant species recorded at Reedy Swamp	23
Table 8: Reedy Swamp IWC subindex score, overall score and associated condition categories	34
Table 9: Ecological Objectives for Reedy Swamp	36
Table 10: Hydrological objectives to maintain Reedy Swamp.....	38
Table 11: The seasonally adaptive approach to river and wetland management	42
Table 12: Potential risks associated with environmental water delivery.....	44
Table 13: IWC sub indices and measures.....	75
Table 14: Weights of each subindex.....	76
Table 15: Swamp condition categories assigned to sub index scores.....	76
Table 16: Swamp condition categories assigned to total IWC scores	76



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ABBREVIATIONS

CAMBA	China Australia Migratory Bird Agreement
CEWH	Commonwealth Environmental Water Holder
CG	Central Goulburn Channel
CMA	Catchment Management Authorities
DSE	Department of Sustainability and Environment
EC	Electrical Conductivity
EG	East Goulburn Channel
EPBC	<i>Environment Protection Biodiversity Act 1999</i>
EVC	Ecological vegetation community
EWMP	Environmental Water Management Plan
EWR	Environmental water reserve
FFG	<i>Flora and Fauna Guarantee Act 1988</i>
GIS	Geographic Information System
GMID	Goulburn-Murray Irrigation District
G-MW	Goulburn-Murray Water
IWC	Index of Wetland Condition
JAMBA	Japan Australia Migratory Birds Agreement
MDBA	Murray Darling Basin Authority
ML	Megalitre (one million litres)
NVIRP	Northern Victoria Irrigation Renewal Project
ROKAMBA	Republic of Korea Australia Migratory Bird Agreement
SKM	Sinclair Knight Mertz
VCAL	Victorian Certificate of Applied Learning
VEWH	Victorian Environmental Water Holder



1. INTRODUCTION

1.1 BACKGROUND

Environmental water management in Victoria is entering a new phase as ongoing water recovery sees significant volumes of water being returned to the environment. The increasing environmental water availability is providing new opportunities to protect, restore and reinstate high value ecosystems throughout northern Victoria. The spatial coverage of environmental watering has expanded considerably in recent years and this trend will continue into the future.

Environmental watering in Victoria has historically been supported by management plans which document key information such as the watering requirements of a site, predicted ecological responses and water delivery arrangements. State and Commonwealth environmental watering programs now have the potential to extend beyond those sites which have been watered in the past. Therefore, new plans are required to provide a transparent and informed approach to environmental water delivery across new environmental watering sites.

1.2 PURPOSE

The Victorian Catchment Management Authorities (CMAs), Department of Sustainability and Environment (DSE) and the Victorian Environmental Water Holder (VEWH) are working together to develop new Environmental Water Management Plans (EWMP) for both current and future environmental watering sites throughout northern Victoria. The primary purpose of the Plans is to provide a consistent set of documents that support Seasonal Watering Proposals to be submitted by Catchment Management Authorities to the Victorian Environmental Water Holder annually (section 6.3 – Implementation: seasonally adaptive approach). The supporting information will include:

- lead management agencies and their management responsibilities;
- the water dependant environmental, social and economic values of the site;
- the sites environmental condition and threats;
- hydrological and ecological objectives;
- opportunities for improved water delivery, efficiency or capacity through structural works or other measures; and
- scientific knowledge gaps and recommendations for future work.

This document is the Environmental Water Management Plan for Reedy Swamp in the Goulburn Broken Catchment Management region. This watering plan is not a holistic management plan for the site; it is limited to issues related to the management of water dependent values and environmental water.

1.3 REGION

The Goulburn Broken Catchment comprises the catchments of the Goulburn and Broken Rivers. The catchment covers a total of 2,391,544 hectares or 10.5 per cent of Victoria's total land area (Figure 1) and approximately two per cent of the Murray Darling Basins total land area (DNRE, 2002). Despite its small contribution to the total land area of the Murray Darling Basin, it generates 11 per cent of the Basin's water resources. Within the Goulburn Broken Catchment approximately 2,000 natural wetlands have been recorded including a number of wetlands formally recognised for their conservation significance. These include the internationally significant Barmah Forest Ramsar site, ten wetlands of national significance listed in *A Directory of Important Wetlands in Australia* (EA, 2001) and 111 wetlands of bioregional significance identified for the *National Land and Water Resource Audit* (CoA, 2002). In addition a large number of wetlands support state and nationally threatened communities and birds listed on international agreements and conventions.

Reedy Swamp is a nationally significant wetland within the Goulburn Broken Catchment. The wetland is situated in the Shepparton Irrigation Region within the Catchment (section 2.1 - Catchment history and Figure 2). The wetland and broader reserve had its conservation status lifted from Wildlife Reserve to National Park in July 2010 via incorporation into the Lower Goulburn National Park which is managed by Parks Victoria (section 2.3 – Wetland characteristics). This wetland is a 130 hectare deep freshwater marsh (Appendix 2) situated on the Goulburn River floodplain north of the Shepparton township (Figures 1 and 2).

Prior to European settlement, Reedy Swamp was a seasonal wetland dominated by river red gums (*Eucalyptus camaldulensis*). It would have become wet in the winter – spring and drawn down in the summer – autumn period. Post-European settlement saw Reedy Swamp partially cleared in the 1860s for cattle and sheep grazing (DPI, 2003).

The 1920s saw the introduction of irrigation to the area and irrigation drainage water was directed into the swamp. In 1932 a sewer drain was connected to the swamp and resulted in increased nutrient loads entering the swamp and prolonged flooding, causing the death of many of the remaining red gums. Rushes began to dominate the wetland in this period (Felton, 1992, DPI, 2003).

The 1970s saw the installation of concrete pipes and earthen banks on the outlet creek (section 2.3 – Wetland characteristics) to assist with erosion minimisation and manage water levels within the swamp. In 1979 the structure was upgraded to a concrete control structure. The structure was continually vandalised causing the swamp to become permanently inundated (DPI, 2003).

In 1993, an unsuccessful attempt by the Fisheries and Wildlife Department to drain the swamp occurred. Due to the wet season and water from the inlet drain the swamp refilled (Patterson, 1995). Blue-green algae became a problem in the swamp at this stage and the Rural Water Corporation installed a channel connecting the inlet drain to the outlet creek to bypass the wetland allowing water to be diverted from Reedy Swamp. In 1994 a regulating structure and overflow sill was constructed on the channel to better control drainage in-flows into the Swamp. This structure is still in place today and is utilised for environmental water delivery (section 4 – Hydrology and Systems Operations). At the end of 1994 the wetland was drained and dried out for the first time in decades.

The wetland then began filling partially until 2005 when a storm event cause flooding within the area. The wetland then began to drawdown and dried until 2008 when the first environmental water allocation was delivered to the swamp (section 4 – Hydrology).

In July 2010 Reedy Swamp, along with the Lower Goulburn River was declared a National Park via the Victorian Environmental Assessment Council (VEAC).



Figure 1: Location of Reedy Swamp within the Goulburn Broken Catchment.

Map created by: Jo Wood, GBCMA 2011.

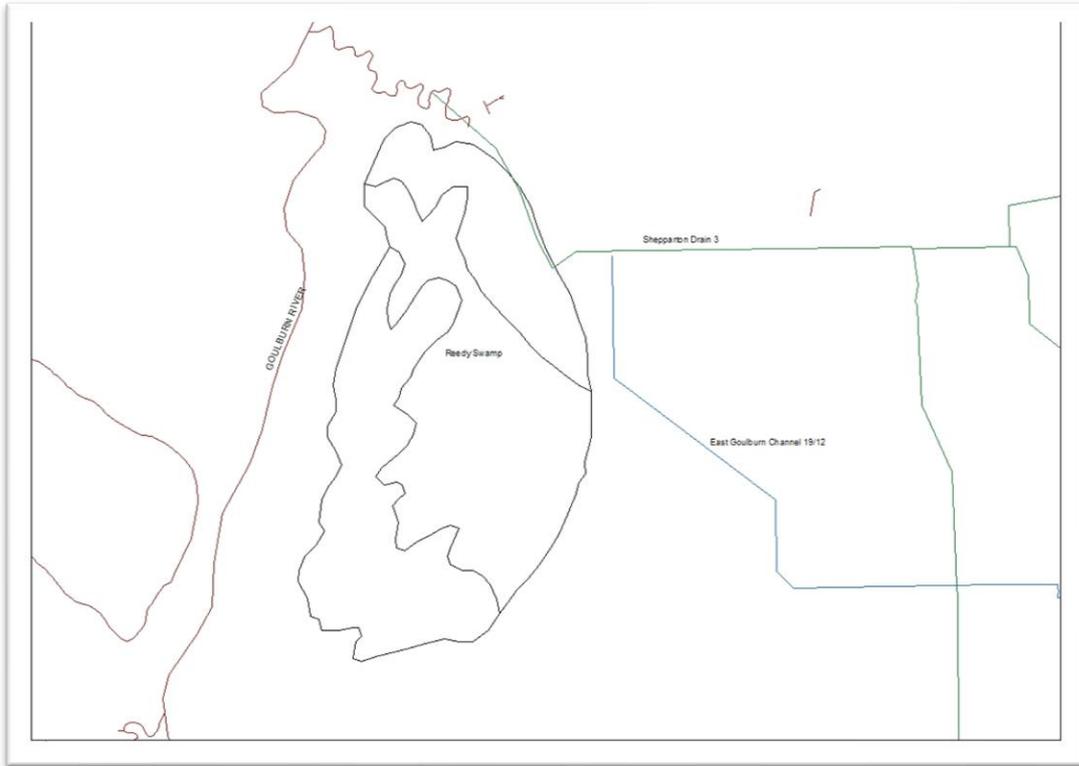


Figure 2: Reedy Swamp location and connection to Goulburn River

1.4 CONSULTATION

This plan was prepared by the Goulburn Broken Catchment Management Authority with input from a Scientific Technical Committee. The Scientific Technical Committee developed ecological and hydrological goals for Kinnairds Swamp at a workshop based on the local history of the swamp, knowledge of past and present watering regimes, the water requirements to support existing ecological values and the current condition of the swamp (Appendix 1). Members of the Scientific Technical Committee included Keith Ward (Goulburn Broken CMA), Sam Green (Goulburn-Murray Water), Damien Cook (Australian Ecosystems), Doug Frod (Pathways Bushland and Environment), Rolf Weber (Department of Sustainability and Environment), Gary Deayton (Moira Shire), Jo Wood (Goulburn Broken CMA) and Simon Casanelia (Goulburn Broken CMA). Draft plans of this report were submitted to members of the Goulburn Broken Wetland Management Group for comment. In addition, Jane Roberts and Terry Hillman provided a scientific review of the draft plan.

1.5 INFORMATION SOURCES

Information used in the development of this Plan was compiled from various sources including:

- Reedy Swamp Environmental Management Plan (DPI, 2003).
- Goulburn Broken Regional River Health Strategy (GBCMA, 2005a).
- Ecological Monitoring of flora and fauna response to environmental water delivery in 2008 and 2010 (Cook and Jolly, 2010, Jolly and Osler, 2011).
- Workshop booklet from the Scientific Technical Committee technical workshop (Committee, 2011).

This information was supplemented by discussions with people with an intimate knowledge of the swamp, its environmental values, and the management and operation of Reedy Swamp.

In addition, a number of statewide data sets and digital mapping layers were used including the:

- Flora Information System of Victoria (DSE, 2005a);
- Atlas of Victorian Wildlife (DSE, 2007a);
- Bioregional Conservation Status of Ecological Vegetation Classes;
- Wetland environments and extent up to 1994; and
- Greater Shepparton Aerial photography (2009).

1.6 LIMITATIONS

The information sources used in the development of this report have a number of limitations. Data contained in the Flora Information System and the Atlas of Victorian Wildlife comes from a combination of incidental records and systematic surveys. The data varies in accuracy and reliability due to the distribution and intensity of survey efforts. In addition, the lack of knowledge about the distribution and characteristics of invertebrates and non-vascular plant species means the data is weighted towards the less cryptic elements of flora and fauna, i.e. vascular flora and vertebrates. The water regime for Reedy Swamp discussed in this Plan was developed using local knowledge, technical experts, field observations and scientific literature on the water required of relevant aquatic flora and fauna where available.

This report also draws on material collated from management plans, research documents and published literature. These sources vary in their age and hence the degree to which they reflect the current situation. However, the Plan is intended to be a live document and will be amended as new information becomes available.

2. SITE OVERVIEW

2.1 CATCHMENT HISTORY

Reedy Swamp is located on the floodplain of the Goulburn River and is part of the Lower Goulburn National Park (Figure 3). The Goulburn River is the longest river in the Goulburn Broken Catchment and is the second longest river in Victoria. The stream flow of the Goulburn River has been modified by two major features, Lake Eildon and the Goulburn Weir (GBCMA, 2005b).

Over 60 per cent of the Goulburn Broken Catchment has been cleared for agricultural purposes (Miles et al., 2010). Primary agriculture activities surrounding Reedy Swamp include dairy, horticulture and livestock production. A more recent threat to Reedy Swamp is urban encroachment.

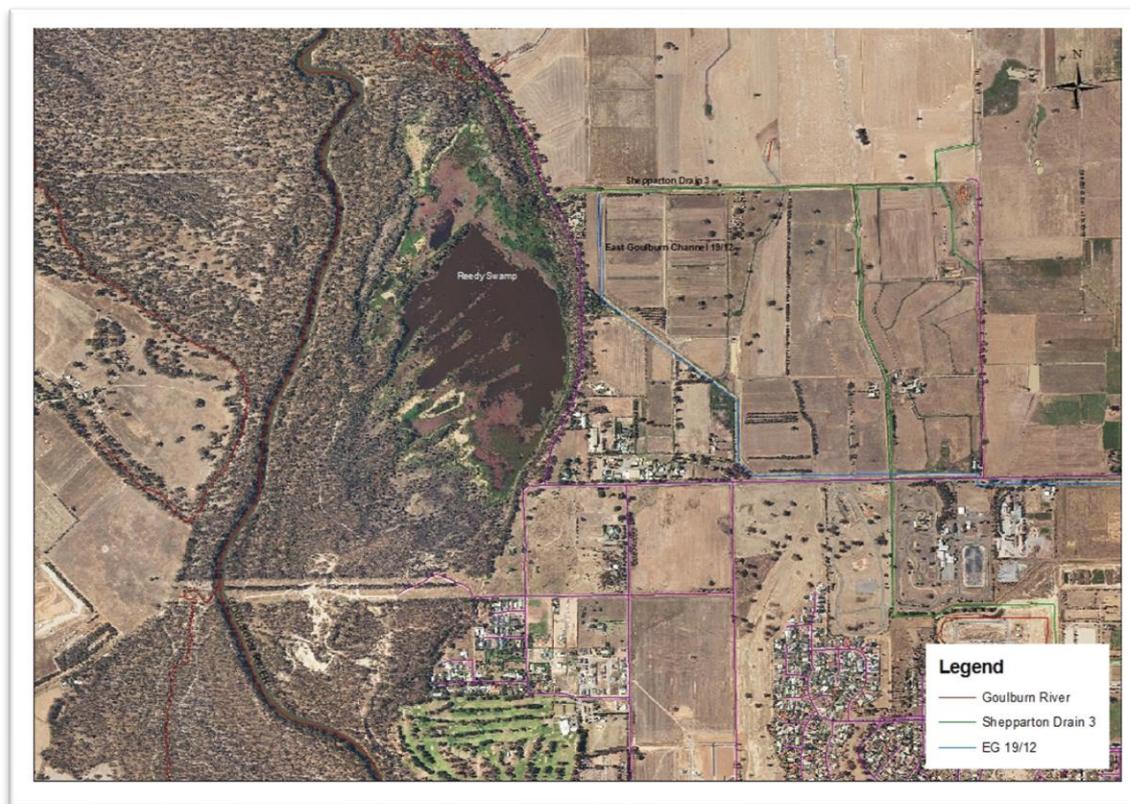


Figure 3: Reedy Swamp and surrounding land use.

2.2 LAND STATUS AND MANAGEMENT

Reedy Swamp is managed by Parks Victoria, however a range of management agencies are also responsible for ensuring that management of the area complies with a broad range of legislative requirements (section 2.3 – Wetland characteristics). Lead management agencies and their key responsibilities are summarised in Table 1. The broader community including adjacent landholders, Yorta Yorta Peoples (section 3.4.1 - Cultural heritage), Landcare and recreational users also have an interest and role in the management of the planning area. The successful management of the study area therefore relies on effective cooperation and partnership between the government agencies and the broader community.

A Reedy Swamp management group has been formed, comprising agency and community representatives and convened by Parks Victoria on an ‘as required’ basis, as a useful committee to bring the interested parties together.

Table 1: Lead government agencies and their responsibilities at Reedy Swamp

Agency	Responsibility
Parks Victoria	Manage Reedy Swamp and implement management actions from Reedy Swamp Environmental Management Plan. Convene Reedy Swamp Management Group.
Department of Primary Industries	Provide technical and extension support for the sustainable management of fisheries, agriculture, minerals and petroleum.
Department of Sustainability and Environment	Provide financial, policy and strategic support for the management of public and private land. Management of flora and fauna, State Forest and public Land Water Frontage. Management of hunting and domestic stock licensing on public land.
Environmental Protection Agency	Protect, restore and enhance air, land and water quality and control of unwanted noise.
Goulburn Broken Catchment Management Authority	Implementation of the Goulburn Broken Regional Catchment Strategy. Works on waterways, regional drainage and floodplain management, and co-ordinating Commonwealth and State natural resource management investment. Determining the environmental water requirements of swamps and streams, developing and submitting annual water proposals to DSE for consideration, and managing the delivery of environmental water in accordance with DSEs watering plan.
Goulburn–Murray Water	Assist with upgrades of Surface Water Management System and implement on ground works to allow Environmental Water delivery to the Swamp.
Aboriginal Affairs Victoria	Promote knowledge and understanding within the wider community of the study area’s Aboriginal people and their history. Administer legislation protecting Aboriginal heritage sites within the study area (<i>State Archaeological and Aboriginal Relics Preservation Act 1972</i> and Part IIA of the Commonwealth <i>Aboriginal Torres Strait Islander Heritage Protection Act 1984</i>).
Reedy Swamp Management Group	Assist with the implementation of Management Actions that have arisen from the Reedy Swamp Environmental Management Plan.
Victorian Environmental Water Holder	Management of Environmental water entitlements on behalf of the Minister for Environment as of July 2011.

2.3 WETLAND CHARACTERISTICS

Wetlands in Victoria are currently classified using a system developed by Corrick and Norman (1980) which includes information on water depth, permanency and salinity. Wetlands through Victoria were mapped and classified between 1975 and 1994 and developed into spatial Geographic Information System (GIS) layers (DSE, 2007b).

Reedy Swamp is located in the Victorian Riverina Bioregion and is classified as a deep freshwater marsh under the wetland 1994 layer. This classification is considered representative of the wetland during the time it was mapped.

Reedy Swamp has a mean depth of approximately 1m and has a volume of approximately 1264ML¹. The wetland is located in the Lower Goulburn National Park, managed by Parks Victoria and is listed in *A Directory of Important wetlands* (VIC 052) under the Lower Goulburn River Floodplain (EA, 2001) (Table 2) .

The eastern edge of Reedy Swamp is Red Gum forest and the Lower Goulburn River. A road and irrigated agricultural properties adjoin the western side of the swamp. Urban encroachment is also an increasing risk to the swamp.

Environmental water can currently be delivered to the swamp by Eastern Goulburn Channel 19/12. This channel is to be decommissioned in 2011/12 and a report by Wood and Walters (2010) and section 8 – Environmental Water Delivery Infrastructure, discuss these options in more detail.

¹ Environmental water allocation volumes will vary corresponding with ecological and hydrological targets that need to be met at the time of delivery.

Table 2: Summary of site characteristics

Characteristics	Description
Name	Reedy Swamp
Mapping Id	7925531768
Area (ha)	130
Bioregion	Victorian Riverina
Conservation Status	Nationally Significant*
Land Status	Public – National Park
Land Manager	Parks Victoria
Surrounding Land Use	Irrigated Agriculture and Urban encroachment
Water Supply	Goulburn River and Shepparton Drain 3
1788 Wetland Category	Deep freshwater marsh
1994 Wetland Category	Deep marsh
Wetland volume (ML)	1264
Wetland depth at Capacity (m)	~1m

*Note: National Significance is listed in *A Directory of Important Wetlands*. Reedy Swamp is listed within the Goulburn catchment of *Directory of Important Wetlands* (VIC 052).

2.4 ENVIRONMENTAL WATER SOURCES

The Environmental Water Reserve (EWR) is the legally recognised amount of water set aside to meet environmental needs. The reserve includes minimum river flows, unregulated flows and specific environmental entitlements. Environmental entitlements are held in storage and can be delivered to wetlands or streams to protect their environmental values and health. Environmental entitlements are held by the Minister for Environment, who delegates management to the Victorian Environmental Water Holder.

Environmental Water for Reedy Swamp can be sourced from the water entitlements and their agencies listed in Table 3 and Appendix 3.

Table 3: Responsible Agencies for Environmental Water Allocations

Water Entitlement	Volume (ML)	Responsible Agency
Victorian River Murray Flora and Fauna Bulk Entitlement	27,600	Victorian Environmental Water Holder
Stockyard Plain Bulk Entitlement	112	Department of Sustainability and Environment
One Tree Swamp Bulk Entitlement	9.3	Parks Victoria
Gaynor Swamp Bulk Entitlement	24	

Future water reserves that may also be used within Reedy Swamp include water savings from the Northern Victoria Irrigation Renewal Project (NVIRP) and environmental water held by the Commonwealth Environmental Water Holder (CEWH). The amount of water available for use depends upon volumes acquired and seasonal water allocations.

Water from Shepparton Drain 3 may also be used in times of need to top up the wetland. Use of this water is opportunistic and bound by agreement with Goulburn-Murray Water. This water source in the past, has represented a relatively large volume that has underpinned Environmental Water Allocation use and outcomes.

2.5 LEGISLATIVE AND POLICY FRAMEWORK

There is a range of international treaties, conventions and initiatives, as well as National and State Acts, policies and strategies that direct the management of the study area. Those with particular relevance to the study area and the management of its environmental and cultural values are listed below. For the functions and major elements of each refer to Appendix 4.

International treaties, conventions and initiatives:

- Japan Australia Migratory Birds Agreement (JAMBA) 1974.
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) 1979.
- China Australia Migratory Birds Agreement (CAMBA) 1986.
- Republic of Korea Australia Migratory Birds Agreement (ROKAMBA) 2002.

Commonwealth legislation and policy:

- *Australian Heritage Commission Act 1975* (Register of the National Estate).
- *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Part IIA).
- *Native Title Act 1993*.
- Swamps Policy of the Commonwealth Government of Australia 1997.
- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- *Water Act 2007*.
- A Framework for Determining Commonwealth Environmental Watering Actions 2009.

Victorian legislation:

- *National Parks Act 1975*.
- *Flora and Fauna Guarantee Act 1988*.
- *Water Act 1989*.
- *Catchment and Land Protection Act 1994*.
- *State Environment Protection Policy (waters of Victoria) 2003*.
- *Aboriginal Heritage Act 2006*.

Victorian policy, codes of practice, charters and strategies:

- Goulburn Broken Catchment Regional Catchment Strategy (GBCMA, 2003).
- Our Water Our Future (DSE, 2004).
- Goulburn Broken Regional River Health Strategy (GBCMA, 2005a).
- Shepparton Irrigation Region Regional Catchment Strategy (GBCMA, 2006b).
- Land and water biodiversity paper. Securing our Natural Future (DSE, 2009b).
- Northern Region Sustainable Water Strategy (DSE, 2009c) .
- Biodiversity Strategy for the Goulburn Broken Catchment, Victoria 2010-2015 (Miles et al., 2010).

2.6 RELATED PLANS AND ACTIVITIES

A number of key management documents have been written that directly or indirectly assist with management of the site. These include:

1. Reedy Swamp Environmental Management Plan (DPI, 2003). This management plan presents the geomorphological, biological, utilisation history, management history and current stakeholder's requirements. It focuses on the values as a breeding and feeding site for species such as Ibis colonies that frequent the site for breeding, as a public amenity and provides drainage protection from catchment drainage and run-off.
2. Reedy Swamp Environmental Watering Plan (Wood and Walters, 2010). This plan presents the proposed rationalisation of the irrigation channel near Reedy Swamp used to deliver environmental water to Shepparton Drain 3 which can outfall into the swamp. The plan determines alternative water supply routes to the swamp.

These plans make a number of recommendations, some of which have been implemented and have assisted with protection and enhancement of Reedy Swamp's natural values including:

1. Revegetation of the degraded sand hill area on the eastern side of the wetland.
2. Pest plant control such as woody weed removal at the site by Victorian Certificate of Applied Learning (VCAL) students.
3. Pest animal control such as red fox (*Vulpes vulpes*) baiting.
4. Upgrade of Shepparton Drain 3 inlet into Reedy Swamp to allow more efficient water delivery.
5. Fencing to protect remnant and revegetated areas and control vehicle access.
6. Environmental water delivered for drought refuge in 2008 and 2009 (section 4.1.4 – Environmental Water).
7. Monitoring the ecological response of flora and fauna to environmental water delivery in 2008 and 2010 (Cook et al., 2009, Jolly and Osler, 2011).
8. Assessment of Reedy Swamp condition using the Index of Wetland Condition methodology (section 5.2 – Current Condition).

3. WATER DEPENDENT VALUES

3.1 ENVIRONMENTAL - FAUNA

3.1.1 FAUNA LISTINGS AND SIGNIFICANCE

Reedy Swamp provides habitat for a wide variety of wetland and terrestrial fauna species. To date 195 fauna species (185 native and 10 exotic) have been recorded at the swamp (Appendix 5). These include 121 bird species (52 wetland species), seven fish species (three exotic), seven frog species, 30 macroinvertebrate species, seven reptile species and eight species of mammal species (three exotic). Of the water dependant species, 11 are listed under the *Flora and Fauna Guarantee Act* (1988), 23 listed under the *Advisory list of threatened vertebrate fauna* (DSE, 2007a), three species are listed under the Japan Australia Migratory Bird Agreement (JAMBA), five are listed under China Australia Migratory Bird Agreement (CAMBA) and three are listed under the Republic of Korea Australia Migratory Bird Agreement (ROKAMBA) (Figure 4, Table 4).

Twenty two waterbird species have been recorded breeding at Reedy Swamp (O'Connor, 2008). This includes species such as Australasian Shovelers (*Anas rhynchos*); Black-winged Stilts (*Himantopus himantopus*); Musk Ducks (*Biziura lobata*) and the White-bellied Sea-Eagle (*Haliaeetus leucogaster*) (Refer to Appendix 4 for full list of species). Australian White Ibis (*Threskiornis molucca*), Straw-necked Ibis (*Threskiornis spinicollis*) and Royal Spoonbills (*Platalea regia*) and Yellow-billed Spoonbills (*Platalea flavipes*) utilise the swamp as a rookery, nesting on beds of Giant rush (*Juncus ingens*) (section 3.1.1 – Fauna – Listings and Significance; Figure 5). Reedy Swamp has previously been managed for successful for breeding events of Ibis and spoonbills utilising the swamp (DPI, 2003) and should be continued to be managed for these species (section 6.2 – Ecological and Hydrological Objectives).

Glossy Ibis (*Plegadis falcinellus*) has been observed at the swamp utilising the mud flats, however, no observations of breeding have been made.

Amphibians thrive at Reedy Swamp when it holds water due to the variety of available aquatic habitat.

Table 4: Conservation status of water dependant fauna species recorded in the study area.

Common Name	Scientific Name	Type	International Agreements	FFG	DSE Status
Australian Little Bittern	<i>Botaurus poiciloptilus</i>	B		L	End
Australasian Shoveler	<i>Anas rhynchotus</i>	B			Vul
Ballion's Crake	<i>Porzana pusilla palustris</i>	B		L	Vul
Blue-billed Duck	<i>Oxyura australis</i>	B		L	End
Brown Quail	<i>Coturnix ypsilophora australis</i>	B			NT
Crimson Spotted Rainbowfish	<i>Melanotaenia fluviatilis</i>	F		L	DD
Eastern Great Egret	<i>Ardea modesta</i>	B	J,C,R,B	L	Vul
Flat-headed Galaxias	<i>Galaxias rostratus</i>	F			Vul
Freckled Duck	<i>Stictonetta naevosa</i>	B		L	End
Glossy Ibis	<i>Plegadis falcinellus</i>	B	C, B		NT
Hardhead	<i>Aythya australis</i>	B			Vul
Intermediate Egret	<i>Ardea intermedia</i>	B		L	CEn
Latham's Snipe	<i>Gallinago hardwickii</i>	B	J, C, R, B		NT
Lewin's Rail	<i>Lewinia pectoralis</i>	B		L	Vul
Little Egret	<i>Egretta garzetta nigripes</i>	B		L	End
Magpie Goose	<i>Anseranus semipalmata</i>	B			Vul
Murray River Turtle	<i>Emydura macquarii</i>	R		L	DD
Musk Duck	<i>Biziura lobata</i>	B			Vul
Nankeen Night Heron	<i>Nycticorax caledonicus</i>	B			NT
Pied Cormorant	<i>Phalacrocorax varius</i>	B			NT
Royal Spoonbill	<i>Platalea regia</i>	B			Vul
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>	B	J, C, R, B		
Whiskered Tern	<i>Chlidonias hybridus javanicus</i>	B			NT
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>	B	C	L	Vul

Legend

Type: Bird, Fish, Reptile

International: CAMBA (C), JAMBA (J), ROKAMBA (R), Bonn (B)

FFG Status: Listed as threatened (L)

DSE Status: Critically Endangered (CEn), Endangered (End), Vulnerable (Vul), Near Threatened (NT), Data Deficient (DD)



Figure 4: Sharp-tailed sandpipers observed at Reedy Swamp in 2008.

Photo: P O'Connor, DSE 2008

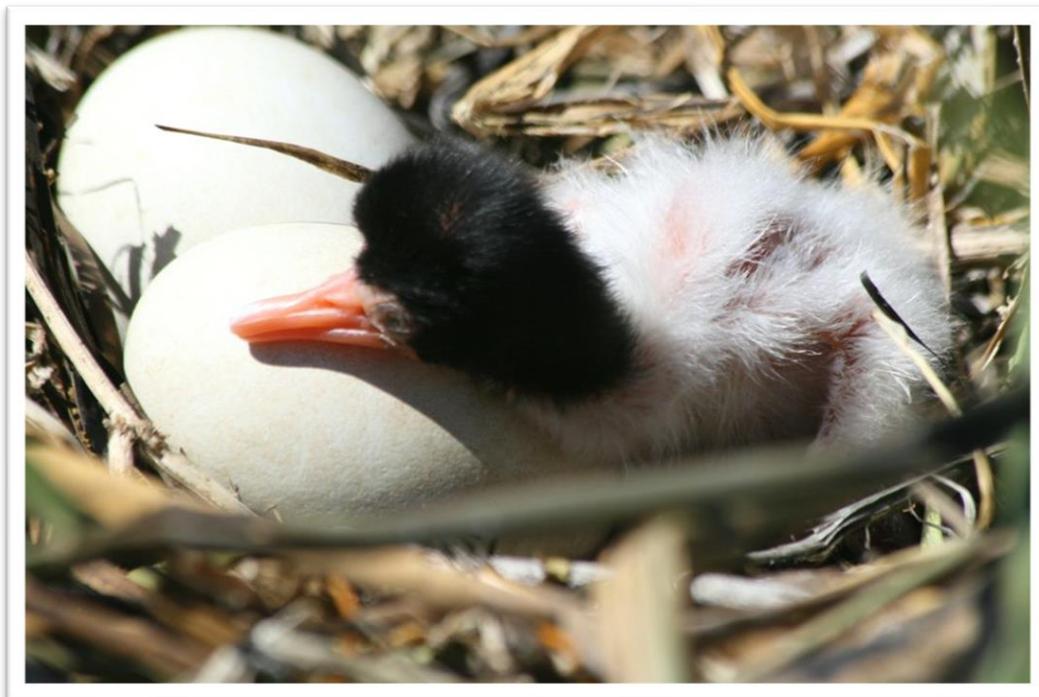


Figure 5: Straw-necked Ibis breeding at Reedy Swamp in 2008.

Photo: P O'Connor, DSE 2008

Aquatic insects were sampled at Reedy Swamp on a fortnightly basis from April 2008 – February 2009 at four different sampling sites (Wood, 2010). A total of 30 taxa were recorded at the swamp (Appendix 5). Functional feeding groups were determined from the samples and this indicated that collectors and predators were the most abundant groups. Collectors feed on decomposing fine particulate organic matter, which was prolific at Reedy Swamp.

Predatory biomass has been observed higher in areas with simple plant architecture and that visually orientated predators flourish in habitats with enough structural complexity to provide increased prey biomass and hunting cover, but not so much as to make predation difficult (Hornung and Foote, 2006). Vegetation structure at Reedy Swamp is classified as simple as it is largely dominated by giant rush (*Juncus ingens*), dead river red gums (*Eucalyptus camaldulensis*) and Water Pepper (*Persicaria spp*).

3.1.2 SIGNIFICANT FAUNA

Reedy Swamp provides breeding habitat for the vulnerable Royal Spoonbill (Figure 6), Yellow-billed Spoonbills, Australian White Ibis and Straw-necked Ibis. The Reedy Swamp Environmental Management Plan (DPI, 2003) has a management regime for Ibis and Spoonbills at the site. This watering regime should continue to be adhered to, to encourage future breeding events of these species (section 6.2 – Ecological and Hydrological requirements).

Australian White Ibis are not well synchronised in their egg-laying. A colony will build up over time with nests containing eggs and young at different stages of development. Straw-necked Ibis are highly synchronised with large groups commencing egg-laying on the same day. Royal Spoonbills (Figure 6) and Yellow-billed Spoonbills are usually synchronised but not as highly as Straw-necked Ibis (DPI, 2003). Table 5 shows the different breeding requirements for these species (Rogers and Ralph, 2011, Ward, 2011)

Table 5: Breeding requirements of Ibis and Spoonbills (Rogers and Ralph, 2011)

Species	Stimulus	Breeding Season	Max Flood timing	Minimum lag time (months)	Ideal lag time (months)	Breeding duration (months)	Nesting requirements	Clutch size	Incubation period (days)	Ideal flood requirement (months)
Australian White Ibis	Flood	Sept- Apr	-	1-3	1-3 months in Northern Victoria	2-3	Giant Rush for Reedy Swamp	1-6	20-23	8-12
Straw-necked Ibis	Flood, season	Sept – Feb	Any time	3	1-3 months in Northern Victoria	3	Giant Rush at Reedy Swamp	2-5	20-23	6-12
Yellow-billed Spoonbill	Flood, season	Sept – Apr	Any time	2	2-6	2-3	Trees. Like to have nests 2-8m above water.	2-4	26-31	9
Royal Spoonbill	Flood, season	Oct- Mar	Oct – May	1-2	>2	2-3	Usually trees, shrubs and reeds. 1-15 m above water. Giant Rush at Reedy Swamp.	2-5	20-25	4-5

Reedy Swamp plays an important role in providing habitat for international migratory species such as Latham’s Snipe and Sharp-tailed Sandpipers (Figure 4). These species have been observed around the margins of the swamp during several flood events.

Many species of duck also utilise the wetland as a feeding and breeding site. Including the Australasian Shoveler, Musk Duck, Blue-billed Duck, Hardhead and Freckled Duck.



Figure 6: Royal Spoonbill nesting at Reedy Swamp in 2010.

Photo: K. Ward, GBCMA 2010

3.2 ENVIRONMENTAL – FLORA VEGETATION COMMUNITIES

A hierarchical system of classification of vegetation communities has been developed in Victoria over the past decade in order to classify vegetation into units that are both ecologically meaningful and useful for vegetation managers. The classification that has been adopted in Victoria is Ecological Vegetation Classes (EVCs), which are defined by a combination of floristic, life-form, position in the landscape and an inferred fidelity to particular environments. Each EVC includes a collection of floristic communities that occur across a biogeographic range and although differing in species, have similar habitat and ecological processes operating. Approximately 300 EVCs have been described for Victoria.

Reedy Swamp is located in the Victorian Riverine Bioregion. EVCs within the wetland include Tall Marsh (EVC #821), Rushy Riverine Swamp (EVC #804) and Floodway Pond Herbland (EVC #810) (Jolly and Osler, 2011). Within the Victorian Riverine bioregion Tall Marsh is classified as endangered, Rushy Riverine Swamp is classified as depleted and Floodway Pond Herbland is classified as vulnerable. EVCs surrounding the swamp include Riverine Swampy Woodland (EVC #815), Sedgely Riverine Forest (EVC #816), Plains Woodland (EVC #803) and Sand Ridge (EVC #264), which are all classified as endangered in the Victorian Riverine Bioregion (Table 6, Appendix 6). However, dead river red gums (*E. camaldulensis*) situated within the wetland body indicate that the wetland was once a Red Gum Swamp (EVC #292) (Table 6, Appendix 6).

The current condition of vegetation at Reedy Swamp is poor, generally as a result of the initial modification of prolonged flooding of the wetland having killed the river red gums on the main wetland floor, and the relatively poor diversity of the wetland vegetation that continues to readjust due to the extremes in flood regimes (Cook et al., 2009).

Table 6: Conservation status of Ecological Vegetation Classes recorded within Reedy Swamp

EVC Number	EVC Name	Bioregional Conservation Status
804	Rushy Riverine Swamp	De
810	Floodway Pond Herbland	Vu
821	Tall Marsh	En

Legend (Wierzbowski et al., 2002)

En = Endangered. Meaning the EVC is on the verge of extinction with 90% or more cleared since European settlement (1750).

Vu = Vulnerable. Meaning the EVC is moving towards extinction with 70% or more of these areas having been cleared since European settlement (1750).

De = Depleted. Meaning the EVC is likely to become threatened if clearing or threatening processes continue and that 50-70% of this EVC has already been cleared since European settlement (1750).

3.2.1 FLORA – SPECIES LISTINGS AND SIGNIFICANCE

A total of 168 native flora species have been recorded at Reedy Swamp including 92 native wetland species (Appendix 7). Table 7 considers three of the wetland species that are considered rare, threatened or endangered in Victoria (DSE, 2005a) and one is listed under the *Flora and Fauna Guarantee Act (1988)*. Terrestrial species can be referred to in Appendix 7.

Table 7: List of water-dependent plant species recorded at Reedy Swamp

Common Name	Scientific Name	EPBC	FFG	DSE
Grey Billy-buttons	<i>Craspedia canens</i>		L	e
Groundsel	<i>Senecio campylocarpus</i>			r
Sand Rush	<i>Juncus psammophilus</i>			r
Woolly Knotweed	<i>Persicaria lanigera</i>			k

Legend: DSE Status: Rare (r), poorly known (k)

The native water couch (*Paspalum distichum*) poses a threat to Reedy Swamp and can dominate the wetland by forming a ‘thick carpet’ and can grow rapidly in the summer months by propagating from seeds or rhizomes. Water couch has an unknown status in Australia (DPI, 2011b) and possibly consists of both native and naturalised species. It can be difficult to eradicate, however maintenance of the species as a mosaic distribution is possible. This can be achieved by returning a more natural flooding regime to Reedy Swamp and allowing a summer drawdown/drying period. Arrowhead (*Sagittaria platyphylla*) within Shepparton Drain 3 poses risk to the site due to its ability to outcompete native flora species if it enters the wetland. This should be treated and monitored accordingly. A total of 121 exotic flora species have been recorded in the study area comprising 15 wetland species (Appendix 7).

3.3 WETLAND DEPLETION AND RARITY

Victoria's wetlands are currently mapped and are contained within a state wetland database, using an accepted statewide wetland classification system, developed by Corrick and Norman (1980) from the Arthur Rylah Institute. Mapping was undertaken from 1981 using 1:25,000 colour aerial photographs, along with field observations (Corrick and Norman, 1980). This database is commonly known as the 1994 wetland layer and contains the following information:

- categories (primary) based on water regimes; and
- subcategories based on dominant vegetation.

At the same time, an attempt was made to categorise and map wetland areas occupied prior to European settlement. This was largely interpretive work and uses only the primary category, based on water regime. This is known as the 1788 layer.

It has been possible to determine the depletion of wetland types across the state using the primary category only, based on comparison of wetland extent between the 1788 and 1994 wetland layers.

Comparison between the wetland layers has demonstrated the impact of European settlement and development on Victorian wetlands. This has been severe, with approximately one-third of the state's wetlands being lost since European settlement; many of those remaining are threatened by continuing degradation from salinity, drainage and agricultural practices (EA, 2001). Across the state, the greatest losses of original wetland area have been in the freshwater meadow (43%), shallow freshwater marsh (60%) and deep freshwater marsh (70%) categories (DNRE, 1997).

Reedy Swamp is classified as a deep freshwater marsh and represents a wetland type where only 30 per cent remains since settlement in Victoria and 40 per cent within the Goulburn Broken catchment (GBCMA, 2006a, Clunie and Lyon, 2002). The conservation and protection of these areas is imperative for the flora and fauna that rely on them as breeding, feeding and roosting sites.

3.3.1 ECOSYSTEM FUNCTIONS

Wetlands are considered ecologically important due to their role in maintaining biological diversity, promoting biochemical transformation and storage and decomposition of organic materials (DSE, 2007b).

Reedy Swamp is a large back-swamp that has formed between a natural levee on the Goulburn River floodplain and a sand ridge to the east, and is located on the northern edge of the Shepparton township (Jolly and Osler, 2011).

Floodplain wetlands perform important functions necessary to maintain the hydrological, physical and ecological health of river systems. These functions include:

- enhancing water quality through filtering sediments and re-using nutrients;
- absorbing and releasing floodwaters;
- providing organic material to rivers to maintain riverine food chains; and
- providing feeding, breeding and drought refuge sites for an array of flora and fauna, especially waterbirds and fish.

However, the capacity of floodplain wetlands to perform the ecological functions outlined above will depend on their condition (section 5 – Threats and Condition).

3.4 SOCIAL

3.4.1 CULTURAL HERITAGE

Reedy Swamp has been identified as a culturally sensitive area (Figure 7). Cultural sensitive areas are classified under the *Aboriginal Heritage Act 2006* (Vic) as waterways or land within 200m of a waterway. Reedy Swamp and its surrounding catchment have had a long history of traditional owner occupation by the Yorta Yorta Aboriginal Nation and is an important part of their cultural and spiritual heritage. Reedy Swamp and the surrounding floodplain would have provided Yorta Yorta people with a rich and diverse supply of plant and animal resources for food, medicine, shelter, clothing and tools (Appendix 7). All aboriginal sites, places and objects are protected under the *Archaeological and Aboriginal Heritage Act 2006* (Vic.) and the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (CoA).

The Yorta Yorta Cooperative Management Agreement was signed in 2004. The agreement establishes a formal role for the Yorta Yorta Peoples in the management of land and water in their traditional country. Currently the agreement does not include reference to Reedy Swamp. However, the exclusion of the planning area from this agreement does not preclude the involvement of the Yorta Yorta Peoples in its management.

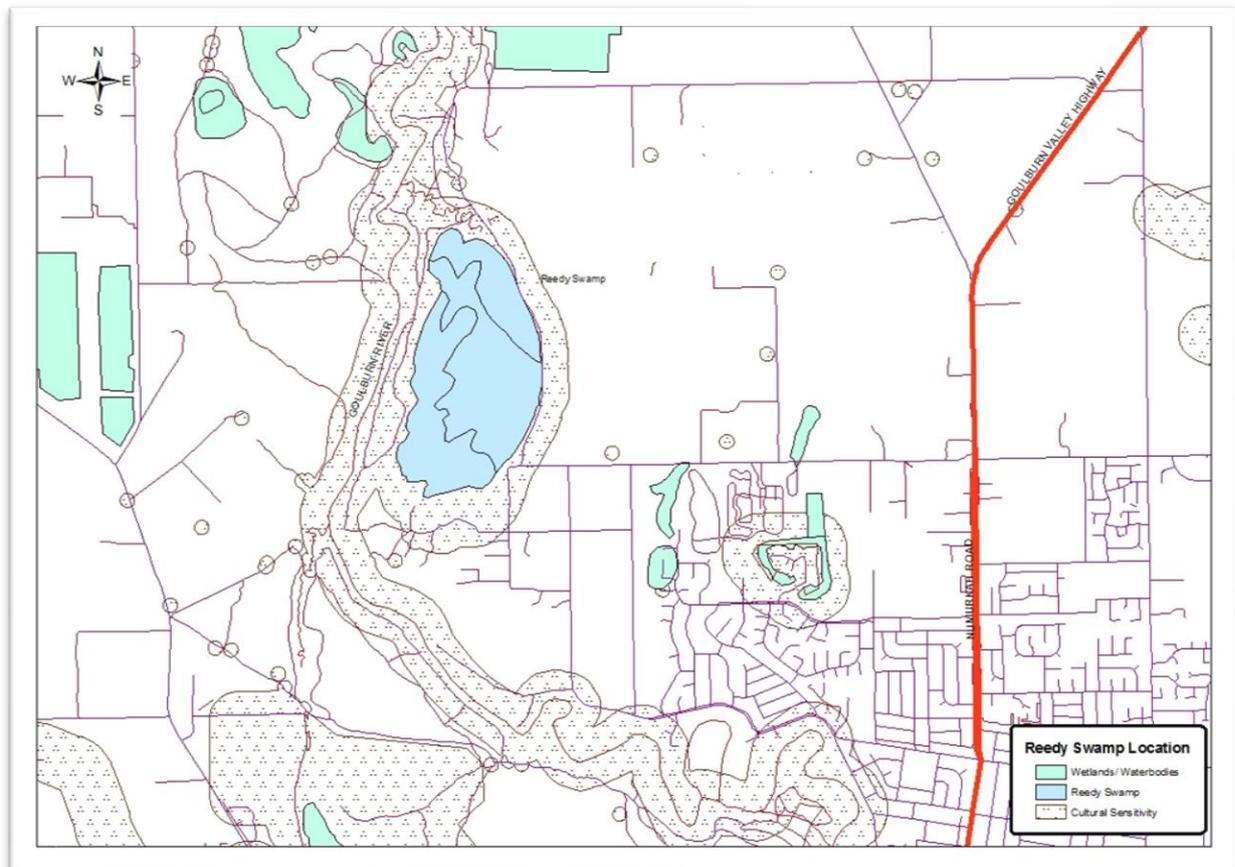


Figure 7: Cultural sensitive areas within and around Reedy Swamp complex

3.4.2 RECREATION

Activities enjoyed by visitors to the study area include bird watching, photography, picnicking, bike riding and walking. None of these activities are directly dependent on wetland flooding. However, wetland flooding can enhance the enjoyment of visitor's activities by providing more diverse habitat and fauna experiences.

3.5 ECONOMIC

Wetlands provide both direct and indirect economic benefits to Goulburn Broken Catchment (Cork et al., 2001). The direct economic values that Reedy Swamp provides to the Goulburn Broken Catchment include non-consumptive uses such as tourism and recreation to the area. Indirect economic values that Reedy Swamp provide to the Goulburn Broken Catchment include a wide range of ecosystem services such as flood retardation, water storage, groundwater recharge, nutrient discharge and carbon storage.

4. HYDROLOGY AND SYSTEM OPERATIONS

Wetland hydrology is the most important determinant in the establishment and maintenance of wetland types and processes. It affects the chemical and physical aspects of the wetland which in turn affects the type of flora and fauna that the wetland supports (DSE, 2007b). A wetlands hydrology is determined by surface and groundwater inflows and outflows in addition to precipitation and evapotranspiration (Mitsch and Gosselink, 1993). Duration, frequency, seasonality (timing) and depth are the main components of a wetlands hydrological regime.

4.1 WATER MANAGEMENT AND DELIVERY

4.1.1 PRE-REGULATION

Before construction of the Goulburn Weir in 1891, the Goulburn River would have flooded annually, inundating Reedy Swamp for up to six months of the year via a small depression (North Creek) to the north of the wetland. Between the 1920s-late 1970s, Reedy Swamp experienced prolonged unnatural flooding from irrigation and water treatment drainage disposal that resulted in the wetland becoming more akin to a more permanent water body. Structural works were constructed in 1993-94 to improve the ability to divert drainage water around the wetland and have the ability to re-introduce a more natural wetting and drying regime.

Under natural conditions Reedy Swamp was dominated by river red gums and would have dried out most years during summer and autumn. Historically, the swamp filled annually by floodwaters flowing from the Goulburn River via a small depression (North Creek) to the north of the wetland (Figure 8). Occasional higher flows would have overtopped the river levee and flowed into the wetland from the south-west. Flood waters would have drained from the wetland back into the Goulburn River via North Creek (DPI, 2003) as they do today.



Figure 8: Goulburn River (left of image) flowing into the North Creek July 2011.

Photo: Jo Wood, GB CMA 2011.

4.1.2 POST-REGULATION

Since the 1860s, selective logging, cattle and sheep grazing and fires have modified Reedy Swamp 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 and high nutrient loading, causing the death of many river red gums and allowing rushes (*Juncus sp*) and water couch to dominate the wetland area (DPI, 2003, Robinson, 1990, Felton, 1992).

In 1977, concrete pipes and an earthen bank were installed on the outlet creek (North Creek) to minimise erosion and give control over water levels. In 1979, this was upgraded to a concrete control structure (Figure 9). Vandalism of this structure kept water levels high within the swamp by preventing drainage water that enters the wetland from escaping to the river.

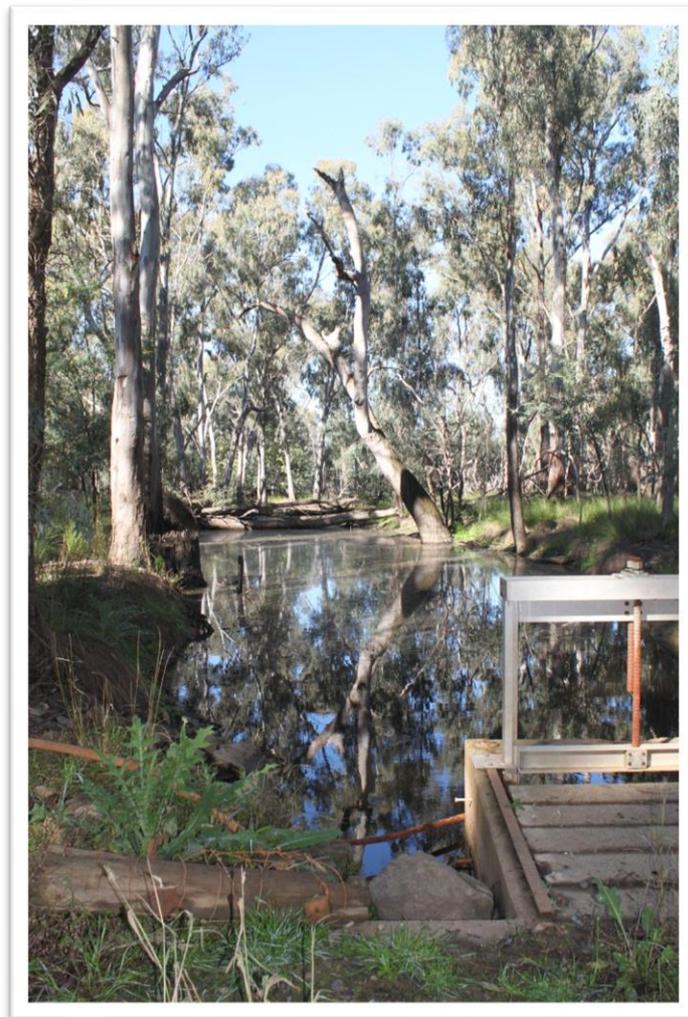


Figure 9: The outlet structure on North Creek at Reedy Swamp, constructed in 1979.

Photo: Jo Wood, GB CMA 2011.

An attempt was made to drain the swamp in 1993 in a quest to return a more natural flood regime to the wetland, though this proved unsuccessful because of particularly high rainfall-induced runoff events that continued to fill the swamp. An extension was then made to Shepparton Drain 3 (which flowed directly into Reedy Swamp) in 1994 to by-pass the drain around the wetland and diverts flow directly into North Creek. These works enabled Reedy Swamp to be drained for the first time in many years.

A regulating structure and overflow sill was also constructed on the drain in 1994 to permit diversion of drainage water into the wetland when required (Figure 10). This drainage water can now be diverted around the Swamp if water quality is too saline (greater than 1000EC) or not required.



Figure 10: Regulating Structure and overflow sill at Reedy Swamp to allow drainage water in the wetland as required.

Photo: Jo Wood, GB CMA 2011.

4.1.3 WETLAND VOLUME

Reedy Swamp is a 130 hectare wetland and has an average depth of 1 metre. The volume of the wetland has been calculated to be 1264ML. It is estimated, however that approximately 50 per cent more of this volume would be required to compensate against loss to the soil profile in the event that environmental water was to be released to fill the wetland from a dry state. Water enters the wetland from the North Creek when the Goulburn River has a flow capacity of 20,000 ML or via Shepparton Drain 3, both of which are situated in Section Three of the Goulburn-Murray Water, water trading zone.

4.1.4 ENVIRONMENTAL WATER

Environmental water can currently be delivered to Reedy Swamp via the East Goulburn 19/12 channel. However, this channel is not classified as a “backbone channel” and is proposed to be decommissioned in 2011/12 with the upgrade of channel systems from the implementation of Northern Victoria Irrigation Renewal Project (NVIRP). An Environmental Watering Plan (Wood and Walters, 2010) discusses optional watering points for Reedy Swamp and has been written to assist with negotiations between relevant agencies to deliver environmental water to Reedy Swamp via other channel and surface water management systems (refer to section 8.3 – Infrastructure recommendations).

Environmental water has been delivered to Reedy Swamp on three occasions, all since 2008. A proposal to deliver environmental water to Reedy Swamp in 2005 became redundant after inflows filled the swamp. In 2007/08, an environmental water delivery of 544ML was delivered to the wetland (Figures 11 and 12) and another 500ML was delivered in 2008/09. In 2009/10, another 300ML of water was delivered to the Swamp. Since then the swamp has been topped up by inflows from Shepparton Drain 3 and overbank flooding due to rainfall activity.



Figure 11: Reedy Swamp on 30th April 2008, the day of the environmental water delivery



Figure 12: Reedy Swamp 17th September 2008, five months after the delivery of environmental water

Photos: Jo Wood, DPI 2008

5. THREATS AND CONDITION

5.1 WATER DEPENDENT THREATS

The key threats to the values of Reedy Swamp are outlined below. These threats result from activities in the wetland, on adjoining land and in the surrounding catchment. To address these threats and the impacts, an integrated approach is required.

Altered water regime – Hydrology is the most important component of wetland ecosystems. It drives the physical and chemical properties of a wetland, and the biota it supports. As described in section 4.1.2 – Post-regulation, the natural hydrological regime of Reedy Swamp has been significantly altered by the regulation of the Goulburn River and connection to Shepparton Drain 3. Decommissioning of the East Goulburn channel 19/12 which currently assists with the delivery of environmental water could also affect the future hydrology of Reedy Swamp.

Altered physical form – Physical form relates to the area and bathymetry of a wetland. The area of Reedy Swamp has been reduced by drainage and excavation activities and the construction of tracks between the Goulburn River and the swamp. Impacts on the wetland bathymetry have not been identified. Future impacts on the physical form of the wetland are likely to be minimal due to the increased protection provided by its current land reservation status. Current sediment deposition rates are unknown; though appear to be locally high only near the inlet channel. Change to wetland capacity is unlikely to significantly vary over foreseeable decades.

Poor water quality – Poor water quality including low dissolved oxygen may reduce the habitat available for native aquatic biota, reducing diversity and abundance. Elevated nutrients, particularly phosphorus, can also promote Blue Green Algae blooms that in turn decrease various wetland values. The water quality within Reedy Swamp may be impacted by:

- Possible high nutrient load run-off from urban and agricultural runoff entering the wetland from Shepparton Drain 3.
- Periodic high nutrient loadings from large densities of nesting waterbirds.
- Exotic fish species such as Carp and Goldfish feeding within the sediment and increasing turbidity.

Degraded habitats (soil disturbance) – Wetland soils provide the physical substrate which aquatic vegetation requires to establish, and provides habitat for benthic invertebrates and microorganisms (DSE 2009). Threatening processes that can lead to poor wetland soils within Reedy Swamp include:

- Human visitation (wading within or walking around the fringe of the wetland).
- Driving of vehicles within the wetland (which has been noted during both wet and dry phases).
- Carp and Goldfish disturbance of the wetland floor increasing turbidity and affecting the soil profile.

Exotic flora and fauna – The invasion of native vegetation by pest plants is listed as potentially threatening process under the Schedule 3 of Victoria's *Flora and Fauna Guarantee Act (1988)* and is considered to be one of the major threats to conservation of biological diversity in Victoria (PV, 2003). The growth of pest plants can be sufficiently vigorous to reduce or prevent the regeneration or establishment of native plant species, altering the composition and structure of indigenous communities. Modifications to the composition and structure of indigenous vegetation as a result of pest plant invasion can modify the abundance of indigenous fauna, geomorphological process, hydrological cycles, and the nutrient content of soil and disturbance regimes including fire, grazing and insect activity (PV, 2003).

As discussed in section 3.2.1 – Flora Species listing and significance, a total of 121 exotic flora species have been recorded at the site, comprising 15 wetland species (Appendix 7). Arrowhead (*Sagittaria platyphylla*) within Shepparton Drain 3 poses risk to the site due to its ability to outcompete native flora species. Water couch (*native – however status is being deliberated in Australia*) dominates a large area at the southern end of the wetland and should be monitored. Aster Weed (*Aster subulatus*) can outcompete native in shallow margins of the wetland trying to establish and Lippia (*Phyla canescens*) can contribute to deep soil drying leading to bank slumping and erosion (DSE, 2009a, DPI, 2011a) and can change floodplain functions such as flood passage, erosion of banks and sediment in water (Roberts and Marston, 2011). Drain sedge (*Cyperus eragrostis*) may also pose a threat to Reedy Swamp due to its persistence in shallow margins of the wetland.

Pest animals threaten the ecological values of wetlands by preying on native species, transmitting diseases, and competing for food and habitat. Pest animals recorded at Reedy Swamp include:

- Foxes - Fox predation is listed as a threatening process under the *EPBC Act (1999)* and Schedule 3 of the *FFG Act (1988)*.
- Carp, Goldfish and Gambusia.

5.2 CURRENT CONDITION

The condition of Reedy Swamp was assessed in 2010 using a method developed by DSE called the Index of Wetland Condition (IWC). The IWC defines wetland condition as the state of the biological, physical and chemical components of the wetland ecosystem and their interactions (DSE, 2005b).

The IWC has six subindices based on the catchment of the wetland and its fundamental characteristics: wetland catchment, physical form, hydrology, water properties, soils and biota (Appendix 8). Each subindex is given a score between 0 and 20 based on the assessment of a number of measures (Appendix 8). The overall IWC score is not a simple summation of the subindex scores. A formula is used that weights each subindex according to the contribution it makes to the overall condition of the wetland. The wetland hydrology subindex for example contributes more to the overall score than the soils subindex. Further information on the method can be found on the IWC website: www.dse.vic.gov.au/iwc.

The overall IWC score for Reedy Swamp in 2010 was six out of ten, which is considered to be moderate (Table 8). Of note the subindices hydrology was considered to be very poor due to the significant impact of river regulation, drainage and outfalls on the natural wetting and drying cycle of Reedy Swamp (refer to Section 4 – Hydrology and system operations). The river red gums that once dominated the swamp have been largely displaced by species such as giant rush that have adapted to prolonged flooding. These hydrological impacts in turn have modified the wetland vegetation (refer to section 3.2 – Flora vegetation communities).

Table 8: Reedy Swamp IWC subindex score, overall score and associated condition categories

IWC subindex	Score	Condition category
Wetland catchment	13.5/20	Good
Physical form	20/20	Excellent
Hydrology	0/20	Very poor
Water properties	15/20	Good
Soils	19.5/20	Excellent
Biota	15.4/20	Moderate
Overall IWC Score	6/10	Moderate

5.3 CONDITION TRAJECTORY

Ongoing management including the delivery of environmental water and continued monitoring of Reedy Swamp is critical to protecting the ecological values of Reedy Swamp. If no intervention occurs, Reedy Swamp will only receive water via flooding and from Shepparton Drain 3. Which with an increasing drying climate, this may occur less frequently than suits the swamp vegetation and dependent aquatic fauna. Shifts in climate such as an increase in summer storm events may also impact upon the wetland. This may cause accelerated loss of species diversity and terrestrialisation of vegetation within the wetland area.

6. MANAGEMENT OBJECTIVES AND ADAPTIVE APPROACHES

6.1 MANAGEMENT GOAL

The management goal of Reedy Swamp is derived from a variety of sources including information from the Reedy Swamp Environmental Management Plan (DPI, 2003) local expertise and knowledge and by a Scientific technical advisory committee (refer to section 1.4 – Consultation). The goal considers the values the wetland supports. This includes consideration of the aquatic dependent values the swamp has historically supported and the likely aquatic dependent values it could support into the future considering climate change.

Reedy Swamp Management Goal

“To provide a more natural hydrological regime that supports waterbird breeding and improves the condition of existing mosaic of EVCs as well as providing a designated primary drought refuge during times of regional need”

The management goal is for Reedy Swamp to have a more natural water regime than what has occurred in the recent past. The operating regime is based on the need for the goal to be achievable and for the Environmental Watering Management Plan to support the desired ecological outcomes of the site.

6.2 ECOLOGICAL AND HYDROLOGICAL OBJECTIVES

6.2.1 ECOLOGICAL OBJECTIVES

Ecological objectives are the desired ecological outcomes of the site. In line with Victoria’s asset-based river health investment, the ecological objectives are based on the key values of the site (outlined in Section 3 – Water dependent values). The ecological objectives are expressed as the target condition or functionality for each key value. The ecological objectives are expressed as establishing one of the following trajectories of each key value, which is related to the present condition or functionality of the value (Table 9):

- Protect – retain the value at an existing stage of succession.
- Improve – improve the condition of the value while allowing natural processes of regeneration, disturbance and succession to occur.
- Maintain – maintain the current condition of the value while allowing natural processes of regeneration, disturbance and succession to occur.
- Reinstate – reintroduce values that can no longer be found in the area.

The ecological objectives for Reedy Swamp are based on values that the wetland provides for the larger Lower Goulburn River Floodplain and on a local scale for its waterbird carrying capacity, ability to support species listed under the Flora and Fauna Guarantee Act (1988) and its ability to support waterbird breeding. The ecological objectives for Reedy Swamp are:

- Improve the diversity of native wetland flora species consistent with the EVC benchmarks.
- Reduce the cover and diversity of exotic flora species.
- Maintain habitat for colonial waterbird refuge and breeding including Australian White Ibis, Straw-necked Ibis, Royal Spoonbills (v) and Yellow-billed Spoonbills.
- Maintain or increase diversity and abundance of frog species supported by the wetland during flood events.
- Provide feeding habitat for significant waterbird species such as Eastern Great Egret, Intermediate Egret, Glossy Ibis and Latham’s Snipe during flood events.

Justification for the ecological objectives is given in Table 9.

Table 9: Ecological Objectives for Reedy Swamp

Ecological Objective	Justification (Value based)
Improve the diversity of native wetland flora species consistent with the mosaic of EVC benchmarks*.	Increase habitat and food sources for native fauna. Increase biodiversity.
Reduce the cover and diversity of exotic and/or highly invasive native flora species.	Exotic plant species present at Reedy Swamp notably Arrowhead in Shepparton Drain 3 poses a threat to entering the wetland and outcompeting native flora. The highly invasive native water couch is also outcompeting other native flora within the wetland in some areas and needs to be monitored and managed appropriately.
Maintain habitat for colonial waterbird refuge and breeding including Australian White Ibis, Straw-necked Ibis, Royal Spoonbills (v) and Yellow-billed Spoonbills.	Reedy Swamp supports breeding populations of colonial waterbirds and is a significant breeding site along the Goulburn River.
Maintain or increase diversity and abundance of frog species supported by the wetland during flood events [^] .	Reedy Swamp is relatively rich in Frog species as seven species have been recorded (Appendix 5)
Provide feeding habitat for significant waterbird species such as Eastern Great Egret, Intermediate Egret, Glossy Ibis and Latham’s Snipe during flood events.	Mudflats are feeding sites for Glossy Ibis and shallow freshwater marsh is a feeding area for Eastern Great Egret.

*Refer to Appendix 9, ^ Refer to Appendix 10

6.2.2 HYDROLOGICAL OBJECTIVES

Consistent with the management goal and the ecological objectives above, the water regime for Reedy Swamp is for flooding to occur 6 in 10 years, in late Autumn-spring, covering at least 75 per cent of the wetland area and drying out within a year (Table 10). In the long term, reinstating a more natural hydrological regime will improve the mosaic of EVCs, and reduce the abundance and distribution of the highly invasive water couch. This coincides with both species of Ibis and Spoonbills breeding events, hence water delivery may need to be extended in order to avoid birds abandoning nests and drawdown should be slow. Drying regimes should occur in late summer – autumn and is required over at least 75 per cent of the wetland area in 6-10 years in ten years to improve sediment consolidation and aeration, and provide conditions more suitable for EVC establishment and maintenance where this requires seasonal flooding regimes (DPI, 2003).

Monitoring of the site will need to be undertaken to determine how long water should be held within the swamp to promote or extend bird breeding events or encourage plant growth and reproduction.

Table 10: Hydrological objectives to maintain Reedy Swamp

Ecological Objectives	Water management area	Hydrological Objectives											
		Recommended number of events in 10 years			Tolerable interval between events once wetland is dry (months)			Duration of ponding (months)			Preferred timing of inflows	Volume to fill to target supply level (ML)	Depth (mm)
		Min	Opt	Max	Min	Opt	Max	Min	Opt	Max			
Improve the diversity of native wetland flora species consistent with the mosaic of EVC benchmarks*.	Wetland body and riparian zone	4	6	10	4	6-10	12-18	6	6-10	12-18	Autumn – Early Spring	1200 ³	Variable to 1m
Maintain habitat for colonial waterbird refuge and breeding including Australian White Ibis, Straw-necked Ibis, Royal Spoonbills and Yellow-billed Spoonbills.	Wetland body	4	6	10	4	6-10	12	6	6-9	NA	Spring ¹	1200	Variable to 1m ⁴
Maintain or increase diversity and abundance of frog species supported by the wetland during flood events.	Wetland body	NA	NA	NA	NA	NA	12	2	2-6	NA	Spring-Summer	1200	Variable to 1m ⁴

1. Filling wetland from dry based on calculations of environmental water delivery to Reedy Swamp (Committee, 2011).
2. Rogers and Ralph 2011; (Young, 2003)
3. Water depth should be kept fairly consistent if waterbirds are nesting/ breeding to avoid nests being abandoned (Young, 2003).
4. (ARC, 2010), Appendix 9.

6.2.3 WATERING REGIME

The wetland watering regime has been derived from the ecological and hydrological objectives. To allow for adaptive and integrated management, the watering regime is framed using the seasonally adaptive approach (Section 6.3 – Implementation: seasonally adaptive approach). This means that a watering regime is identified for optimal conditions, as well as the maximum and minimum tolerable watering scenarios. The minimum watering regime is likely to be provided in drought or dry years, the optimum watering regime in average conditions and the maximum watering regime in wet or flood years.

Minimum watering requirement

Provide four flooding events every ten years. Fill the wetland to variable depths to provide habitat for colonial waterbirds and to maintain existing vegetation communities.

Optimum watering requirement

Provide six flooding events every ten years. Fill the wetland to variable depths to provide habitat for colonial waterbirds and to allow regeneration and recruitment of vegetation communities.

Maximum watering requirement

Provide an annual flooding event over a ten year period. Fill the wetland to provide habitat for breeding waterbirds and maintain vegetation communities.

The optimal, minimum and maximum watering regimes are described below; however the duration of watering may vary between these hydrological regimes. Due to the inter-annual variability of these estimates (particularly the climatic conditions), determination of the predicted volume requirements in any given year will need to be undertaken by the environmental water manager when watering is planned.

Filling the wetland to full supply level is not always desired. Flooding Reedy Swamp to variable depths and drawing down the wetland slowly will allow the habitat to change, resulting in a mosaic of vegetation communities establishing within the wetland body. This will assist in meeting the EVC benchmarks required to restore Reedy Swamp. Wherever possible, this managed hydrological regime should be aligned with local climatic conditions.

6.3 IMPLEMENTATION: SEASONALLY ADAPTIVE APPROACH

Each year CMAs prepare **seasonal watering proposals** for wetlands and rivers. The proposals identify the environmental water requirements of wetlands and rivers in the Goulburn Broken Catchment in the coming year. The proposals are informed by the Environmental Water Management Plans, scientific studies and reports that identify the flood or flow regimes required to meet the ecological objectives of each site or system. **Seasonal Watering Proposals** are developed using the “seasonally adaptive” approach, originally developed through the Northern Regional Sustainable Water Strategy and now incorporated in the Victorian Strategy for Healthy Rivers, Estuaries and Wetlands.

The seasonally adaptive approach identifies the priorities for environmental watering, works and complementary measures, depending on the amount of water available in a given year or prevailing climatic conditions. It is a flexible way to deal with short-term climatic variability and helps guide annual priorities and manage drought. This approach is outlined in Table 11.

The seasonally adaptive approach has been used to guide the watering regime under various climatic scenarios. In drier periods, restricted water resource availability will potentially limit the number of ecological objectives which can realistically be provided through environmental water management. However, these ecological objectives can be achieved in wetter periods as water resource availability increases.

The proposals are prepared in consultation with key stakeholders and partners and are approved by CMA boards. The proposals are submitted to the Victorian Environmental Water Holder (VEWH) for consideration. The VEWH then prepares **seasonal watering plans** based on the CMAs seasonal watering proposals. The plans describe the desired environmental water use for rivers and wetlands across Victoria in the coming year. To help facilitate the desired environmental water use outlined in these plans, the VEWH negotiates access to environmental water managed by the Commonwealth Environmental Water Holder (CEWH) and the Murray Darling Basin Authority (MDBA). The VEWH then prepares **seasonal watering statements** that authorise CMAs to undertake the agreed watering activities, including the use of CEWH and MDBA water. As more environmental water becomes available during the season the VEWH may prepare additional seasonal watering statements. Where possible, the VEWH, CEWH and the MDBA seek to coordinate the delivery and management of environmental water to maximise ecological benefits (Figure 13).

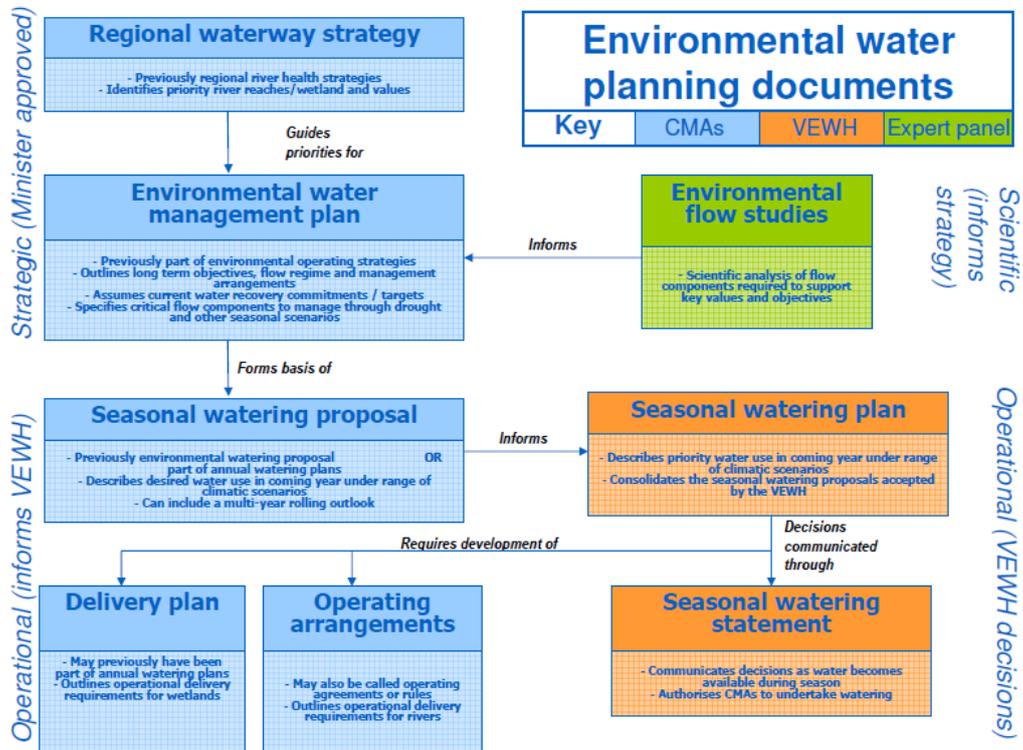


Figure 13: Flow chart for Environmental water planning

Table 11: The seasonally adaptive approach to river and wetland management

	Drought	Dry	Average	Wet to very wet
Long-term ecological objectives	Long-term objectives to move towards ecologically healthy rivers – set through regional river health strategies and sustainable water strategies and reviewed through the 15-year resource review			
Short-term ecological objectives	Priority sites have avoided irreversible losses and have capacity for recovery	Priority river reaches and wetlands have maintained their basic functions	The ecological health of priority river reaches and wetlands has been maintained or improved	The health and resilience of priority rivers and wetlands has been improved
Annual management objectives	Avoid critical loss Maintain key refuges Avoid catastrophic events	Maintain river functioning with reduced reproductive capacity Maintain key functions of high priority wetlands Manage within dry-spell tolerances	Improve ecological health and resilience	Maximise recruitment opportunities for key river and wetland species Minimise impacts of flooding on human communities Restore key floodplain linkages
Environmental water reserve	Water critical refuges Undertake emergency watering to avoid catastrophic events Provide carryover (for critical environmental needs the following year) If necessary, use the market to sell or purchase water	In priority river reaches provide summer and winter baseflows Water high priority wetlands Provide river flushes where required to break critical dry spells Provide carryover (for critical environmental needs the following year) If necessary, use the market to sell or purchase water	Provide all aspects of the flow regime Provide sufficient flows to promote breeding and recovery Provide carryover to accrue water for large watering events If necessary, use the market to sell or purchase water	Provide overbank flows Provide flows needed to promote breeding and recovery If necessary, use the market to sell or purchase water
River and wetland catchment activities	Protect refuges (including stock exclusion) Increase awareness of the importance of refuges Enhanced monitoring of high risk areas and contingency plans in place Investigate feasibility of translocations Environmental emergency management plans in place Protect high priority river reaches and wetlands through fencing; pest, plant and animal management; and water quality improvement works Implement post-bushfire river recovery plans	Protect refuges Protect high priority river reaches and wetlands through fencing, revegetation, pest plant and animal management, water quality improvement and in-stream habitat works Environmental emergency management plans in place Improve connectivity Implement post-bushfire river recovery plans	Protect and restore high priority river reaches and wetlands through fencing, revegetation, pest plant and animal management, water quality improvement and works Monitor and survey wetland condition Improve connectivity between rivers and floodplain wetlands	Protect and restore high priority river reaches and wetlands through fencing, revegetation, pest plant and animal management, water quality improvement and habitat works Monitor and survey river and wetland condition Improve connectivity between rivers and floodplain wetlands Emergency flood management plans in place Implementation of post-flood river restoration programs

7. POTENTIAL RISKS AND MITIGATION MEASURES

Potential risks associated with impacts from the application of environmental water to Reedy Swamp are listed in Table 12. In addition, a detailed risk assessment process will be developed prior to delivering environmental water in any given season and will be provided in the site watering proposal. Mitigation measures will also be implemented during environmental water delivery to address any potential risks.

Potential risk of environmental water delivery to Reedy Swamp include:

- Flood duration is too long or short. If duration is too short, birds breeding may abandon nests, frogs may not complete all stages in life-cycle and aquatic flora may not set-seed. If duration is too long, vegetation composition may be lost or become less diverse due to waterlogging.
- Flood timing is too late or early. Environmental water that is delivered using irrigation infrastructure can only be delivered to Reedy Swamp when there is sufficient capacity in the delivery Channel, which may not coincide with the desired timing of filling.
- Flood depth is too shallow or deep. This may occur if environmental water allocations cannot be achieved due to delivery constraints, or a high rainfall event occurs after delivery, causing deeper flooding than required.
- Flood frequency too often or too infrequent. This may occur if water cannot be delivered within a sufficient time frame to adequately satisfy target responses.
- Poor water quality. Water quality in Shepparton Drain 3 may have high turbidity or, elevated salinity and nutrient levels when adding environmental water to Reedy Swamp. Flooding wetlands that have accumulated large amounts of organic material can also lead to low dissolved oxygen.
- Pest aquatic flora and fauna invasion. Pest plants such as water couch and animals such as Carp can be introduced via the inlet delivery channel and Shepparton Drain 3. Flooding can also stimulate the growth of pest plants and animals if it is at the wrong time or duration.
- Impacts to social and economic values such as reduced public access or degradation of cultural heritage sites may occur if flooding is too high.

Table 12: Potential risks associated with environmental water delivery

#	Risk	Description	Potential Impacts							Mitigation	
			Environmental					Social	Economic		
			Fish <i>Water regime does not support breeding and feeding requirements</i>	Birds <i>Water regime does not support breeding and feeding requirements</i>	Amphibians <i>Water regime does not support breeding and feeding requirements</i>	Invertebrate <i>Water regime does not support breeding and feeding requirements</i>	Native aquatic flora <i>Watering requirement does not support establishment and growth.</i>	Reduced public access and use	Degradation of cultural heritage sites		Flooding of adjacent land
1	Required watering regime not met	Flood duration too long or short		✓	✓		✓				<p>Determine environmental water requirements based on seasonal conditions and to support potential bird breeding events</p> <p>Monitor flood duration to inform environmental water delivery</p> <p>Monitor the ecological response of the wetland to flooding</p> <p>Add or drawdown water where appropriate or practical</p>
		Flood timing too late or early		✓	✓		✓	✓			<p>Liaise with Goulburn-Murray Water to seek optimum timing of water delivery</p> <p>Monitor flood timing to inform environmental water delivery</p> <p>Monitor the ecological response of the wetland to flooding</p>
		Flooding depth too shallow or deep		✓			✓	✓	✓		<p>Determine environmental water requirements based on seasonal conditions and to support potential bird breeding events</p> <p>Monitor flood depth to inform environmental water delivery</p> <p>Liaise with adjoining landowners prior to and during the delivery of environmental water to discuss and resolve potential or current flooding issues</p> <p>Add or drawdown water where appropriate or practical</p>
		Flood frequency too long or short	✓	✓	✓	✓	✓	✓			<p>Prioritise water requirements of wetlands in seasonal watering proposals according to their required water regimes and inundation history</p> <p>Monitor the condition of the wetland</p> <p>Monitor the ecological response of the wetland to flooding</p>
2	Poor water quality	Low dissolved oxygen	✓	✓			✓				<p>Monitor dissolved oxygen levels and the ecological response of the wetland to flooding</p> <p>Add or drawdown water where appropriate or practical</p>
		High turbidity	✓				✓				<p>Monitor turbidity levels and the ecological response of the wetland to flooding</p> <p>Add or drawdown water where appropriate or practical</p>
		High water temperature	✓				✓				<p>Monitor water temperature and the ecological response of the wetland to flooding</p> <p>Add or drawdown water where appropriate or practical</p>

		Increased salinity levels	✓		✓	✓	✓				<p>Monitor salinity levels and the ecological response of the wetland to flooding</p> <p>Add or drawdown water where appropriate or practical</p>
		Increased nutrient levels									<p>Monitor nutrient and Blue Green Algae levels, and the ecological response of the wetland to flooding</p> <p>Place public warning signs at the wetland if BGA levels are a public health risk</p> <p>Add or drawdown water where appropriate or practical</p>
		Increased organic matter	✓				✓				<p>Implement the required water regime</p>
3	Pest aquatic plant and animal invasion	Introduction of pest fish	✓		✓	✓	✓				<p>Monitor the ecological response of the wetland to flooding</p> <p>Install a carp screen</p> <p>Implement an appropriate drying regime</p>
		Growth and establishment of aquatic pest plants	✓	✓	✓	✓	✓				<p>Monitor the abundance of native and pest aquatic plants</p> <p>Control pest plants in connected waterways</p> <p>Spray or mechanically remove pest plants</p> <p>Implement an appropriate drying regime</p>



8. ENVIRONMENTAL WATER DELIVERY INFRASTRUCTURE

8.1 CONSTRAINTS

Environmental water can currently be delivered to Reedy Swamp via the East Goulburn 19/12 Channel and Shepparton Drain 3. Constraints posed by the existing arrangement at the swamp include:

- Flow duration – Timing of flows and if the delivery system can be run long enough for time allocated to fill the swamp to the desired level.
- Connection loss - loss of environmental water delivery channel connection to Shepparton Drain 3.
- Irrigation demands – Reedy Swamp does not have a delivery share, therefore environmental water can only be delivered when there is spare capacity to carry the water in the current East Goulburn Channel 19/12.

8.2 IRRIGATION MODERNISATION

The Northern Victoria Irrigation Renewal Project (NVIRP) is a \$2 billion works program to upgrade ageing irrigation infrastructure across the Goulburn-Murray Irrigation District (GMID) and to save water lost through leakage, evaporation and system inefficiencies. Works will include lining and automating channels, building pipelines and installing new, modern metering technology.

Reedy Swamp is situated in the Central Goulburn 1-4 (CG1-4) channel district. Goulburn-Murray Water created a new alliance in 2008 known as Future Flow. Future Flow was a consortium of Goulburn-Murray Water, Transfield Services (Australia) Pty Ltd, Comdain Civil Constructions Pty Ltd and Sinclair Knight Merz (SKM). This alliance delivered the modernisation infrastructure upgrade to channels within the 1-4 channel districts.

The East Goulburn (EG) channel 19/12 which outfalls into Shepparton Drain 3 and has been the delivery mechanism for Environmental Water to Reedy Swamp, is to be decommissioned with the modernisation of CG 1-4. As this will impinge on the delivery of environmental water, a watering plan discussing water delivery options was written by Department of Primary Industries and the Goulburn Broken CMA in 2010 (Wood and Walters, 2010).

8.3 INFRASTRUCTURE RECOMMENDATIONS

The rationalisation of the East Goulburn 19/12 channel will provide an opportunity to connect to the East Goulburn 12 channel as part of the alternate supply system for properties impacted by the rationalisation. Option one is that a direct connection to Reedy Swamp could be negotiated and installed by the water authority as part of this rationalisation project. Long-term security of supply from this “backbone” channel is better than the current system. Option one is shown in Figure 14. Option two is to connect East Goulburn channel 12 directly to Shepparton Drain 3. Details of this option are still being negotiated with appropriate authorities. Responsibility for options one and two are currently being discussed by the relevant land managers and water authorities.

Negotiations, compensation and ongoing security of supply connection could be built into any agreements with property owners with either option one or two.

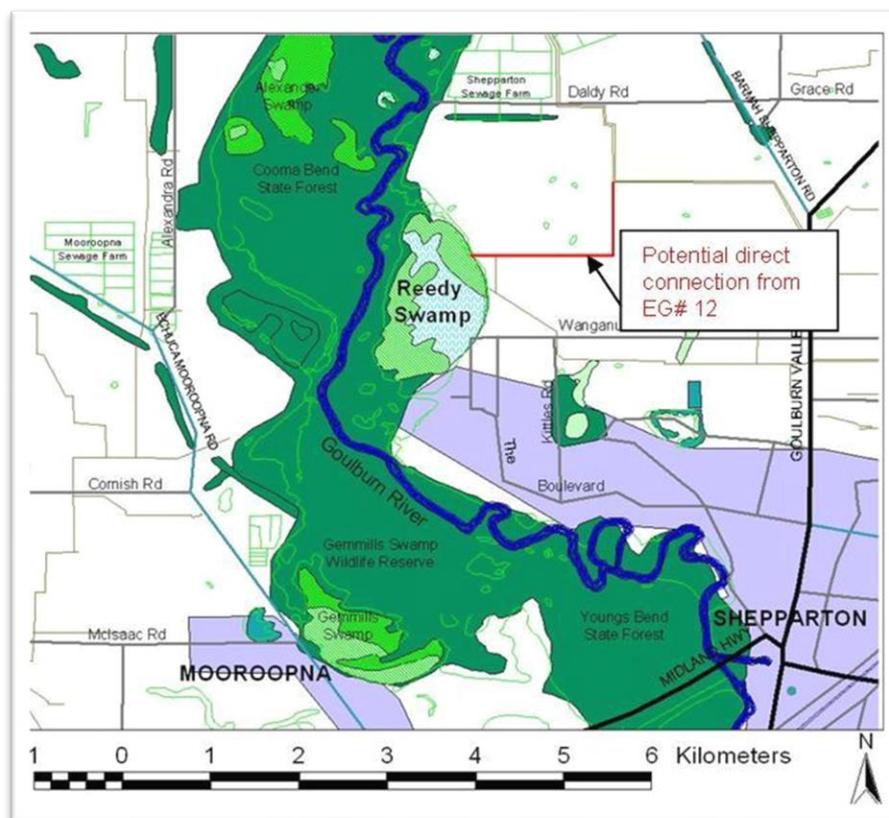


Figure 14: Potential direct connection from East Goulburn 12

The capacity of the outfall for East Goulburn channel 19/12 is 15ML/day (optimum channel capacity) and is discharged into Shepparton Drain 3. It is therefore important to ensure the rationalisation of any part of the channel system does not compromise the ability to deliver environmental water or ability to top up flows in Shepparton Drain 3 and Reedy Swamp.

9. KNOWLEDGE GAPS AND RECOMMENDATIONS

There are currently a number of knowledge gaps in relation to environmental water management at Reedy Swamp. While most of these do not impact the ability to provide water to the wetland and generate ecological benefit, the addressing of these knowledge gaps would significantly improve the accuracy of environmental water bids, and provide long-term ecological understanding of the site.

The following list describes recognised knowledge gaps that may assist with more efficient environmental water delivery to Reedy Swamp.

1. Monitoring of the water dependant environmental values of the Swamp such as aquatic flora and fauna and water depth.
2. Monitoring the sites environmental conditions and issues that may pose threats. This includes monitoring species such as water couch and arrowhead when conditions are deemed favourable for growth and collection of water quality data from Goulburn Broken Waterwatch regarding Shepparton Drain 3 inflows to determine suitability for drainage water diversion into the wetland. This monitoring should continue on a long-term basis ensuring control of water couch and other pest plant species. Pest animals should be monitored and prevention/ eradication should occur where possible. Investigation of management options for exotic fish species entering Reedy Swamp such as Carp exclusion screens, one-way push traps, carp separation cages and prolonged drying events may assist with this.
3. Simulating the natural hydrological regime to provide ecological benefits by delivering environmental water on average 6 years out of 10 year period if conditions prevail.
4. Monitoring water quality in Reedy Swamp on a consistent basis ensuring nutrient loads do not reach critical levels.
5. Undertaking a risk management matrix before delivering environmental water to Reedy Swamp.
6. Exploring opportunities for improved water delivery especially once the EG 19/12 Channel is decommissioned.
7. Observing scientific knowledge gaps and working towards filling these gaps. Currently fish species data is being collected at Reedy Swamp but may need to be an ongoing occurrence due to wetting and drying of the wetland. Other monitoring gaps that may need to be addressed include monitoring water quality data within the Swamp and modelling inflows into Reedy Swamp and a more detailed macroinvertebrate study.

10. GLOSSARY

Complex

A conceptual whole made up of complicated and related parts.

Depression

A sunken or depressed geological formation within the landscape.

Ephemeral

Wetland alternates between holding water and being completely dry, with the dry phase being the usual state; flooding occurs rarely and irregularly; surface water persists only very briefly, days to a few weeks.

Seasonal

Wetland alternates between holding water and being completely dry, in nearly all years, except possibly extremely wet and extremely dry years, and on a fairly predictable seasonal pattern; surface water persists for months (Brock et al., 2003, Roberts and Marston, 2011).

Semi-permanent

Predictable flooding, though water levels may vary. The annual input of water is greater than the losses (does not dry out) 9 years out of 10. The majority of organisms living here will not tolerate desiccation.

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12. APPENDICES

APPENDIX 1: WORKSHOP NOTES

Participants were given a booklet with wetland characteristics, maps and site information to discuss (all found in relevant sections of this plan). Ecological and hydrological requirements were determined by J. Wood and S. Casanelia before the Scientific Committee met and were discussed and changed where relevant and are now in section 6 – Management Goal.

APPENDIX 2: CORRICK AND NORMAN CLASSIFICATION OF WETLAND CATEGORIES

A system of wetland classification developed by Corrick and Norman is used to describe wetlands in Victoria. Under this system six naturally occurring wetland types are described based on water depth, frequency of inundation, salinity and dominant vegetation.

Freshwater meadow

These include shallow (up to 0.3m) and temporary (less than four months duration) surface water, although soils are generally waterlogged throughout winter.

Shallow freshwater marsh

Wetlands that are usually dry by mid-summer and fill again with the onset of winter rains. Soils are waterlogged throughout the year and surface water up to 0.5m deep may be present for as long as eight months.

Deep freshwater marsh

Wetlands that generally remain inundated to a depth of 1-2m throughout the year.

Permanent open freshwater

Wetlands that are usually more than 1m deep. They can be natural or artificial. Wetlands are described to be permanent if they retain water for longer than 12 months, however they can have periods of drying.

Semi-permanent saline

These wetlands may be inundated to a depth of 2m for as long as eight months each year. Saline wetlands are those in which salinity exceeds 3,000mg/L throughout the whole year.

Permanent saline

These wetlands include coastal wetlands and part of the intertidal zones. Saline wetlands are those in which salinity exceeds 3,000mg/L throughout the whole year.

APPENDIX 3: ENVIRONMENTAL WATER SOURCES

Victorian River Murray Flora and Fauna Bulk Entitlement – Deployed along the length of the Murray River in Victoria. This has been used in the past to supply water to Barmah Forest and wetlands connected to the supply networks of the Goulburn River and lower Broken Creek Systems.

Stockyard Plain Bulk Entitlement – 112ML of water entitlement held by DSE that can be transferred to Reedy Swamp depending on competing priorities.

One Tree Swamp Bulk Entitlement – 9.3ML bulk entitlement managed by Parks Victoria that can be transferred for use in Reedy Swamp depending on competing priorities.

Gaynor Swamp Bulk Entitlement – 24ML bulk entitlement managed by Parks Victoria that can be transferred for use in Reedy Swamp depending on competing priorities.

Future NVIRP Environmental Water Entitlements

One third of water saving from Stage 1 of the NVIRP project will be used for the environment, some of which will be stored in Lake Eildon. This water will be released into stressed rivers and streams when required. The NVIRP water savings are predicted to provide up to 75GL as a statutory environmental entitlement, which will be used to help improve the health of priority stressed rivers and wetlands in northern Victoria (DSE, 2008). The entitlement will have properties which enable the water to be used at multiple locations as the water travels downstream (provided losses and water quality issues are accounted for); meaning that the water can be called out of storage at desired times to meet specific environmental needs.

The environment's share of water savings will be over and above The Living Murray and Snowy commitments and will primarily target the use of environmental water for priority Victorian wetlands and tributaries.

This will also have flow on benefits when the water enters the River Murray, which can then be reused to meet the needs of the Murray and its floodplains and wetlands, including Kerang Lakes, Barmah Forest, Gunbower Forest, Hattah Lakes, Lindsay-Wallpolla Island and various other sites along the River Murray.

Stage 2 is expected to deliver a further 200 billion litres of water savings a year, which will be shared equally between irrigators and the environment.

Commonwealth Environmental Water Holder (CEWH)

The WATER ACT 2007 established the [Commonwealth Environmental Water Holder](#) to manage the water entitlements that the Commonwealth acquires. These water entitlements will be used to protect or restore environmental assets such as wetlands and streams.

69 GL of environmental water will be available for the Lower Goulburn between February and July 2011. Commonwealth environmental water is available to avoid the critical loss of threatened species. It is also available to avoid irretrievable damage or catastrophic events and to maintain key refuges to allow re-colonisation when conditions improve.

APPENDIX 4: LEGISLATIVE FRAMEWORK

Acts and Agreements

Convention on Wetlands of International Importance (Ramsar) 1971 – The Australian Government is a contracting party to ‘The Convention on Wetlands on International Importance’, which is an inter-governmental treaty whose mission is “the conservation and wise use of all wetlands through local, regional and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world”.

JAMBA 1974 - Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment.

Australian Heritage Commission Act 1975 - An Act to establish an Australian Heritage Commission.

Convention of Migratory Species (Bonn Convention) 1979 - The Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or Bonn Convention) aims to conserve terrestrial, marine and avian migratory species throughout their range. It is an **intergovernmental treaty**, concluded under the aegis of the United Nations Environment Programme, concerned with the conservation of wildlife and habitats on a global scale. Since the Convention's entry into force, its membership has grown steadily to include 114 (as of 1 October 2010) Parties from Africa, Central and South America, Asia, Europe and Oceania.

Aboriginal and Torres Strait Islander Heritage Protection Act 1984 - An Act to preserve and protect places, areas and objects of particular significance to Aboriginals, and for related purposes.

CAMBA 1986 - Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment.

Native Title Act 1993 – Legislation to protect any native title that has survived 200 years of colonisation.

Environment Protection Biodiversity Conservation Act 1999 - The Australian Government's central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places — defined in the Act as matters of national environmental significance.

Water Act 2007 - An Act to make provision for the management of the water resources of the Murray-Darling Basin, and to make provision for other matters of national interest in relation to water and water information, and for related purposes.

Water Amendment Act 2008 - An Act to amend the Water Act 2007, and for related purposes.

ROKAMBA 2009 – Agreement between the Government of Australia and the Government of the Republic of Korea on the protection of Migratory birds.

ACTS AND AGREEMENTS (VICTORIA)

Flora and Fauna Guarantee Act 1988 - Victorian legislation for the conservation of threatened species and communities and for the management of potentially threatening processes.

Water Act 1989 - The legislation that governs the way water entitlements are issued and allocated in Victoria. It defines water entitlements and establishes the mechanisms for managing Victoria's water resources.

Catchment and Land Protection Act 1994 - has an objective of establishing a framework for the integrated and coordinated management of catchments which will;

- maintain and enhance long-term land productivity while also conserving the environment, and
- aim to ensure that the quality of the State's land and water resources and their associated plant and animal life are maintained and enhanced.

The Act established ten Catchment and Land Protection Boards, nine of which have since expanded their roles to become Catchment Management Authorities. The *Catchment and Land Protection Act (1994)* provides for the development of Regional Catchment Strategies which, among other things, must assess the nature, causes, extent and severity of land degradation of the catchments in the region and identify areas for priority attention. Local Planning schemes must have regard for the Regional Catchment Strategies.

Aboriginal Heritage Act 2006 - The main purpose of this Act is to provide for the protection of Aboriginal cultural heritage in Victoria. The objectives of this Act are-

- (a) to recognise, protect and conserve Aboriginal cultural heritage in Victoria in ways that are based on respect for Aboriginal knowledge and cultural and traditional practices;
- (b) to recognise Aboriginal people as the primary guardians, keepers and knowledge holders of Aboriginal cultural heritage;
- (c) to accord appropriate status to Aboriginal people with traditional or familial links with Aboriginal cultural heritage in protecting that heritage;
- (d) to promote the management of Aboriginal cultural heritage as an integral part of land and natural resource management;
- (e) to promote public awareness and understanding of Aboriginal cultural heritage in Victoria;
- (f) to establish an Aboriginal cultural heritage register to record Aboriginal cultural heritage;
- (g) to establish processes for the timely and efficient assessment of activities that have the potential to harm Aboriginal cultural heritage;

(h) to promote the use of agreements that provide for the management and protection of Aboriginal cultural heritage;

(i) to establish mechanisms that enable the resolution of dispute relating to the protection of Aboriginal cultural heritage;

(j) to provide appropriate sanctions and penalties to prevent harm to Aboriginal cultural heritage.

Policy and Frameworks

Wetland Policy of the Commonwealth Government of Australia 1997 - On 2 February 1997, the inaugural World Wetlands Day, the Commonwealth Government released the Wetlands Policy of the Commonwealth Government of Australia. The Wetlands Policy aims to promote the conservation, repair, and wise use of wetlands and - within the broader context of environmental management - incorporate the conservation of wetlands into the daily business of the Commonwealth Government.

Framework for Determining Commonwealth Environmental Watering Actions 2009 - The purpose of this paper is to outline a framework for determining Commonwealth environmental watering actions in the Murray-Darling Basin. The framework will be developed and implemented over the period 2009-2011, prior to the development of the Environmental Watering Plan (EWP) by the Murray Darling Basin Authority, and be adapted in accordance with the EWP once that is available.

Policy and Frameworks (Victoria)

The State Environment Protection Policy (Waters of Victoria) 2003 - sets the framework for government agencies, businesses and the community to work together, to protect and rehabilitate Victoria's surface water environments.

Northern Region Sustainable Water Strategy 2009 - The Northern Region Sustainable Water Strategy has been released by the Victorian Government to secure the water future for urban, industrial, agricultural and environmental water users for the next 50 years.

Reports Applicable to the Environmental Watering Plan

Reedy Swamp Environmental Management Plan 2003 – A management plan for Reedy Swamp that details all management activities.

Goulburn Broken Catchment Regional Catchment Strategy 2003 – A strategy that sets the framework for Natural Resource Management and the context for sub-strategies and action plans within the Goulburn Broken Catchment.

Our Water Our Future 2004 - sets out 110 actions for sustainable water management aimed at every sector of the community, seeking to secure water supplies and sustain growth over the next 50 years.

The 110 actions aim to:

- Repair rivers and groundwater systems – the natural source of all our fresh water – by giving them legal water rights and conducting restoration works;
- Price water to encourage people to use it more wisely;
- Permanently save water in our towns and cities, through common sense water saving and recycling measures;
- Secure water for farms through pioneering water allocation and trading systems; and
- Manage water allocation to find the right balance between economic, environmental and social values.

Biodiversity strategy for Goulburn Broken Catchment 2009 - This Strategy follows implementation of Goulburn Broken CMA's Native Vegetation Management Strategy (developed in 2000) and from the Fringe to mainstream – a Strategic Plan for Integrating Native Biodiversity (developed in 2004). The Strategy provides a regional perspective for implementing Victoria's White Paper for Land and Biodiversity at a time of Climate Change (released December 2009).

Reedy Swamp Environmental Watering Plan 2010 – This plan discussed the available options for environmental water delivery to Reedy Swamp after the decommissioning of East Goulburn Channel 19/12, which is currently used to delivery environmental water.

APPENDIX 5: FAUNA SPECIES LIST

Fauna list of Reedy Swamp – taken from Victorian Fauna Database 2010, P. O'Connor 2008-2009 counts and D. Cook 2008-2009 counts.

L = listed as threatened under the *Flora and Fauna Guarantee Act (1988)*

vu = Listed as vulnerable on the DSE Advisory list of threatened vertebrate fauna (2007)

en = Listed as endangered on the DSE Advisory list of threatened vertebrate fauna (2007)

nt = Listed as near threatened on the DSE Advisory list of threatened vertebrate fauna (2007)

dd = Listed as data deficient on the DSE Advisory list of threatened vertebrate fauna (2007)

cr = Listed as critically endangered on the DSE Advisory list of threatened vertebrate fauna (2007)

w = wetland species b = observed breeding at the site

Common Name	Scientific Name	FFG	VROTS	Origin
BIRDS				
Australasian Darter	<i>Anhinga novaehollandiae</i>			w
Australasian Grebe	<i>Tachybaptus novaehollandiae</i>			w
Australasian Shoveler	<i>Anas rhynchotis</i>		vu	w,b
Australian Little Bittern	<i>Ixobrychus dubius</i>	L	en	w
Australian Magpie	<i>Gymnorhina tibicen</i>			
Australian Pelican	<i>Pelecanus conspicillatus</i>			w
Australian Raven	<i>Corvus coronoides</i>			
Australian Shelduck	<i>Tadorna tadornoides</i>			w
Australian White Ibis	<i>Threskiornis molucca</i>			w,b
Australian Wood Duck	<i>Chenonetta jubata</i>			w,b
Baillon's Crake	<i>Porzana pusilla</i>	L	vu	w
Black Swan	<i>Cygnus atratus</i>			w,b
Black-chinned Honeyeater	<i>Melithreptus gularis gularis</i>		nt	
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>			
Black-fronted Dotterel	<i>Euseyonis melanops</i>			w
Black-tailed Native-hen	<i>Gallinula ventralis</i>			w
Black-winged Stilt	<i>Himantopus himantopus</i>			w,b
Blue-billed Duck	<i>Oxyura australis</i>	L	en	w
Brown Falcon	<i>Falco berigora</i>			
Brown Goshawk	<i>Accipiter fasciatus</i>			
Brown Quail	<i>Coturnix ypsilophora australis</i>		nt	
Brown Treecreeper (south-eastern ssp.)	<i>Climacteris picumnus victoriae</i>		nt	
Buff-rumped Thornbill	<i>Acanthiza reguloides</i>			
Chestnut Teal	<i>Anas castanea</i>			w,b
Australian Reed Warbler	<i>Acrocephalus stentoreus</i>			w
Cockatiel	<i>Nymphicus hollandicus</i>			
Collared Sparrowhawk	<i>Accipiter cirrhocephalus</i>			
Crested Pigeon	<i>Ocyphaps lophotes</i>			
Crimson Rosella	<i>Platycercus elegans elegans</i>			
Dollarbird	<i>Eurystomus orientalis</i>			
Dusky Moorhen	<i>Gallinula tenebrosa</i>			w,b
Eastern Great Egret	<i>Ardea modesta</i>	L	vu	w
Eastern Rosella	<i>Platycercus eximius</i>			
Eurasian Coot	<i>Fulica atra</i>			w,b
Fairy Martin	<i>Hirundo ariel</i>			

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Flame Robin	<i>Petroica phoenicea</i>			
Freckled Duck	<i>Stictonetta naevosa</i>	L	en	w
Galah	<i>Eolophus roseicapilla</i>			
Glossy Ibis	<i>Plegadis falcinellus</i>		nt	w
Golden Whistler	<i>Pachycephala pectoralis</i>			
Great Cormorant	<i>Phalacrocorax carbo</i>			w
Great Crested Grebe	<i>Podiceps cristatus</i>			w
Grey Fantail	<i>Rhipidura albiscarpa</i>			
Grey Shrike-thrush	<i>Colluricincla harmonica</i>			
Grey Teal	<i>Anas gracilis</i>			w,b
Hardhead	<i>Aythya australis</i>		vu	w
Hoary-headed Grebe	<i>Poliiocephalus poliocephalus</i>			w
Horsfield's Bronze-Cuckoo	<i>Chrysococcyx basalis</i>			
Intermediate Egret	<i>Ardea intermedia</i>	L	cr	w
Latham's Snipe	<i>Gallinago hardwickii</i>			w
Laughing Kookaburra	<i>Dacelo novaeguineae</i>			
Lewin's Rail	<i>Lewinia pectoralis</i>	L	vu	w
Little Black Cormorant	<i>Phalacrocorax sulcirostris</i>			w
Little Corella	<i>Cacatua sanguinea</i>			
Little Egret	<i>Egretta garzetta nigripes</i>	L	en	w
Little Friarbird	<i>Philemon citreogularis</i>			
Little Grassbird	<i>Megalurus grammurus</i>			w
Little Lorikeet	<i>Glossopsitta pusilla</i>			
Little Pied Cormorant	<i>Microcarbo melanoleucos</i>			w
Little Raven	<i>Corvus mellori</i>			
Long-billed Corella	<i>Cacatua tenuirostris</i>			
Magpie Goose	<i>Anseranas semipalmata</i>	L	nt	w
Magpie-lark	<i>Grallina cyanoleuca</i>			
Marsh Sandpiper	<i>Tringa stagnatilis</i>			w
Masked Lapwing	<i>Vanellus miles</i>			w,b
Mistletoe bird	<i>Dicaeum hirundinaceum</i>			
Musk Duck	<i>Biziura lobata</i>		vu	w,b
Musk Lorikeet	<i>Glossopsitta concinna</i>			
Nankeen Night Heron	<i>Nycticorax caledonicus</i>		nt	w
Noisy Friarbird	<i>Philemon corniculatus</i>			
Noisy Miner	<i>Manorina melanocephala</i>			
Olive-backed Oriole	<i>Oriolus sagittatus</i>			
Pacific Black Duck	<i>Anas superciliosa</i>			w,b
Pallid Cuckoo	<i>Cuculus pallidus</i>			
Peaceful Dove	<i>Geopelia striata</i>			
Peregrine Falcon	<i>Falco peregrinus</i>			b
Pied Butcherbird	<i>Cracticus nigrogularis</i>			
Pied Cormorant	<i>Phalacrocorax varius</i>		nt	w
Pied Currawong	<i>Strepera graculina</i>			
Pink-eared Duck	<i>Malacorhynchus membranaceus</i>			w
Powerful Owl	<i>Ninox strenua</i>	L	vu	
Purple Swampphen	<i>Porphyrio porphyrio</i>			w,b
Rainbow Bee-eater	<i>Merops ornatus</i>			b
Red Wattlebird	<i>Anthochaera carunculata</i>			
Red-browed Finch	<i>Neochmia temporalis</i>			
Red-kneed Dotterel	<i>Erythronyx cinctus</i>			w
Red-rumped Parrot	<i>Psephotus haematonotus</i>			
Restless Flycatcher	<i>Myiagra inquieta</i>			
Royal Spoonbill	<i>Platalea regia</i>		vu	w,b

Sacred Kingfisher	<i>Todiramphus sanctus</i>			w
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>			w
Silver Gull	<i>Chroicocephalus novaehollandiae</i>			w
Silvereye	<i>Zosterops lateralis</i>			
Southern Boobook	<i>Ninox novaeseelandiae</i>			
Spotless Crake	<i>Porzana tabuensis</i>			w
Straw-necked Ibis	<i>Threskiornis spinicollis</i>			w,b
Striated Pardalote	<i>Pardalotus striatus</i>			
Striated Thornbill	<i>Acanthiza lineata</i>			
Sulphur-crested Cockatoo	<i>Cacatua galerita</i>			
Superb Fairy-wren	<i>Malurus cyaneus</i>			
Swamp Harrier	<i>Circus approximans</i>			w
Tawny Frogmouth	<i>Podargus strigoides</i>			b
Tree Martin	<i>Hirundo nigricans</i>			
Varied Sittella	<i>Daphoenositta chrysoptera</i>			
Wedge-tailed Eagle	<i>Aquila audax</i>			
Welcome Swallow	<i>Hirundo neoxena</i>			w
Whiskered Tern	<i>Chlidonias hybridus javanicus</i>		nt	w
Whistling Kite	<i>Haliastur sphenurus</i>			
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>	L	vu	w,b
White-breasted Woodswallow	<i>Artamus leucorhynchus</i>			
White-faced Heron	<i>Egretta novaehollandiae</i>			w,b
White-necked Heron	<i>Ardea pacifica</i>			w,b
White-plumed Honeyeater	<i>Lichenostomus penicillatus</i>			
White-throated Tree Creeper	<i>Cormobates leucophaeus</i>			
White-winged Chough	<i>Corcorax melanorhamphos</i>			
White-winged Triller	<i>Lalage sueurii</i>			
Willie Wagtail	<i>Rhipidura leucophrys</i>			
Yellow Rosella	<i>Platycercus elegans flaveolus</i>			
Yellow-billed Spoonbill	<i>Platalea flavipes</i>			w,b
Yellow-rumped Thornbill	<i>Acanthiza chrysorrhoa</i>			
MACROINVERTEBRATES				
Aquatic caterpillar	Family Crambidae			
Backswimmer	Family Notonectidae			
Bloodworms	<i>Chironomus sp</i>			
Caddisfly	<i>Triplectides sp</i>			
Copepod	Order Cyclopodia			
Damselfly Larvae	<i>Ischura sp</i>			
Dragonfly Larvae	<i>Hemicordula sp</i>			
Flatworm	Class Tubellaria			
Freshwater snail	Family Pyralidae			
Hydra	Family Hydridae			
March Fly Larvae	Family Tabanidae			
Marsh Beetle	Family Scritidae			
Mosquito Larvae	Family Culicidae			
Non-biting Midge	<i>Chironomus sp</i>			
Predaceous Diving Beetle	<i>Eretes australis</i>			
Roundworm	Phylum Nematoda			
Seed Shrimp	<i>Notodromadidae sp</i>			
Segmented Worm	Class Oligochaeta			
Small water strider	Family Veliidae			
Soldier Fly	Family Stratiomyidae			
Spider Mite	<i>Arrenuridae sp</i>			
Springtail	Family Isotomidae			

Springtail	Family Sminthuridae			
Water boatman	<i>Agraptocorixa sp</i>			
Water boatman	<i>Micronecta sp</i>			
Water boatman	<i>Sigara sp</i>			
Water Flea	<i>Daphnia sp</i>			
Water Mite	<i>Eylaisae sp</i>			
Water Scavenger Beetle	<i>Berosus sp</i>			
Water Scavenger Beetle	<i>Helochaeres sp</i>			
FISH				
Australian Smelt	<i>Retropinna semoni</i>			
Carp Gudgeon	<i>Hypseleotris sp</i>			
Crimson-spotted Rainbowfish	<i>Melanotaenia fluviatilis</i>	L	dd	
Flat-headed Galaxias	<i>Galaxias rostratus</i>		vu	
FROGS				
Common Froglet	<i>Crinia signifera</i>			
Peron's Tree Frog	<i>Litoria peronii</i>			
Plains Brown Tree Frog	<i>Litoria paraewingi</i>			
Plains Froglet	<i>Crinia parinsignifera</i>			
Sloane's Froglet	<i>Crinia sloanei</i>			
Pobblebonk	<i>Limnodynastes dumerilii</i>			
Spotted Marsh Frog	<i>Limnodynastes tasmaniensis</i>			
MAMMALS				
Common Brushtail Possum	<i>Trichosurus vulpecula</i>			
Eastern Grey Kangaroo	<i>Macropus gigantus</i>			
Echinda	<i>Tachyglossus aculeatus</i>			
Feathertail Glider	<i>Acrobatus pygmaeus</i>			
Gould's Wattle Bat	<i>Chalinolobus gouldii</i>			
Inland Broad-nose Bat	<i>Scototrepens balstoni</i>			
Large Forest Bat	<i>Vespadelus darlingtoni</i>			
Little Forest Bat	<i>Vespadelus vulturnus</i>			
Little Red Flying-fox	<i>Pteropus scapulatus</i>			
Platypus	<i>Ornithorhynchus anatinus</i>			
Southern Forest Bat	<i>Vespadelus vegulus</i>			
Squirrel Glider	<i>Petaurus norfolcensis</i>	L	en	
Sugar Glider	<i>Petaurus breviceps</i>			
Swamp Wallaby	<i>Wallabia bicolor</i>			
Water Rat	<i>Hydromys chrysogaster</i>			
White-striped Freetail Bat	<i>Tadarida australis</i>			
Yellow-footed Antechinus	<i>Antechinus flavipes flavipes</i>			
REPTILES				
Brown Snake	<i>Pseudonaja textilis</i>			
Carnaby's Wall Skink	<i>Cryoblepharis carnabyi</i>			
Eastern Snake-necked Turtle	<i>Chelodina longicollis</i>			
Garden Skink	<i>Lampropholis guichanoti</i>			
Gray's Blind Snake	<i>Ramphotyphlops nigrescens</i>			
Marbled Gecko	<i>Phyllodactylus marmoratus</i>			
Murray River Turtle	<i>Emydura macquarii</i>	L	dd	
Lace Monitor	<i>Varanus varius</i>		vu	
Olive Legless Lizard	<i>Delma inornata</i>			
Tiger Snake	<i>Notechis scutatus</i>			
Yellow-bellied Water Skink	<i>Eulamprus heatwolei</i>			
EXTOIC SPECIES				
Brown Hare	<i>Lepus capensis</i>			
Common Blackbird	<i>Turdus merula</i>			

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Common Starling	<i>Sturnus vulgaris</i>			
Eastern Gambusia	<i>Gambusia holbrooki</i>			
European Carp	<i>Cyprinus carpio</i>			
Goldfish	<i>Carassius auratus</i> Linnaeus, 1785			
House Sparrow	<i>Passer domesticus</i>			
Rabbit	<i>Oryctolagus cuniculus</i>			
Red Fox	<i>Vulpes vulpes</i>			

APPENDIX 6: ECOLOGICAL VEGETATION CLASSES

The following information has been cited from the Index of Wetland Condition Assessment of Wetland Vegetation Update- March 2006 (DSE, 2007b). Victoria's Framework for the Native Vegetation Management (DNRE 2002) utilises the notion of Ecological Vegetation Classes (EVC's). The Framework defines an EVC as follows: "An EVC is a type of native vegetation classification that is described through a combination of floristic, life form and ecological characteristics, and through an inferred fidelity to particular environmental attributes. Each EVC includes a collection of floristic communities (ie: a lower level in the classification that is based solely on groups of the same species) that occur across a biogeographic range, and although differing in species, have similar habitat and ecological processes operating (3.1.1 EVC's that occur in wetlands pg 5).

Below is a description of the EVC's found within and surrounding Reedy Swamp (www.dse.gov.au).

Sand Ridge [EVC #264]

Open pine-box woodland 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 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.

Sedgy Riverine Forest [EVC #803]

An open, eucalypt woodland to 15 m tall occurring on a number of geologies and soil types. Occupies fertile clays and clay loam soils on flat or gently undulating plains at low elevations in areas with <600 mm annual rainfall. The understorey consists of a few sparse shrubs over a species-rich grassy and herbaceous ground layer and chenopods are often present.

Rushy Riverine Swamp [EVC #804]

Collective label for the various zones of vegetation associated with semi-permanent wetlands with (turf/aquatic) grassy species co-dominating in mosaic or association with components of tall rushland and aquatic herbs. Concentrically zoned wetland with lawn-like grassy centres during drier periods or as patchy structural mosaic. Can be viewed as an aggregate or a set of variously represented components, variously including species poor components of Tall Marsh, Floodplain Grassy Wetland, Aquatic Sedgeland, Aquatic Herbland and Dwarf Floating Aquatic Herbland.

Floodway Pond Herbland [EVC #810]

Low herbland on the drying mud of floors of ponds on floodway systems (mainly riverine floodplains). The floristics (and diversity) can be quite variable (both spatially and temporally), according to the traits of the relevant individual pond. The floristics also vary in temporal cycles with the 'unvegetated' unit and probably between seasons at some locations.

Riverine Swampy Woodland [EVC #815]

Eucalypt woodland to 15 m tall above a grassy to sedgy – herbaceous ground layer, with species indicative of periodic waterlogging. Occupies areas subject to shallow inundation only from higher-level flooding on riverine flood plain. Soils are typically heavy, cracking mottled grey-brown clays/clay-loams and water-retentive, often with a gilgai profile which can be wet during winter.

Tall Marsh [EVC #821]

Wetland dominated by tall emergent graminoids, typically in thick species-poor swards. Rushland, sedgeland or reedbed - locally closed or in association or fine-scale mosaic with Aquatic Herbland (e.g. along floodway lagoons). At optimum development, the vegetation is treeless, but sparse *Eucalyptus camaldulensis* (or in higher rainfall areas, *E. ovata*) are dispersed through some sites where sufficient dry periods occur to allow their survival.

APPENDIX 7: FLORA SPECIES LIST

Flora list of Reedy Swamp – taken from Victorian Flora Database 2010, D. Cook 2008-2009 counts.

L = Listed as threatened under the Flora and Fauna Guarantee Act (1988)

E = Endangered under the Environmental Protection Biodiversity Act (1999)

e = Endangered in Victoria in DSE Advisory list of rare and threatened plants in Victoria (2005)

k = Poorly known in Victoria in DSE Advisory list of rare and threatened plants in Victoria (2005)

v = Vulnerable in Victoria in DSE Advisory list of rare and threatened plants in Victoria (2005)

r = Rare in Victoria in DSE Advisory list of rare and threatened plants in Victoria (2005)

w = Wetland species

p = Planted

= Native to Victoria but grows outside natural range

Common Name	Scientific Name	EVC 815	EVC 804	EVC 810	EPBC	FFG	VROT	Origin	Indigenous Use
Grey Mulga	<i>Acacia brachybotra</i>								
Silver Wattle	<i>Acacia dealbata</i>								Gum eaten or made into paste. Wood used for tools.
Lightwood	<i>Acacia implexa</i>								
Mallee Wattle	<i>Acacia montana</i>								
Golden Wattle	<i>Acacia pycantha</i>	✓							Gum used for drink, food and medicine
Water Plantain	<i>Alisma plantago-aquatica</i>			✓				w	
Lesser Joyweed	<i>Alternanthera denticulata s.l.</i>	✓	✓	✓				w	
Plains Joyweed	<i>Alternanthera sp 1 (plains)</i>	✓					k		
Common Swamp Wallaby-grass	<i>Amphibromus nervosus</i>							w	
Box Mistletoe	<i>Amyema miquelii</i>								
Fleshy Mistletoe	<i>Amyema miraculosa</i>								
Drooping Mistletoe	<i>Amyema pendulata subs. pendulata</i>								
Grey Mistletoe	<i>Amyema quandang var. quandang</i>								
Jericho Wire-grass	<i>Aristida jerichoensis var. subspinulifera</i>					L	e		
Cane Wire-grass	<i>Aristida ramosa</i>								
Small Vanilla-lily	<i>Arthropodium minus</i>							w	Tubers eaten.
Chocolate Lily	<i>Arthropodium strictum</i>								Tubers Eaten
Berry Saltbush	<i>Atriplex semibaccata</i>	✓							
Stiped Wallaby-grass	<i>Austrodanthonia racemosa var. racemosa</i>								
Common Wallaby-grass	<i>Austrodanthonia caespitosa</i>								
Brown-back Wallaby-grass	<i>Austrodanthonia duttoniana</i>	✓						w	
Copper-awned Wallaby-grass	<i>Austrodanthonia fulva</i>								
Slender Wallaby-grass	<i>Austrodanthonia racemosa var. racemosa</i>	✓							
Bristly Wallaby-grass	<i>Austrodanthonia setacea</i>	✓							
Rough Spear-grass	<i>Austrostipa scabra</i>								

Rough Spear-grass	<i>Austrostipa scabra subsp. falcata</i>									
Pacific Azolla	<i>Azolla filiculoides</i>	✓	✓	✓				w		
Tah-vine	<i>Boerhavia dominii</i>									
River Bottlebrush	<i>Callistemon sieberi</i>							w		
White Cypress-pine	<i>Callitris columellaris</i>							p		
Tufted Burr-daisy	<i>Calotis scapigera</i>	✓						w		
Annual Bitter-cress	<i>Cardamine paucijuga s.l.</i>							w		
Tall Sedge	<i>Carex appressa</i>							w		
Sedge	<i>Carex bichenoviana</i>	✓						w		
Common Sedge	<i>Carex inversa</i>	✓						w		
Poong'ort	<i>Carex tereticaulis</i>	✓						w	Used to make string and fibre.	
Common Sneezeweed	<i>Centipeda cunninghamii</i>							w	Used to make medicinal tonic	
Flat Spurge	<i>Chamaesyce drummondii</i>							#	Milk sap used for medicinal purposes	
Clammy Goosefoot	<i>Chenopodium pumilio</i>							w		
Windmill Grass	<i>Chloris truncata</i>									
Grey Billy-buttons	<i>Craspedia canens</i>						L	e	w	
Common Billy-buttons	<i>Craspedia glauca spp. agg.</i>								w	
Swamp Billy-buttons	<i>Craspedia paludicola</i>								w	
Dense Crassula	<i>Crassula colorata</i>								w	
Spreading Crassula	<i>Crassula decumbens var. decumbens</i>	✓							w	
Purple Crassula	<i>Crassula peduncularis</i>								w	
Sieber Crassula	<i>Crassula sieberiana s.l.</i>								w	
Small Scurf-pea	<i>Cullen parvum</i>					E	L	e		
Couch	<i>Cynodon dactylon</i>								w	
Tall Flat-sedge	<i>Cyperus exaltatus</i>								w	
Flecked Flat-sedge	<i>Cyperus gunnii subsp. gunnii</i>								w	
Star Fruit	<i>Damasonium minus</i>								w	
Reed Bent-grass	<i>Deyeuxia quadriseta</i>									
Pale Flax-lily	<i>Dianella longifolia s.l.</i>								Leaves used for making cord and baskets.	
Riverine Flax-lily	<i>Dianella sp. aff. longifolia (Riverina)</i>							v		
Kidney-weed	<i>Dichondra repens</i>	✓							W	
Grey Parrot-pea	<i>Dillwynia cinerascens s.l.</i>									
Nodding Saltbush	<i>Einadia nutans subsp. nutans</i>	✓								
Waterwort	<i>Elatine gratioloides</i>			✓					w	
Common Spike-sedge	<i>Eleocharis acuta</i>	✓							w	
Small Spike-sedge	<i>Eleocharis pusilla</i>								w	
Short-awned Wheat Grass	<i>Elymus multiflorus</i>	✓							k	
Common Wheat-grass	<i>Elymus scaber var. scaber</i>									
Wheat-grass	<i>Elymus scabrous</i>	✓								
Variable Willow-herb	<i>Epilobium billardierianum</i>	✓							w	
Grey Willow-herb	<i>Epilobium billardierianum subsp. cinereum</i>								w	
Hairy Willow-herb	<i>Epilobium hirtigerum</i>									
Common Love-grass	<i>Eragrostis brownii</i>									
Blue Devil	<i>Eryngium ovinum</i>								w	
River Red-gum	<i>Eucalyptus camaldulensis</i>	✓	✓	✓					w	Used to make canoes and water vessels.
Yellow Box	<i>Eucalyptus melliodora</i>	✓								
Grey Box	<i>Eucalyptus microcarpa</i>									

OFFICIAL

Creeping Cudweed	<i>Euchiton collinus s.s.</i>								
Common Cudweed	<i>Euchiton involucratus s.l.</i>							w	
Annual Cudweed	<i>Euchiton sphaericus</i>							w	
Silky Browntop	<i>Eulalia aurea</i>								
Grassland Crane's-bill	<i>Geranium retrorsum s.l.</i>								
Variable Cranesbill	<i>Geranium sp 2</i>								
Variable Glycine	<i>Glycine tabacina</i>								
Slender Goodenia	<i>Goodenia gracilis</i>							w	
Varied Raspwort	<i>Haloragis heterophylla</i>								
Pale Everlasting	<i>Helichrysum rutidolepis s.l.</i>							w	
Common Heliotrope	<i>Heliotropium europaeum</i>								
Mat Grass	<i>Hemarthria uncinata var. uncinata</i>							w	
Grassy Club-sedge	<i>Isolepis hookeriana</i>							w	
Hollow Rush	<i>Juncus amabilis</i>							w	
Toad Rush	<i>Juncus bufonius</i>							w	
Gold Rush	<i>Juncus flavidus</i>	✓						w	
Joint-leaf Rush	<i>Juncus holoschoenus</i>							w	
Wiry Rush	<i>Juncus homalocalis</i>							w	
Giant Rush	<i>Juncus ingens</i>		✓					w	
Sand Rush	<i>Juncus psammophilus</i>						r	w	
Broom Rush	<i>Juncus sarophorus</i>							w	
Finger Rush	<i>Juncus subsecundus</i>							w	
Billabong Rush	<i>Juncus usitatus</i>	✓						w	
Common Blown-grass	<i>Lachnagrostis filiformis</i>	✓	✓					w	
Common Blown-grass	<i>Lachnagrostis filiformis var. 1</i>		✓					w	
Thin Duckweed	<i>Landoltia punctata</i>		✓	✓				w	
Common Duckweed	<i>Lemna disperma</i>	✓	✓	✓				w	
River Tea-tree	<i>Leptospermum obovatum</i>							w	
Native Flax	<i>Linum marginale</i>								Used for fishnets and cord. Seeds eaten.
Poison Lobelia	<i>Lobelia pratioides</i>							w	
Wattle Matt-rush	<i>Lomandra filiformis var. 1</i>								
Clove-strip	<i>Ludwigia peploides subsp. montevidensis</i>	✓	✓	✓				w	
Small Loosestrife	<i>Lythrum hyssopifolia</i>	✓						w	
Wingless Bluebush	<i>Maireana enchylaenoides</i>								
Narrow-leaf Nardoo	<i>Marsilea costulifera</i>							w	
River Mint	<i>Mentha australis</i>							w	
Slender Mint	<i>Mentha diemenica</i>							w	
Creeping Mint	<i>Mentha saturoides</i>								Leaves used as medicine
Weeping Grass	<i>Microlaena stipoides var. stipoides</i>								
Creeping Mistletoe	<i>Muellerina eucalyptoides</i>								
Upright Water-milfoil	<i>Myriophyllum crispatum</i>							w	
Robust Water-milfoil	<i>Myriophyllum papillosum</i>							w	
Water-milfoil	<i>Myriophyllum spp.</i>							w	
Swamp Lily	<i>Ottelia ovalifolia subsp. ovalifolia</i>							w	
Shady Wood-sorrel	<i>Oxalis exilis</i>								
Grassland Wood-sorrel	<i>Oxalis perennans</i>								
Wood Sorrel	<i>Oxalis spp.</i>								
Hairy Panic	<i>Panicum effusum</i>								

OFFICIAL

Water Couch	<i>Paspalum distichum</i>	✓	✓	✓				w	
Warrego Summer-grass	<i>Paspalidium jubiflorum</i>	✓						#w	
Slender Knotweed	<i>Persicaria decipiens</i>		✓	✓				w	
Water Pepper	<i>Persicaria hydropiper</i>							w	Stems and leaves eaten. Leaves used to poison fish.
Woolly Knotweed	<i>Persicaria lanigera</i>						k	w	
Pale Knotweed	<i>Persicaria lapathifolia</i>		✓	✓				w	
Spotted Knotweed	<i>Persicaria praetermissa</i>		✓					w	
Creeping Knotweed	<i>Persicaria prostrata</i>							w	
Knotweed	<i>Persicaria spp.</i>	✓						w	
Common Reed	<i>Phragmites australis</i>							w	
Weeping Pittosporum	<i>Pittosporum angustifolium</i>							p	
Common Tussock-grass	<i>Poa labillardierei</i>	✓							Used for making string baskets
Common Tussock-grass	<i>Poa labillardierei var. labillardierei</i>							w	
Floating Pondweed	<i>Potamogeton tricarlinatus s.l.</i>							w	
Jersey Cudweed	<i>Pseudognaphalium luteoalbum</i>							w	Leaves used in tea for medicinal purposes
River Buttercup	<i>Ranunculus inundatus</i>							w	
Australian Buttercup	<i>Ranunculus lappaceus</i>								
Ferny Small-flower Buttercup	<i>Ranunculus pumilio var. pumilio</i>	✓						w	
Annual Buttercup	<i>Ranunculus sessiflorus</i>	✓							
Buttercup	<i>Ranunculus spp.</i>								
Fringed Heartwort	<i>Ricciocarpus natans</i>	✓	✓	✓				w	
Bitter Cress	<i>Rorippa spp.</i>								
Small-leaf Bramble	<i>Rubus parvifolius</i>								
Slender Dock	<i>Rumex brownii</i>	✓						w	
Glistening Dock	<i>Rumex crystallinus s.l.</i>							w	
Groundsel	<i>Senecio campylocarpus</i>		✓				r	w	
Cotton Fireweed	<i>Senecio quadridentatus</i>	✓							
Tall Fireweed	<i>Senecio runcinifolius</i>								
Variable Sida	<i>Sida corrugata</i>								
Indian Weed	<i>Sigesbeckia orientalis subsp. orientalis</i>								
Smooth Solenogyne	<i>Solenogyne dominii</i>								
Large Duckweed	<i>Spirodela polyrhiza</i>		✓					w	
Kangaroo Grass	<i>Themeda triandra</i>								Made into string and fishnets.
Northern Water-ribbons	<i>Triglochin multifructa</i>							#w	
Water Ribbons	<i>Triglochin procera s.l.</i>							w	
Narrow-leaf Cumbungi	<i>Typha domingensis</i>		✓					w	
Cumbungi	<i>Typha orientalis</i>							w	
Yellow Bladderwort	<i>Utricularia australis</i>							w	
Common Verbena	<i>Verbena officinalis s.l.</i>							#	
Slender Speedwell	<i>Veronica gracilis</i>								
Fuzzy New Holland Daisy	<i>Vittadinia cuneata</i>								
Fuzzy New Holland Daisy	<i>Vittadinia cuneata var. cuneata</i>								
Woolly New Holland Daisy	<i>Vittadinia gracilis</i>								
River Bluebell	<i>Wahlenbergia fluminalis</i>	✓						w	
Sprawling Bluebell	<i>Wahlenbergia gracilis</i>								
Branching Bluebell	<i>Wahlenbergia multicaulis</i>								
Rigid Panic	<i>Walwhalleya proluta</i>							w	Seeds ground to make flour.

OFFICIAL

Tiny Duckweed	<i>Wolffia australiana</i>	✓	✓	✓					w
Common Early Nancy	<i>Wurmbea dioica</i>								
EXOTIC SPECIES									
Early Black-wattle	<i>Acacia decurrens</i>								
Sycamore Maple	<i>Acer pseudoplatanus</i>								
Maple	<i>Acer spp.</i>								
Sheep Sorrel	<i>Acetosella vulgaris</i>								
Quicksilver Grass	<i>Aira cupaniana</i>								
Marsh Fox-tail	<i>Alopecurus geniculatus</i>								
Pimpernel	<i>Anagallis arvensis</i>								
Cape Weed	<i>Arctotheca calendula</i>								
Asparagus	<i>Asparagus officinale</i>								
Aster-weed	<i>Aster subulatus</i>	✓	✓	✓					w
Hastate Orache	<i>Atriplex prostrata</i>		✓						w
Wild Oat	<i>Avena fatua</i>								
Oat	<i>Avena sp.</i>								
Trifid Burr-marigold	<i>Bidens tripartite</i>								
Large Quaking-grass	<i>Briza maxima</i>								
Lesser Quaking-grass	<i>Briza minor</i>								
Prairie Grass	<i>Bromus catharticus</i>								
Great Brome	<i>Bromus diandrus</i>	✓							
Soft Brome	<i>Bromus hordeaceus subsp. hordeaceus</i>								
Red Brome	<i>Bromus rubens</i>								
Thread Water-starwort	<i>Callitriche hamulata</i>								
Common Water-starwort	<i>Callitriche stagnalis</i>								w
Shepherd's Purse	<i>Capsella bursa-pastoris</i>								w
Winged Slender-thistle	<i>Carduus tenuiflorus</i>								
Saffron Thistle	<i>Carthamus lanatus</i>								
Slender Centaury	<i>Centaurium tenuiflorum</i>								
Common Mouse-ear Chickweed	<i>Cerastium glomeratum s.l.</i>								
Fat Hen	<i>Chenopodium album</i>								
Skeleton Weed	<i>Chondrilla juncea</i>								
Chicory	<i>Cichorium intybus</i>								
Spear Thistle	<i>Cirsium vulgare</i>	✓	✓						
Flaxleaf Fleabane	<i>Conyza bonariensis</i>								
Tall Fleabane	<i>Conyza sumatrensis</i>								
Ferny Cotula	<i>Cotula bipinnata</i>	✓							
Water Buttons	<i>Cotula coronopifolia</i>								
Water Crassula	<i>Crassula natans var. minus</i>								w
Hawthorn	<i>Crataegus monogyna</i>								w
Paddy Melon	<i>Cucumis myriocarpus subsp. leptodermis</i>								
Field Dodder	<i>Cuscuta campestris</i>								
Couch	<i>Cynodon dactylon var. dactylon</i>								
Drain Flat-sedge	<i>Cyperus eragrostis</i>		✓						
Summer Grass	<i>Digitaria sanguinalis</i>								w
Stinkwort	<i>Ditrichia graveolens</i>								
Barnyard Grass	<i>Echinochloa crus-galli</i>								
Paterson's Curse	<i>Echium plantagineum</i>								

Glandular Willow-herb	<i>Epilobium ciliatum</i>								
Stink Grass	<i>Eragrostis ciliaris</i>								
Fennel	<i>Foeniculum vulgare</i>								
Bastards Fumitory	<i>Fumaria bastardii</i>								
Cleavers	<i>Galium aparine</i>	✓							
Purple Cudweed	<i>Gamochaeta purpurea s.l.</i>								
Ox-tongue	<i>Helminthotheca echioides</i>								
Yorkshire Fog	<i>Holcus lanatus</i>		✓						
Barley-grass	<i>Hordeum murinum s.l.</i>								
St John's Wort	<i>Hypericum perforatum subsp. Veronense</i>								
Smooth Cat's Ear	<i>Hypochoeris glabra</i>	✓	✓						
Cat's Ear/ Flatweed	<i>Hypochoeris radicata</i>	✓							
Hairy Toadflax	<i>Kickxia elatine</i>								
Twining Toadflax	<i>Kickxia elatine subsp. Crinita</i>								
Willow-leaf Lettuce	<i>Lactuca saligna</i>								
Prickly Lettuce	<i>Lactuca serriola</i>	✓	✓						
Hairy Hawkbit	<i>Leontodon taraxacoides subsp. taraxacoides</i>								
Common Peppergrass	<i>Lepidium africanum</i>								
Wimmera Rye-grass	<i>Lolium rigidum</i>	✓							
Marsh Ludwigia	<i>Ludwigia palustris</i>								
African Box-thorn	<i>Lycium ferocissimum</i>								
Burr Medic	<i>Medicago polymorpha</i>								
Lucerne	<i>Medicago sativa var. sativa</i>								
Sweet Mellilot	<i>Mellilotus indicus</i>								
Pennyroyal	<i>Mentha pulegium</i>								
Red-flower Mallow	<i>Modiola caroliniana</i>								
Fragrant False-garlic	<i>Nothoscordum borbonicum</i>								
Olive	<i>Olea europaea subsp. europaea</i>								
Soursob	<i>Oxalis pes-caprae</i>								
Coolah Grass	<i>Panicum coloratum</i>								
Paspalum	<i>Paspalum dilatatum</i>								
Toowoomba Canary-grass	<i>Phalaris aquatica</i>							w	
Lesser Canary-grass	<i>Phalaris minor</i>								
Paradoxical Canary-grass	<i>Phalaris paradoxa</i>								
Canary Island Date-palm	<i>Phoenix canariensis</i>								
Fog-fruit	<i>Phyla canescens</i>	✓						w	
Sticky Ground-cherry	<i>Physalis viscosa</i>								
Ribwort	<i>Plantago lanceolata</i>	✓							
Annual Meadow-grass	<i>Poa annua</i>	✓							
Wireweed	<i>Polygonum arenastrum</i>								
Prostrate Knotweed	<i>Polygonum aviculare s.l.</i>								
Hogweed	<i>Polygonum aviculare s.s.</i>								
Sharp Buttercup	<i>Ranunculus muricatus</i>		✓						
Celery Buttercup	<i>Ranunculus sceleratus subsp. sceleratus</i>	✓						w	
Wild Radish	<i>Raphanus raphanistrum</i>								
Onion Grass	<i>Romulea rosea</i>								
Yellow Marsh-cress	<i>Rorippa palustris</i>	✓	✓						
Sweet Briar	<i>Rosa rubiginosa</i>							w	

OFFICIAL

Clustered Dock	<i>Rumex conglomeratus</i>								
Curled Dock	<i>Rumex crispus</i>		✓					w	
Broad-leaf Dock	<i>Rumex obtusifolius subsp. obtusifolius</i>							w	
Dock (naturalised)	<i>Rumex spp. (naturalised)</i>								
Sagittaria	<i>Sagittaria platyphylla</i>							w	
Pepper Tree	<i>Schinus molle</i>							w	
Variogated Thistle	<i>Silybum marianum</i>								
London Rocket	<i>Sisymbrium irio</i>								
Black Nightshade	<i>Solanum nigrum s.s.</i>	✓							
Black Nightshade	<i>Solanum nigrum sensu Willis (1972)</i>								
Madeira Winter-cherry	<i>Solanum pseudocapsicum</i>								
Rough Sow-thistle	<i>Sonchus asper s.l.</i>		✓						
Common Sow-thistle	<i>Sonchus oleraceus</i>	✓	✓						
Red Sand-spurrey	<i>Spergularia rubra s.l.</i>								
Lesser Chickweed	<i>Stellaria pallida</i>								
Caltrop	<i>Tribulus terrestris</i>								
Narrow-leaf Clover	<i>Trifolium angustifolium var. angustifolium</i>								
Hare's-foot Clover	<i>Trifolium arvense var. arvense</i>								
Cluster Clover	<i>Trifolium glomeratum</i>								
Knotted Clover	<i>Trifolium striatum</i>								
Subterranean Clover	<i>Trifolium subterraneum</i>								
Twiggy Mullein	<i>Verbascum virgatum</i>								
Wandering Speedwell	<i>Veronica peregrina</i>								
Common Vetch	<i>Vicia sativa</i>								
Narrow-leaf Vetch	<i>Vicia sativa subsp. Nigra</i>								
Squirrel-tail Fescue	<i>Vulpia bromoides</i>								
Rat's-tail Fescue	<i>Vulpia myuros</i>								
Bathurst Burr	<i>Xanthium spinosum</i>								

APPENDIX 8: INDEX OF WETLAND CONDITION METHOD

Table 13 below shows what is measured for each of the six subindices and how they are scored.

Table 13: IWC sub indices and measures.

IWC subindex	What is measured	How it is scored
Swamp catchment	1. The intensity of the land use within 250 metres of the swamp	<ul style="list-style-type: none"> The more intensive the land use the lower the score
	2. The width of the native vegetation surrounding the swamp and whether it is a continuous zone or fragmented	<ul style="list-style-type: none"> The wider the zone and more continuous the zone, the higher the score
Physical form	3. Whether the size of the swamp has been reduced from its estimated pre-European settlement size	<ul style="list-style-type: none"> A reduction in area results in a lowering of the score
	4. The percentage of the swamp bed which has been excavated or filled	<ul style="list-style-type: none"> The greater the percentage of swamp bed modified, the lower the score
Hydrology	5. Whether the swamp's water regime (i.e. the timing, frequency of filling and duration of flooding) has been changed by human activities	<ul style="list-style-type: none"> The more severe the impacts on the water regime, the lower the score
Water properties	6. Whether activities and impacts such as grazing and fertilizer run-off that would lead to an input of nutrients to the swamp are present	<ul style="list-style-type: none"> The more activities present, the lower the score
	7. Whether the swamp has become more saline or in the case of a naturally salty swamp, whether it has become more fresh	<ul style="list-style-type: none"> An increase in salinity for a fresh swamp lowers the score or a decrease in salinity of a naturally salty swamp lowers the score
Soils	8. The percentage and severity of swamp soil disturbance from human, feral animals or stock activities	<ul style="list-style-type: none"> The more soil disturbance and the more severe it is, the lower the score
Biota	9. The diversity, health and weediness of the native swamp vegetation	<ul style="list-style-type: none"> The lower the diversity and poorer health of native swamp vegetation, the lower the score The increased degree of weediness in the native swamp vegetation, the lower the score

Adapted from DSE letter 29 April 2010

Scoring method

Each subindex is given a score between 0 and 20 based on the assessment of a number of measures (Table 13). Weightings are then applied to the scores (Table 14). The maximum possible total score for a swamp is 38.4, which for ease of reporting, is scaled to 10 by dividing the total score by 38.4 and multiplying by 10. The score is then rounded to the nearest whole number.

Table 14: Weights of each subindex

IWC sub-index	Weight
Biota	0.73
Swamp catchment	0.26
Water properties	0.47
Hydrology	0.31
Physical form	0.08
Soils	0.07

Five swamp condition categories have been assigned to the subindex scores (Table 15) and total IWC scores (Table 16), to be consistent with the number of categories used in other condition indices such as the Victorian Index of Stream Condition. Biota score categories were determined by expert opinion and differ to those of the other subindices.

Table 15: Swamp condition categories assigned to sub index scores.

Sub-index score range (all except biota)	Biota sub-index score range	Swamp condition category
0-4	0-8	Very poor
5-8	9-13	Poor
9-12	14-16	Moderate
13-16	17-18	Good
16-20	19-20	Excellent
N/A	N/A	Insufficient data

Table 16: Swamp condition categories assigned to total IWC scores

IWC total score range	Swamp condition category
0-2	Very poor
3-4	Poor
5-6	Moderate
7-8	Good
9-10	Excellent
N/A	Insufficient data

This information has been drawn from - Version 9 of the Index of Swamp Condition - Methods Manual was prepared by Phil Papas, Janet Holmes and Shanaugh Lyon of the Department of Sustainability and Environment January 2010.

APPENDIX 9: EVC BENCHMARKS FOR REEDY SWAMP

EVC benchmarks have been determined for Reedy Swamp by monitoring the site between 2008-2011.

Benchmarks for Rushy Riverine Swamp include: Aquatic or mat-forming grasses and sedges (aim to 3 species and 20% cover); Aquatic herbs (aim to have 3 species >50% benchmark cover); Tall rushes (aim to have 1 species and >50% benchmark cover).

Benchmarks for Floodway Pond Herbland include: Medium to tall herbs (aim to have 2 species as seasonal herbs on wetland floor) and Small herbs (aim to have 2 species as seasonal herbs on wetland floor).

Benchmarks for Tall Marsh include: Herbs (aim to have 2 species which are inundation tolerant – but not aquatics); Small to medium aquatic herbs (aim to have 1 species); Small to medium aquatic to semi-aquatic graminoids (aim to have 1 species either of sedges and grasses); Tall monocots (aim to have 1 species with a 20% cover).



EVC Benchmark for the Index of Wetland Condition

EVC 804: Rushy Riverine Swamp

Description:

Collective label for the various zones of vegetation associated with semi-permanent wetlands with (turf/aquatic) grassy species co-dominating in mosaic or association with components of tall rushland and aquatic herbs. Concentric zoned wetland with lawn-like grassy centres during drier periods or as patchy structural mosaic. Can be viewed as an aggregate or a set of variously represented components, variously including species poor components of Tall Marsh, Floodplain Grassy Wetland, Aquatic Sedgeland, Aquatic Herbland and Dwarf Floating Aquatic Herbland. Scattered and restricted, floodplains in less arid parts of the Riverina, upstream from Gunbower Island.

Indicator species (some or all of these species should be present)

Scientific name	Common name	Comments
<i>Amphibromus fluitans</i>	River Swamp Wallaby-grass	dominated by this species and/or <i>Pseudoraphis spinescens</i>
<i>Eucalyptus camaldulensis</i>	River Red-gum	present around the verges
<i>Juncus spens</i>	Giant Rush	rings swamp or may be in mosaic with dominants
<i>Myrtophyllum</i> spp.	Water-milfoil	occurs with dominants - mostly <i>M. verticillatum</i> or <i>M. crispatum</i>
<i>Pseudoraphis spinescens</i>	Spiry Mud-grass	dominated by this species and/or <i>Amphibromus fluitans</i>
<i>Stellaria caespitosa</i>	Matted Starwort	occurs with dominants
<i>Additional aquatic species which can be present</i>		
<i>Azolla filiculoides</i>	Pacific Azolla	
<i>Baccharis sphacelata</i>	Tall Spike-sedge	
<i>Landoltia punctata</i>	Thin Duckweed	
<i>Ludwigia pepioides</i> subsp. <i>montevideoensis</i>	Clove-strip	
<i>Podanopeton tricanthatus</i> L.	Floating Pondweed	
<i>Ricobocarpus radans</i>	Fringed Hearwort	
<i>Valtoneria americana</i> var. <i>americana</i>	Fel Grass	

Conditions when the EVC should not be assessed

None recognised, subject to accessibility of all relevant strata following inundation.

1. CRITICAL LIFEFORMS

Conditions when specific critical lifeform groupings should not be assessed
None recognised.

General comments on assessing critical lifeform groupings
None.

EVC 804: Rushy Riverine Swamp

Critical lifeform groupings and threshold values for determining if lifeform is substantially modified

Critical lifeform	No. spp.	% Cover	Comments
Aquatic or mat-forming grasses and sedges	3	20	
Aquatic herbs	3	+	
Tall rushes	1	+	substantially modified if absent

+ denotes presence

2. WEEDS

High threat weed species

Scientific name	Common name
<i>Paspalum distichum</i>	Water Couch
<i>Sagittaria</i> spp.	Sagittaria

Conditions where weeds are considered to have a negligible impact

None recognised.

3. INDICATORS OF ALTERED PROCESSES

None recognised.

4. VEGETATION STRUCTURE AND HEALTH

Assess separately and average scores.

Structural dominant	Benchmark cover
Aquatic grasses	40%
Aquatic herbs	Assess for scoring category of >50% benchmark cover
Rush <i>Juncus</i> spp.	Assess for scoring category of >50% benchmark cover

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EVC Benchmark for the Index of Wetland Condition

EVC 810: Floodway Pond Herbland

Description:

Low herbland on the drying mud of floors of ponds on floodway systems (mainly riverine floodplains). The floristics (and diversity) can be quite variable (both spatially and temporally), according to the traits of the relevant individual pond. The floristics also vary in temporal cycles with the 'unvegetated' unit and probably between seasons at some locations. Widely dispersed along major riparian floodplains, especially of Murray river and tributaries.

Indicator species (some or all of these species should be present)

Scientific name	Common name	Comments
<i>Alternanthera</i> spp.	Joyweed	
<i>Carex pseudochaudiana</i>	Fen Sedge	sometimes in narrow fringes
<i>Cortipeda</i> spp.	Sneezeweed	
<i>Dysphania glomulifera</i> ssp. <i>glomulifera</i>	Globular Pigweed	
<i>Eleocharis acuta</i>	Common Spike-sedge	sometimes in narrow fringes
<i>Fimbristylis</i> spp.	Fringe Sedge	
<i>Glinus</i> spp.	Carpet Weed	
<i>Lachnagrostis filiformis</i> var. 1	Common Blown-grass	
<i>Panicum</i> spp.	Knobweed	
<i>Polygonum plebeium</i>	Small Knobweed	
<i>Pseudoraphis spinescens</i>	Spry Mud-grass	sometimes in narrow fringes
<i>Stellaria crepitosa</i>	Matted Starwort	

Semi-arid versions can include an increased component of species shared with the lacustrine habitat, notably:-

<i>Glossostigma distichoides</i>	Small Mud-mat
<i>Glycyrrhiza acanthocarpa</i>	Southern Liquorice
<i>Heliotropium</i> spp.	Heliotrope

Conditions when the EVC should not be assessed

Deep flooding, where emergent habitat is lacking or sustained drought where component species are not evident.

1. CRITICAL LIFEFORM GROUPINGS

Conditions when specific critical lifeform groupings should not be assessed

During immersion phases, assess only from post-emergent areas.

Critical lifeform groupings and threshold values for determining if lifeform is substantially modified

Critical lifeform	No. spp.	% Cover	Comments
Medium (to tall) herbs	2	+	seasonal herbs on wetland floor
Small herbs	2	+	seasonal herbs on wetland floor

+ denotes presence

EVC 810: Floodway Pond Herbland

2. WEEDS

High threat weed species

Scientific name	Common name
<i>Callitriche stagnalis</i>	Common Starwort
<i>Juncus articulatus</i>	Jointed Rush
<i>Xanthium</i> spp.	Cocklebur

Conditions where weeds are considered to have a negligible impact

Annuals during sustained dry conditions.

3. INDICATORS OF ALTERED PROCESSES

Indicators	Regeneration cover (%)	Scale of severity
Invasion by woody species (typically River Red-gum <i>Eucalyptus camaldulensis</i>).	Scattered regeneration <1%	Minor
	Regeneration 1-5%	Moderate
	Dense regeneration >5%	Severe

Circumstances where some critical lifeform groupings may not be evident

None recognised.

4. VEGETATION STRUCTURE AND HEALTH

Lowere dieback due to natural drying cycles.

Structural dominant	Benchmark cover
Small to medium herbs	Assess for scoring category of >50% benchmark cover. Cover varies dramatically according to wetting and drying cycles.

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EVC Benchmark for the Index of Wetland Condition

EVC 821: Tall Marsh

Description:

Wetland dominated by tall emergent graminoids, typically in thick species-poor swards. Rushland, sedgeland or reedbed - locally closed or in association or fine-scale mosaic with Aquatic Hermland (e.g. along floodway lagoons). At optimum development, the vegetation is treeless, but sparse *Eucalyptus camaldulensis* (or in higher rainfall areas, *E. ovata*) are dispersed through some sites where sufficient dry periods occur to allow their survival. Scattered across lowland Victoria.

Indicator species (some or all of these species should be present)

Scientific name	Common name
<i>Bolboschoenus</i> spp.	Club Sedge
<i>Cladium procerum</i>	Leafy Twig-sedge
<i>Cyperus</i> spp.	Flat Sedge
<i>Juncus ingens</i>	Giant Rush
<i>Phragmites australis</i>	Common Reed
<i>Schoenoplectus tabernaemontani</i>	River Club-sedge
<i>Typha</i> spp.	Bulrush
Associated Species	
<i>Amphibromus iulians</i>	River Swamp Wallaby-grass
<i>Azolla</i> spp.	Azolla
<i>Landoltia punctata</i>	Thin Duckweed
<i>Lemna</i> spp.	Duckweed
<i>Myriophyllum</i> spp.	Water-milfoil
<i>Potamogeton</i> spp.	Pondweed
<i>Pseudoraphis spinescens</i>	Spirly Mud-grass
<i>Rumex bidens</i>	Mud Dock
<i>Stellaria caespitosa</i>	Matted Starwort
<i>Calystegia sepium</i> subsp. <i>roseata</i>	Large Bindweed
In cooler or more reliably inundated areas	
<i>Urtica incisa</i>	Scrub Nettle
<i>Wolffia</i> spp.	Duckweed

Notes on indicator species

Various with *P. australis*, *Typha* spp., *J. ingens*, *S. tabernaemontani* and in more marginal sites sometimes also *Bolboschoenus* spp., *Cyperus* spp. or (locally) *C. procerum*. Associated species are quite variable.

Conditions when the EVC should not be assessed

None recognised subject to water quality (if beyond the ability to view submerged vegetation). Winter sampling may underestimate scoring.

1. CRITICAL LIFEFORMS

Conditions when specific critical lifeform groupings should not be assessed

None recognised.

General comments on assessing critical lifeform groupings

None.

EVC 821: Tall Marsh

Critical lifeform groupings and threshold values for determining if lifeform is substantially modified

Critical lifeform	No. spp.	% Cover	Comments
Herbs	2	+	Scrambling plants and broad-leaved plants which are inundation tolerant (but not aquatics). Substantially modified if absent
Small to medium aquatic herbs	1	+	substantially modified if absent
Small to medium aquatic to semi-aquatic graminoids	1	+	sedges and grasses, substantially modified if absent
Tall monocots	1	20	Leafy species, e.g. Cumbung, reeds, sedges. Substantially modified if clearly dying.

+ denotes presence

2. WEEDS

High threat weed species

Scientific name	Common name
<i>Aster subulatus</i>	Aster-weed
<i>Cotula coronopifolia</i>	Water Buttons
<i>Delainia odorata</i>	Cape Ivy
<i>Gallium aparine</i>	Cleavers
<i>Juncus articulatus</i>	Jointed Rush
<i>Paspalum distichum</i>	Water Couch
<i>Rorippa palustris</i>	Marsh Yellow-cress
<i>Typha latifolia</i>	Lesser Reed-mace
<i>Salix</i> spp.	Willow
<i>Rubus anglocandicans</i>	Blackberry

Conditions where weeds are considered to have a negligible impact

None recognised.

3. INDICATORS OF ALTERED PROCESSES

None recognised.

4. VEGETATION STRUCTURE AND HEALTH

Where Tall Marsh is a sparse component in mosaic or complex with other EVCs, assess for scoring category of >50% of benchmark cover.

Structural dominant	Benchmark cover
Tall graminoids, variously Bulrush <i>Typha</i> spp., Common Reed <i>Phragmites australis</i> , River Club-sedge <i>Schoenoplectus tabernaemontani</i> , Giant Rush <i>Juncus ingens</i>	40%

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APPENDIX 10: FROG BREEDING EVENTS

Table extracted from Rogers and Ralph 2011.

Frog species	Preferred hydrology of breeding site (Months)			Timing of breeding				Tadpole lifespan (Months)
	< 3	3-6	Permanent	Spring	Summer	Autumn	Winter	
Common Froglet <i>Crinia signifera</i>	*	*	*	C	CM	CM	C	2-4
Plains Froglet <i>Crinia parsignifera</i>	*	*	*	C	CM	CM	C	2-4
Pobblebonk <i>Limnodynastes dumerili</i>		*	*	CT	CM	CM	C	5-6
Barking Marsh Frog <i>Limnodynastes fletcheri</i>		*	*	C	CM	M		3-4
Spotted Marsh Frog <i>Limnodynastes tasmaniensis</i>	*	*	*	C	CM	M		3-4
Perons Tree Frog <i>Litoria peronii</i>	*	*	*	C	CM	M		3-4
Growling Grass Frog <i>Litoria raniformis</i>		*	*	C	CM	M		3-5

C = Calling, M = Mating, T = Tadpoles may be present