



# Doctors Swamp Environmental Water Management Plan 2011

Goulburn Broken Catchment  
Management Authority



**GOULBURN  
BROKEN**  
CATCHMENT  
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## EXECUTIVE SUMMARY

This plan outlines the water regimes required to protect and enhance the water dependent environmental values of Doctors 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.

Doctors Swamp is a shallow and intermittent wetland dominated by river red gums. It is located west of Murchison Township in northern Victoria. The wetland provides important breeding habitat for waterbirds and is the most pristine wetlands in the Goulburn Broken Catchment. The wetland is managed by Parks Victoria and is bioregionally significant defined by the National Land and Water Audit. 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 wetland:

- maintain the diversity of wetland flora species consistent with the applicable Ecological Vegetation Class benchmarks;
- reduce the cover and diversity of exotic flora species;
- provide opportunities for waterbird breeding especially Brolga at least five to seven years in every ten years; and
- provide opportunities for native frog breeding at least five to seven years in every ten years.

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 Doctors Swamp

**Minimum** – Provide two flooding events every ten years, filling the wetland to variable depths up to 600mm to maintain EVCs and provide habitat for aquatic biota.

**Optimum** – Provide five to seven flooding events in ten years, filling the wetland to variable depths up to 600mm to provide EVCs with appropriate water regimes, allowing regeneration of recruitment species and encourage breeding opportunities for aquatic biota.

**Maximum** – Provide an annual flooding event over a ten year period, filling the wetland to variable depths to maintain EVCs or encourage breeding opportunities for aquatic biota.

The plan also details potential risks associated with the delivery of environmental water to the wetland, opportunities to develop alternative methods for environmental water delivery efficiency to the wetland, and key environmental water management knowledge gaps including monitoring of aquatic fauna and flora.

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## ABBREVIATIONS

BE	Bulk entitlement
CEWH	Commonwealth Environmental Water Holder
DPI	Department of Primary Industries
DSE	Department of Sustainability and Environment
EPA	Environment Protection Authority
EVC	Ecological vegetation community
EWaMPs	Environmental Water Management Plans
EWR	Environmental water reserve
GB CMA	Goulburn Broken Catchment Management Authority
GL	Gigalitre (one billion litres)
G-MW	Goulburn Murray Water
IVT	Inter-valley transfer
IWC	Index of Wetland Condition
KL	Kilolitre (one thousand litres)
KM	Kilometre
MDBA	Murray-Darling Basin Authority
ML	Megalitre (one million litres)
NVIRP	Northern Victoria Irrigation Renewal Project
PV	Parks Victoria
SIR	Shepparton Irrigation Region
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) and Department of Sustainability and Environment (DSE) and the Victorian Environmental Water Holder (VEWH) are working together to develop new Environmental Water Management Plans 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 (CMAs) to the Victorian Environmental Water Holder annually. The Plans describe:

- lead management agencies and their management responsibilities;
- the water dependent 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 Doctors Swamp in the Goulburn Broken catchment. 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 2 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 Basins 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 Audit* (CoA, 2002). In addition, a large number of wetlands support state and nationally threatened biota communities and fauna listed on international agreements and conventions.

Doctors Swamp is a bioregionally significant wetland within the Goulburn Broken catchment. The wetland is a 200 hectare shallow freshwater marsh (Appendix 1) situated on the Cattnach Canal, west of the Murchison township (Figures 1, 2 and 3).



Figure 1: Location of Doctors Swamp within the Goulburn Broken Catchment

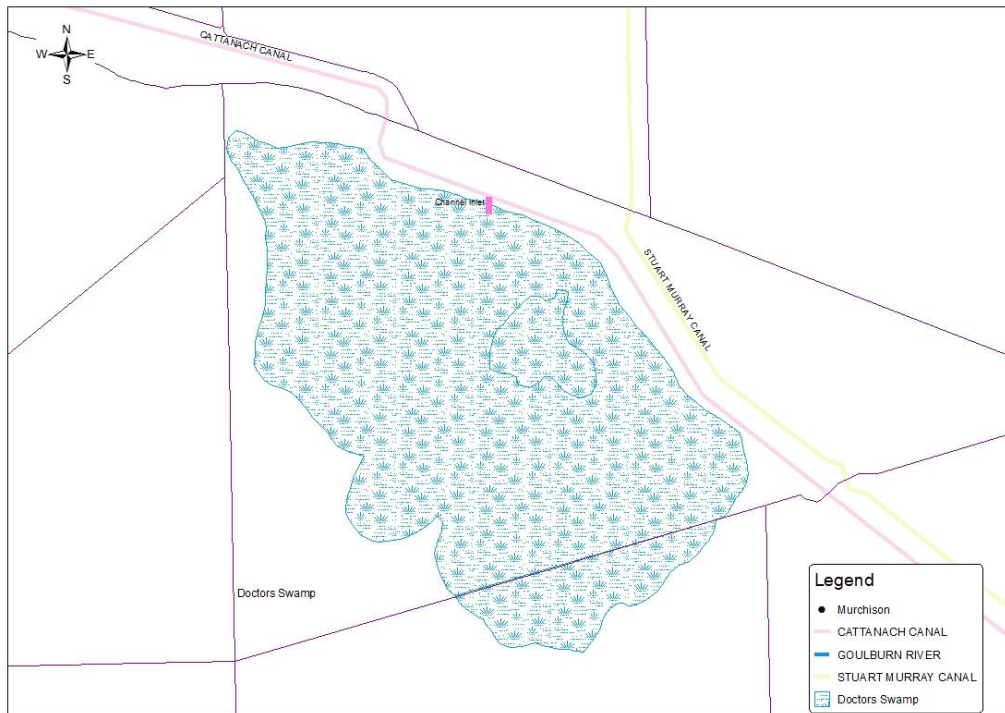


Figure 2: Doctors Swamp connection to Cattanach Canal



Figure 3: Aerial view of Doctors Swamp with Cattanach (nearest to Doctors Swamp) and Stuart Murray Canal.



## 1.4 CONSULTATION

This plan was prepared by the Goulburn Broken Catchment Management Authority (Goulburn Broken CMA) with input from a Scientific Technical Committee. The Scientific Technical Committee developed ecological and hydrological goals for Doctors Swamp at a workshop based on local history of the swamp, knowledge of the 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 include 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 (Moirra 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 and the Kinnairds Swamp Advisory 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:

- Doctors Swamp Environmental Management Statement (DPI, 2010).
- Goulburn Broken Regional River Health Strategy (GBCMA, 2005).
- Monitoring Ecological Response to Flooding. A study of Black, Doctors, Reedy and Kinnairds Swamp in the Goulburn Broken Catchment (Jolly and Osler, 2011).
- Workshop booklet from the Scientific Committee Technical Workshop (Committee, 2011).

This information was supplemented by discussions with people with an intimate knowledge of the study area, its environmental values, and the management and operation of the swamp. In addition a number of state-wide data sets and digital mapping layers were used including the:

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



## 1.6 LIMITATIONS

The information sources used in the development of this report have a number of limitations. These limitations include the 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 Doctors 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

Doctors Swamp is located beside the Cattnach Canal, west of Murchison Township (Figure 4). The Cattnach Canal is approximately 26km in length and provides irrigation flows from the Goulburn Weir to Waranga Basin. Doctors Swamp is classified as bioregionally significant and was listed under the Box Ironbark Investigation (ECC, 2001).

Native vegetation in the Goulburn Broken Catchment has been extensively cleared for agriculture. Primary agricultural activities in the south of the catchment include dryland grazing and mixed cereal cropping. The north of the catchment lies within the Murray Valley and Shepparton Irrigation districts where intensive dairy, and livestock production occurs. Drainage, land forming and river regulation have also significantly reduced the number and area of wetland habitats. Therefore, the remnant vegetation and wetlands within the catchment form an important corridor in the catchment and are a stronghold for native flora and fauna.

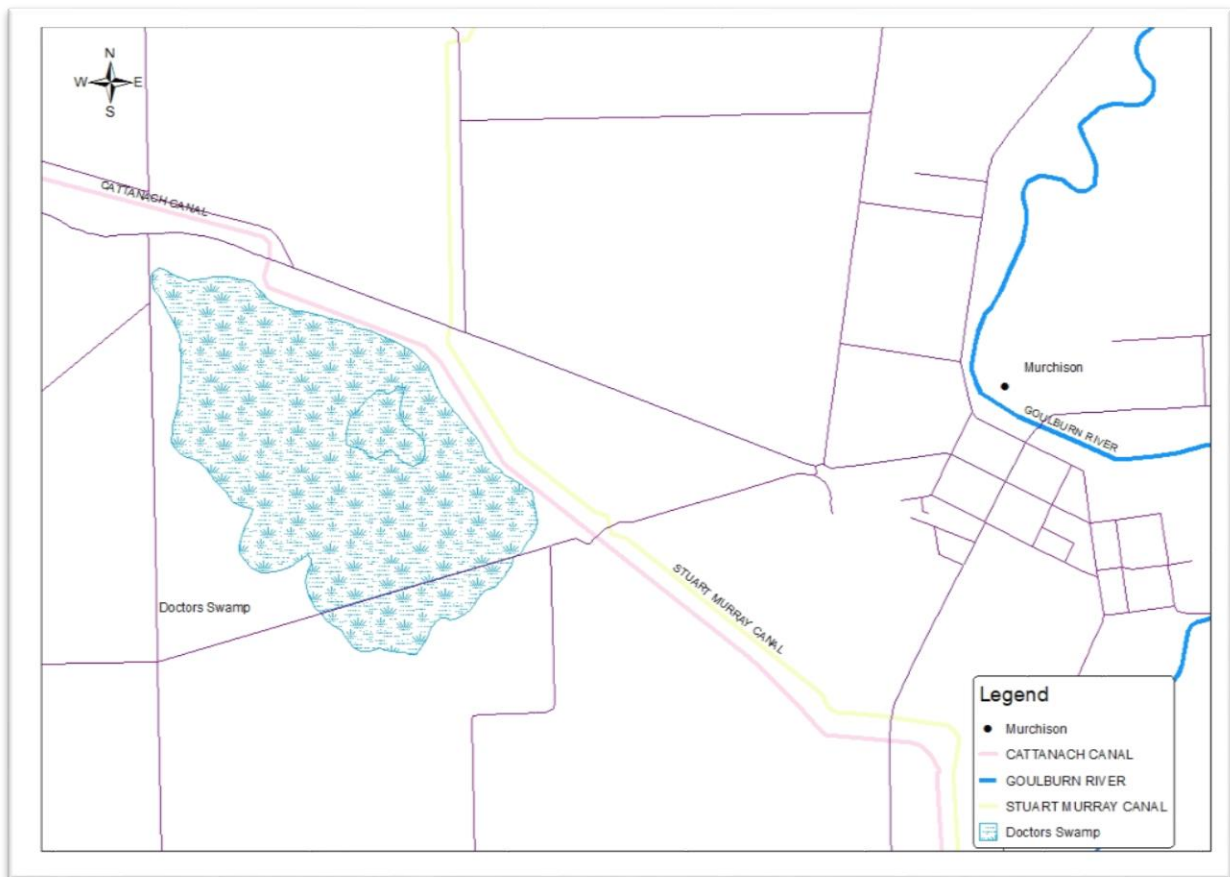


Figure 4: Doctors Swamp within the landscape





## 2.2 LAND STATUS AND MANAGEMENT

The study area is located within the Doctors Swamp Wildlife Reserve, which is managed by Parks Victoria (refer to section 2.3 – Wetland characteristics). A range of management agencies are also responsible for ensuring that management of the study area complies with a broad range of legislative requirements. Lead management agencies and their key responsibilities are summarised in Table 1. The broader community including adjacent landholders, Yorta Yorta Peoples (section 3.2.1 – 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.

**Table 1: Lead government agencies and their key study area responsibilities**

Agency	Responsibility
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>Aboriginal Heritage Act 2006</i> and Part IIA of the Commonwealth <i>Aboriginal Torres Strait Islander Heritage Protection Act 1984</i> ).
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. Manage a 22.62 hectare area within the north-west corner of Doctors Swamp.
Council of Greater Shepparton	Manage a disused roadway in the north-west corner of Doctors Swamp.
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 wetlands 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	Manage water related services including storage, delivery and drainage systems across Northern Victoria.
Murray Darling Basin Authority	The Murray–Darling Basin Authority's principal aim is to manage the Basin's water resources in the national interest.
Parks Victoria	Management of Doctors Swamp.
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 (Corrick and Norman, 1980) refer to Appendix 1. Wetlands through Victoria were mapped and classified between 1975 and 1994 and developed into spatial Geographic Information Systems (GIS) layers (DSE, 2007b).

Doctors Swamp is classified as a shallow freshwater marsh under the wetlands 1994 layer this classification is considered representative of the wetland during the time it was mapped and classified.

Doctors Swamp is located within the Victorian Riverine and Goldfields bioregions. It varies in depth to approximately 600mm and has a volume of 1284ML from dry. Doctors Swamp is a 200 hectare swamp which is part of the Doctors Swamp Natural Features Reserve (263 hectares) and was identified in the *Box-Ironbark Forest and Woodlands Investigations* (ECC, 2001). The Swamp is of bioregional significance and is managed by Parks Victoria (Table 2).

Environmental Water can currently be delivered to Doctors Swamp via the Cattanach Canal. However, delivery can only occur when the channel is near full capacity.



Table 2: Doctors Swamp site characteristics

Characteristics	Description
<b>Name</b>	Doctors Swamp
<b>Mapping Id</b>	7924374458
<b>Area (ha)</b>	200
<b>Bioregion</b>	Victorian Riverina Goldfields
<b>Conservation Status</b>	Bioregionally Significant*
<b>Land Status</b>	Natural Features Reserve – Wildlife Area
<b>Land Manager</b>	Parks Victoria
<b>Surrounding Land Use</b>	Dryland Agriculture
<b>Water Supply</b>	Local catchment run-off, Cattnach Canal
<b>1788 Wetland Category</b>	Shallow Freshwater Marsh
<b>1994 Wetland Category</b>	Shallow Marsh Subcategory: Red Gum and Rush
<b>Wetland Volume (ML)</b>	1284 from dry
<b>Mean wetland depth at Capacity (m)</b>	0.6m <sup>^</sup>

\*Note: Bioregional Significance is defined by the National Land and Water Audit (NLWWRA) which established a national framework for identifying biodiversity assets of bioregional significance.

<sup>^</sup>Note: filling Doctors Swamp to 0.6m will not occur during every environmental watering event. Filling the wetland to variable depths will promote an increased plant species community and drawing down the wetland slowly will allow the habitat to change in its natural state, resulting in different vegetation communities establishing within the wetland body.



## 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 can be called out of storage when needed and delivered to wetlands or streams to protect their environmental values and health. Environmental water entitlements are held by the Minister for Environment, who delegates management to the Victorian Environmental Water Holder.

Environmental Water for Doctors 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
One Tree Swamp Bulk Entitlement	9.3	Parks Victoria
Gaynor Swamp Bulk Entitlement	24	
Stockyard Plain Bulk Entitlement	112	Department of Sustainability and Environment

Future water reserves that may also be used within Doctors 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.



## 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.
- Wetlands 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:

- 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, 1997).
- Our Water Our Future (DSE, 2004).
- Securing our Natural Future. Land and Biodiversity White Paper (DSE, 2009c).
- Northern Region Sustainable Water Strategy (DSE, 2009d).
- Biodiversity Strategy for the Goulburn Broken Catchment, Victoria 2010-2015 (Miles et al., 2010).



## 2.6 RELATED PLANS AND ACTIVITIES

Two key management documents have been written that directly or indirectly assist with the management of Doctors Swamp. These include:

1. Doctors Swamp Environmental Management Statement (DPI, 2010). The purpose of the Doctors Swamp Environmental Management Statement is to outline its natural values and guide its short term management as a drought refuge within the Shepparton Irrigation Region.
2. Box-Ironbark Forest and Woodlands Investigations (ECC, 2001). The purpose of the investigation was to protect and restore a percentage of the Box-Ironbark Forests and Woodlands within Victoria. This included increasing box-ironbark forests and woodlands from 9% to 23% (public land) or from about 1% of the original extent of box-ironbark forests and woodlands to 3%.

These documents make a number of recommendations, some of which have been implemented and have assisted with the protection and enhancement of Doctors Swamp natural values including:

Natural resource management activities that have taken place to conserve Doctors Swamp, which may be directly, or indirectly associated with the abovementioned documents includes:

1. Pest plant and animal control including weed eradication and removal.
2. Infrastructure upgrade of the channel inlet to Doctors Swamp.
3. Channel maintenance of the Cattnach Canal.
4. Trial environmental water delivery in 2009 for drought refuge (refer to Section 4.1.2 – Post-regulation).
5. Ecological Monitoring of natural flooding on flora and fauna in 2010/11 (Jolly and Osler, 2011).



### 3. WATER DEPENDENT VALUES

#### 3.1 ENVIRONMENTAL

##### 3.1.1 FAUNA LISTINGS AND SIGNIFICANCE

Doctors Swamp Wildlife Reserve provides habitat for a wide variety of wetland and terrestrial fauna species (Figure 5). To date 151 fauna species have been recorded in the study area (Appendix 5). These include 120 bird species (44 wetland species and 76 terrestrial species), five frogs, ten mammals, five reptiles and eleven introduced species. Of these species one is listed under the *Environmental Protection Biodiversity Conservation Act* (1999) seven are listed under *Flora and Fauna Guarantee Act* (1988) and *DSE Advisory list of threatened vertebrate fauna in Victoria* (2007). Two species are listed under the JAMBA and CAMBA treaties and one is listed under the ROKAMBA treaty. Two species are listed under the *Convention on the Conservation of Migratory Species* (Bonn) (Table 4, Appendix 5). Latham’s Snipe (*Gallinago hardwickii*), Brolga (*Grus rubicunda*) and Blue-billed Duck (*Oxyura australis*) has been observed at Doctors Swamp (O’Connor, 2011, Weber, 2011).

Table 4: Conservation status of fauna species recorded at Doctors Swamp

Common Name	Scientific Name	Type	International Agreements	FFG	DSE status
<b>Australasian Shoveler</b>	<i>Anas rhynchos</i>	B			End
<b>Blue-billed Duck</b>	<i>Oxyura australis</i>	B		L	End
<b>Brolga</b>	<i>Grus rubicunda</i>	B		L	Vul
<b>Caspian Tern</b>	<i>Hydroprogne caspia</i>	B		L	NT
<b>Eastern Great Egret</b>	<i>Ardea modesta</i>	B	J,C,B	L	Vul
<b>Hardhead</b>	<i>Aythya australis</i>	B			Vul
<b>Latham’s Snipe</b>	<i>Gallinago hardwickii</i>	B	J,C,R		NT
<b>Musk Duck</b>	<i>Biziura lobata</i>	B			Vul
<b>Royal Spoonbill</b>	<i>Platalea regia</i>	B			Vul

**Legend**

Type: Bird

International: Camba (C), Jamba (J), Rokamba (R), Bonn (B)

FFG Status: Listed as threatened (L)

DSE Status: Endangered (End), Vulnerable (Vul), Near Threatened (NT)





Figure 5: White-necked Heron at Doctors Swamp flood in 2010

Photo: D.Cook, *Australian Ecosystems 2010*

Breeding data of bird species at Doctors Swamp was recorded by Jolly and Osler (2011) during 2010/ 2011 floods. Water birds that bred at Doctors Swamp included Black Swans, Chestnut Teal, Grey Teal and Eurasian Coots.

Many waterbirds such as the Royal Spoonbill, White-bellied Sea Eagle, Nankeen Night Heron, Musk Duck, Egrets, Herons (Figure 5) and other ducks utilise the swamp as a feeding and roosting ground. Brolga have also been sighted utilising the swamp as a feeding site.



### 3.2 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 floristics, lifeform, 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.

Doctors Swamp is located in the Victorian Riverina and Goldfields bioregions. Within these bioregions the Red Gum Swamp EVC (#292) has a vulnerable (Victorian Riverine) and endangered (Goldfields) conservation status, Plains Woodland (EVC #803) and Plains Grassy Wetland (EVC #125) is endangered in both bioregions (Appendix 5).

Doctors Swamp has experienced a pattern of wetting and drying of approximately two years wet or partially wet and then two years dry over the past ten years. The wetland will pond or fill via rainfall induced catchment run-off if rainfall is between 50-100mm or if the Cattanach Canal is flowing at a capacity of approximately 2500ML/day and spills over into the swamp (Weber, 2011).

Australian Ecosystems surveyed Doctors Swamp once a month for six months from April 2010 - December 2010 and noted “typically Red Gum Swamp occurring on gentle gradients such as that at Doctors Swamp has been significantly manipulated resulting in changes to species composition and distribution. Any such manipulation that may have occurred at Doctors Swamp has had minimal impact on the ecological value of the site” (Jolly and Osler, 2011).

Table 5: Conservation status of Ecological Vegetation classes recorded at Doctors Swamp

EVC number	EVC Name	Victorian Riverina Bioregion	Goldfields Bioregion
125	Plains Grassy Wetland	En	En
292	Red Gum Swamp	Vul	En
803	Plains Woodland	En	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 157 native flora species have been recorded at Doctors Swamp including 73 wetland species (Appendix 6). Of these species seven are considered rare or threatened in Victoria (Table 6, Figures 6 and 7). No species recorded were listed under the *Flora and Fauna Guarantee Act* (1988) or *Environmental Protection Biodiversity Conservation Act* (1999).

A total of 22 exotic flora species have been recorded at Doctors Swamp comprising five wetland species. Of these 22 species three are listed under the *Catchment and Land Protection Act* (CaLP 1994). Six high-risk weeds listed under the *DSE Advisory list of environmental weeds of the Inland Plains bioregions of Victoria* (2009) have also been recorded (section 5.1 – Water dependent threats and Appendix 7).

**Table 6: Conservation Status of Flora species recorded at Doctors Swamp**

Common Name	Scientific Name	DSE Status
Grey-spike sedge	<i>Eleocharis macbarronii</i>	k
Long eryngium	<i>Eryngium paludosum</i>	v
Open marshwort	<i>Nymphoides germinate</i>	r
Slender water-ribbons	<i>Triglochin dubia</i>	r
Smooth nardoo	<i>Marsilea mutica</i>	k
Swamp early Nancy	<i>Wurmbea dioica subsp. Lacunaria</i>	k
Swamp water-starwort	<i>Callitriche palustris</i>	k

**Legend**

DSE Status: Vulnerable (v), Rare (r), Poorly Known (k)

The River Red Gum Swamp EVC is dominated by *Myriophyllum crispatum* (Upright Water-milfoil) and *Eleocharis sphacelata* (Tall Spike-sedge). Species such as *Eleocharis macbarronii* (Grey Spike-sedge), *Eleocharis pusilla* (Small Spike-sedge), *Goodenia gracilis* (Slender Goodenia), *Marsilea mutica* (Smooth Nardoo) and *Triglochin dubia* (Slender water-ribbons) were also present.

The Plains Grassy Wetland EVC is dominated by *Cardamine moirensis* (Riverina Bitter-cress), *Craspedia paludicola* (Swamp Billy-buttons), *Eleocharis acuta* (Common Spike-sedge) and *Walwhalleya proluta* (Rigid panic) and *Amphibromus nervosus* (Common Swamp Wallaby-grass).

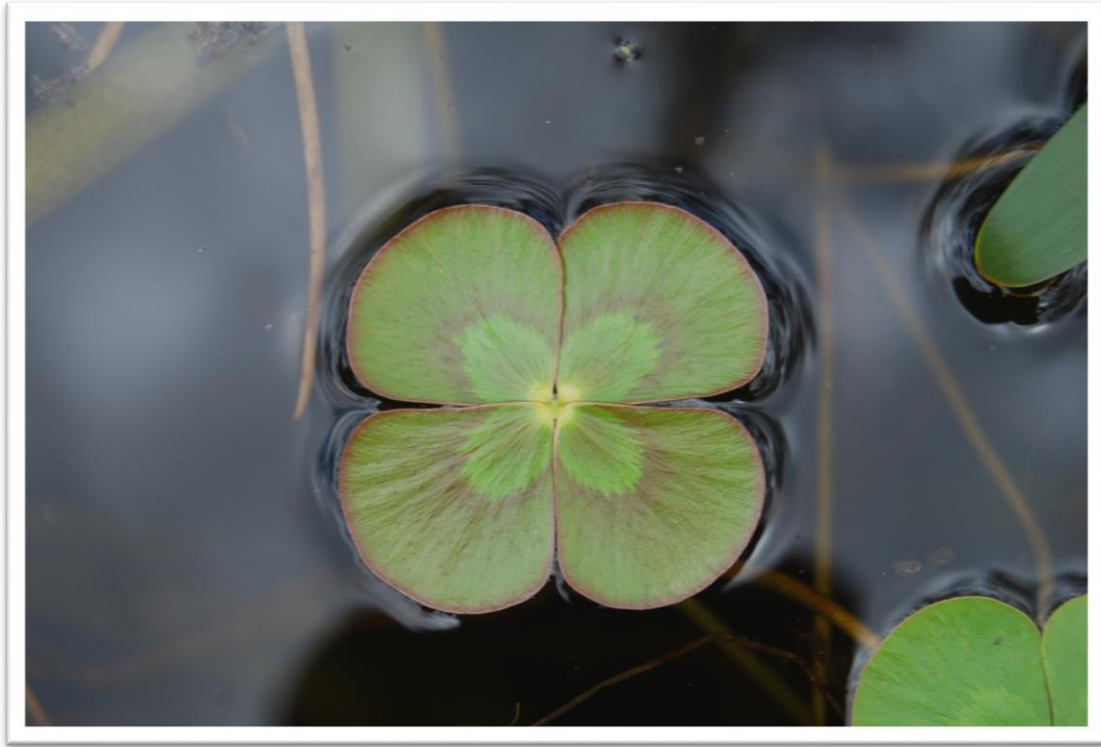


Figure 6: Smooth nardoo (*Marsilea mutica*) at Doctors swamp

Photo: J.Wood; GB CMA 2010



Figure 7: Swamp early Nancy (*Wurumbea sp*) at Doctors Swamp

Photo: D.Cook; Australian Ecosystems 2010



### 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 Andrew Corrick from the Arthur Rylah Institute. Mapping was undertaken from 1981 using 1:25,000 colour aerial photographs, along with field checking. This database is commonly known as the 1994 wetland layer and contains the following information:

- categories (primary) based on water regime; 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 a 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 per cent), shallow freshwater marsh (60 per cent) and deep freshwater marsh (70 per cent) categories (DNRE, 1997).

Doctors Swamp is classified as a Shallow Freshwater Marsh. Shallow Freshwater Marshes within the Goulburn Broken Catchment have declined by 40 per cent (GBCMA, 2006). Shallow Freshwater marshes within the Goulburn Broken Catchment tend to be smaller and less permanent than some other wetland types and are therefore more susceptible to changes in condition as a result of threats impacting on them including drainage and water regulation (GBCMA, 2006, Lyon et al., 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.



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### 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).

Doctors Swamp is a floodplain wetland. 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 VALUES

### 3.4.1 CULTURAL HERITAGE

The study area and the surrounding catchment have a long history of Indigenous occupation by the Yorta Yorta Peoples and are an important part of their cultural and spiritual heritage. The study area would have provided the Yorta Yorta Peoples with a rich and diverse supply of plant and animal resources for food, medicines, shelter, clothing and tools (Appendix 7). All aboriginal sites, places and objects are protected under the *Aboriginal Heritage Act 2006* (Vic.) and the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cwlth).

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 the study area. However, the exclusion of the planning area from this agreement does not preclude the active involvement of the Yorta Yorta Peoples in its management.

Doctors Swamp is identified as a culturally sensitive area (Figure 8). Culturally sensitive areas are classified under the *Aboriginal Heritage Act 2006* (Vic) as waterways or land within 200m of a waterway.

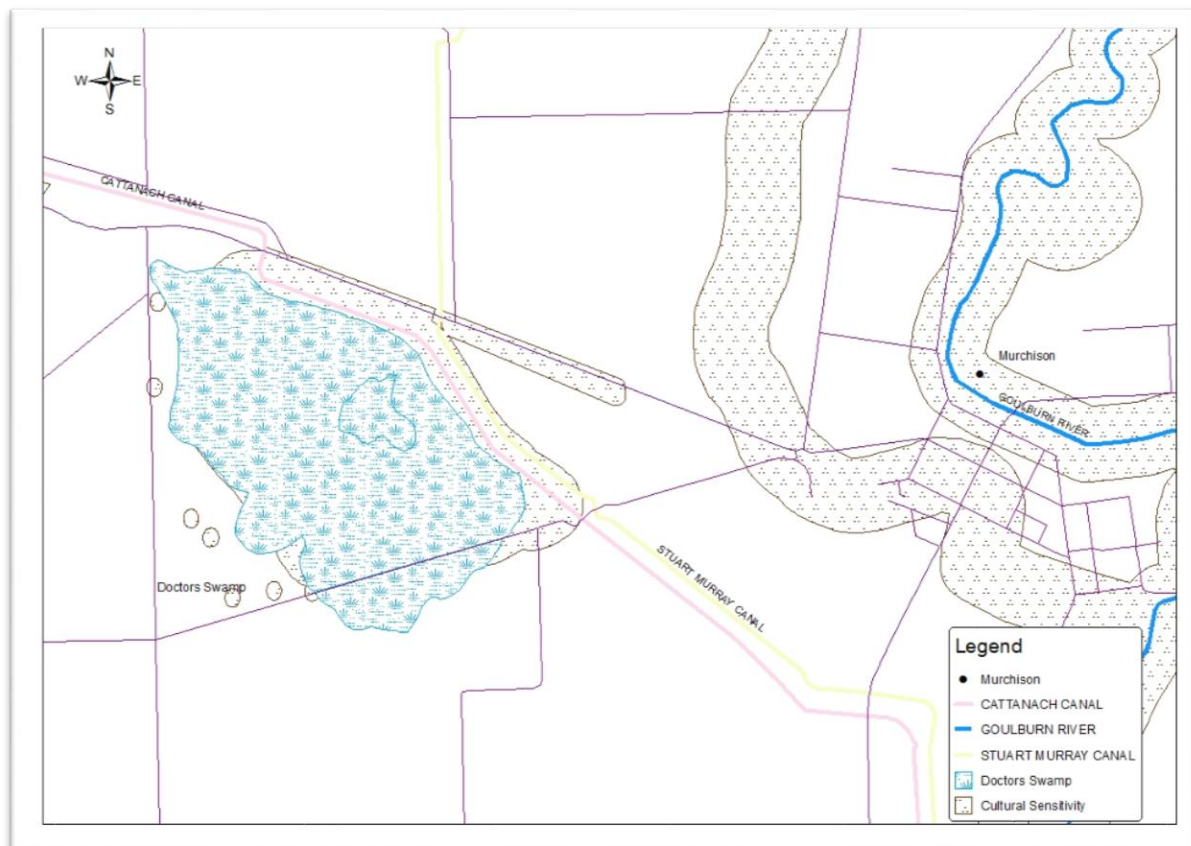


Figure 8: Culturally sensitive areas within and around Doctors Swamp





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### 3.4.2 RECREATION

Activities enjoyed by visitors to the study area include bird watching, picnicking and walking. Camping is a relatively low-level activity at Doctors Swamp, and there is no defined camping area or facilities. Recreational hunting of ducks, quails and other game species in season is permitted at Doctors Swamp.

### 3.5 ECONOMIC

Wetlands provide both direct and indirect economic values to the Goulburn Broken catchment (O'Connor, 2010). The direct economic values that Doctors Swamp contributes to the Goulburn Broken catchment include consumptive uses such as hunting and non-consumptive such as tourism and recreation. Indirect economic values that Doctors Swamp provide to the Goulburn Broken Catchment include water filtration, flood protection, groundwater recharge, nutrient discharge, carbon storage and habitat for threatened flora and fauna species.



## 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 wetland's hydrology is determined by surface and groundwater inflows and outflows in addition to precipitation and evapotranspiration (GBCMA, 2006, Mitsch and Gosselink, 1993). Duration, frequency, seasonality (timing) and depth are the main components of the wetlands hydrological regime.

### 4.1 WATER MANAGEMENT AND DELIVERY

#### 4.1.1 PRE-REGULATION

Under natural conditions Doctors Swamp would have filled via rainfall run-off entering natural drainage entering the southern and western boundaries of the wetland.

#### 4.1.2 POST-REGULATION

The natural hydrological regime of the wetland has been significantly altered since European settlement. The construction of the Goulburn Weir and Waranga Basin led to water being diverted from the Goulburn River. The Cattnach Canal skirts the edge of Doctors Swamp and is one of two main channels that are used to divert water from the Goulburn River entering the Goulburn Weir and supplying water to the Waranga Basin.

#### 4.1.3 WETLAND VOLUME

Doctors Swamp has currently not been used for operational purposes such as flood mitigation, drainage or water quality management; however, it has the capacity to do so. Based on field measurements Doctors Swamp is 200 hectares in size and has an average depth of 600mm. Therefore, the volume of the wetland equates to approximately 1284ML. When dry the amount of water required to inundate the wetland to the desired depth may be twice its volume. This is due to delivery losses and the water required to saturate the soil profile of the wetland. Doctors Swamp can only receive water via rainfall run off or delivery via the Cattnach Canal which is situated in the 1A Water Trading Zone.

#### 4.1.4 ENVIRONMENTAL WATER

An Environmental Management Statement was written for Doctors Swamp in 2010 (DPI, 2010). The purpose of the document was to outline the wetlands natural values and guide its short term management as a drought refuge within the Shepparton Irrigation Region.

A trial Environmental Water application was delivered to Doctors Swamp in October 2009 (Figure 9). 40ML of Environmental Water from the Murray Flora and Fauna Entitlement was gravity fed via the inlet on the Cattnach Canal. The delivery was achievable as the Cattnach Canal was running at near full capacity.



Figure 9: Environmental Water being delivered via the Cattnach Canal inlet - October 2009.



## 5. THREATS AND CONDITION

### 5.1 WATER DEPENDENT THREATS

The key threats to the values of Doctors 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 – Hydrology, the natural hydrological regime of Doctors Swamp has been altered by the construction of the Cattanach Canal and the regulation of the Goulburn River. This in turn has modified the structure and composition of the aquatic vegetation. However, due to the successful environmental water trial, it is now possible to deliver water to allow a more natural hydrological regime.

**Altered physical form** – Physical form relates to the area and bathymetry of a wetland. The area of Doctors Swamp has been physically reduced by past excavation activities, the construction of the Cattanach Canal to its northern margin and the construction of roads along the southern and western margins. Impacts on the bathymetry of the wetland have not yet been identified. Future impacts on the physical form of the wetland are unlikely to occur due to the protection provided by its current land status.

**Poor Water Quality** – Poor water quality including low dissolved oxygen may reduce habitat available for native aquatic biota, reducing its diversity and abundance. The water quality in Doctors Swamp may be impacted by:

- Run-off containing high nutrient loads or pollutants entering Doctors Swamp from surrounding agricultural land.
- Introduction of exotic fish such as Carp (*Cyprinus carpio*) via water delivery from the Cattanach Canal.

**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, 2009a). Threatening processes that can lead to poor wetland soils within Doctors Swamp include:

- Pugging by illegal livestock and feral animals.
- Human visitation (wading or walking within and around the edge of the wetland).
- Driving of vehicles within the wetland, especially if it is wet.
- Carp (*C. carpio*) 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 a potentially threatening process under Schedule 3 of Victoria’s *FFG Act* (1988) and is considered to be one of the major threats to the conservation of biological diversity in Victoria (PV, 2003). The growth of pest plants can be sufficiently vigorous to reduce or prevent 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, the nutrient content of soil and disturbance regimes including fire, grazing and insect activity (PV, 2003).

As discussed in Section 3.1.4 – Flora Species, 22 exotic flora species have been recorded at the site comprising five wetland species (Appendix 6). Of these species, Pepper tree (*Schinus molle*) poses the most threat near the inlet structure. Most weeds are confined to the margins of the Red Gum Swamp and do not extend significantly into areas that are inundated (Jolly and Osler, 2011). Aster Weed (*Aster subulatus*) is the only wetland weed listed as threatening on the *DSE Advisory list of Environmental Weeds* (DSE, 2009b).

Terrestrial weeds of significance found within the surrounds of Doctors Swamp include Spear Thistle (*Cirsium vulgare*), Stinkwort (*Dittrichia graveolens*) and Bathurst Burr (*Xanthium spinosum*) listed under the *Catchment and Land Protection Act* (1994). Weeds of very high and high risk as listed in the *DSE Advisory list of Environmental Weeds* (DSE, 2009b) include Aster weed, Ox-tongue (*Helminthotheca echioides*), Bucks-horn Plantain (*Plantago coronopus*), Narrow-leaf Clover (*Trifolium angustifolium*), Burr Medic (*Medicago polymorpha*) and Pepper Tree (*Schinus molle*).

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 Doctors Swamp include:

- Cats (*Felis catus*). Cat predation is listed as a threatening process under the *EPBC Act* (1999) and Schedule 3 of the *FFG Act* (1988).
- Foxes (*Vulpes vulpes*). Fox predation is listed as a threatening process under the *EPBC Act* (1999) and Schedule 3 of the *FFG Act* (1988).
- European Rabbit (*Oryctolagus cuniculus*) and Hare (*Lepus capensis*).

**Hunting** – Recreational hunting of ducks, quails and other game species in season is permitted at the site. The potential impacts of irresponsible shooting include noise disturbance to visitors and neighbours, shooting of non-target species, disturbance to other fauna (e.g. from hunting dogs), possible damage to cultural sensitive sites (e.g. scar trees and artefact scatters) and litter (PV, 2003).



## 5.2 CURRENT CONDITION

The condition of Doctors Swamp was assessed in December 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, 2007b).

The IWC has six subindices based on the catchment of the wetland and its fundamental characteristics: physical form, hydrology, water properties, soils and biota (Appendix 6). Each subindex is given a score between 0 and 20 based on the assessment of a number of measures (Appendix 6). 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](http://www.dse.vic.gov.au/iwc).

The overall IWC score for Doctors Swamp in December 2010 was eight out of ten, which is considered to be good and is the highest score of wetlands assessed in the Goulburn Broken Catchment to date (Table 7).

**Table 7: Doctors Swamp IWC subindex score, overall score and associated condition categories**

IWC subindex	Score	Condition category
<b>Wetland catchment</b>	13/20	Good
<b>Physical form</b>	12/20	Moderate
<b>Hydrology</b>	10/20	Moderate
<b>Water properties</b>	17/20	Excellent
<b>Soils</b>	15.5/20	Good
<b>Biota</b>	18.10/20	Excellent
<b>Overall IWC Score</b>	<b>8/10</b>	<b>Good</b>

## 5.3 CONDITION TRAJECTORY

With an increasing drying climate, natural watering events may occur less frequently. This may cause the loss of species diversity and terrestrialisation of vegetation within the wetland. However, the successful trial of environmental water delivery to Doctors Swamp provides the ability to deliver a more natural hydrological regime to the wetland, which in turn can increase the abundance, distribution and diversity of native wetland species at the site. Ongoing management including the delivery of environmental water and consistent monitoring of the site is critical to protecting values at Doctors Swamp.



## 6. MANAGEMENT OBJECTIVES AND ADAPTIVE APPROACHES

### 6.1 MANAGEMENT GOAL

The water management goal of Doctors Swamp is derived from sources including the Doctors Swamp Environmental Management Statement (DPI, 2010), local expertise and knowledge. The goal considers the values the wetland supports. This includes consideration of the aquatic dependent values the wetland has historically supported and the likely aquatic dependent values it could support into the future considering climate change.

#### Doctors Swamp Management Goal

*“To provide a watering regime that supports Red Gum Swamp and Plains Grassy Wetland EVCs and provides breeding opportunities for a diverse range of native wetland biota”*

The goal for Doctors Swamp recommends a watering regime that maintains the current values of the wetland.

### 6.2 ECOLOGICAL AND HYDROLOGICAL OBJECTIVES

#### 6.2.1 ECOLOGICAL OBJECTIVES

Ecological objectives are the desired ecological outcomes of the site. In line with the draft policy Victorian Strategy for Healthy Rivers, Estuaries and Wetlands (VSHREW), the ecological objectives are based on the key values of the site (section 3 – Water Dependent Values). The ecological objectives, where appropriate are expressed as the target condition or functionality for each key value. The ecological objectives are expressed as one of the following trajectories of each key value:

- 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 following ecological objectives for Doctors Swamp are based on values that the wetland provides for the larger catchment and on a local scale for its ability to support a large variety of flora and fauna species:

- Maintain the diversity of native wetland flora species consistent with Red Gum Swamp and Plains Grassy Wetland EVC benchmarks.
- Reduce the cover and diversity of exotic flora species.
- Provide opportunities for waterbird breeding at least three in ten years.
- Provide opportunities for native frog breeding at least three in ten years.

Justifications of these ecological objectives are discussed in Table 8, Appendix 5, 9 and 10.

**Table 8: Ecological Objectives for Doctors swamp**

Ecological Objective	Justification (Value based)
Achieve a diversity of native wetland flora species consistent with Red Gum Swamp and Plains Grassy Wetland EVC benchmark*.	Increase habitat and food sources for native fauna. Increase biodiversity.
Reduce the cover and diversity of exotic flora species.	Exotic plant species present at Doctors Swamp notable Aster Weed and the highly invasive native water couch are believed to be outcompeting native wetland plants.
Provide opportunities for waterbird breeding.	Doctors Swamp is relatively rich in waterbird species however, records of breeding are scarce.
Provide opportunities for native frog breeding at least one in three years.	Doctors Swamp is relatively rich in frog species as five have been recorded at the site.

\* Refer to Appendix 9

### 6.2.2 HYDROLOGICAL OBJECTIVES

Consistent with the management goal and the ecological objectives above, the water regime for Doctors Swamp is for flooding to occur 5 in 10 years to 7 in 10 years, in late Autumn-spring, and drying out within a year (Table 9). In the long term, reinstating a more natural hydrological regime will encourage the restoration of the original Red Gum Swamp EVC, and reduce the abundance and distribution of aquatic weeds. Red Gums grow more if flooded in spring – summer (Roberts and Marston, 2011). Monitoring will be needed in order to determine how long water should be held within the swamp. Soil should be kept moist for a duration of 12-18 months if establishment of river red gum seedlings is desired (Committee, 2011). Watering the wetland every 5 in 10 to 7 in 10 years will allow submerged aquatic species to germinate, grow and reseed.





**Table 9: Hydrological Objectives for Doctors Swamp**

Ecological Objectives	Water management area	Hydrological Objectives											
		Mean frequency of events (in 10 years)			Tolerable interval between events once wetland is dry (months)			Median 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			
Maintain Red Gum Swamp EVC	Wetland body and riparian zone	2	5-7	10	3	6	54	3	5-9	18 <sup>1</sup>	Late Autumn – Spring	1284	Variable to 600mm
Maintain Red Gum Swamp EVC	Wetland body and riparian zone	3	5-7	10	6	6	42	3	6	9	Late Autumn – Spring	1284	Variable to 600mm
Provide opportunities for waterbird breeding	Wetland body	3	10	10	6	9	12	6	8	NA	Spring <sup>2</sup>	1284 <sup>3</sup>	Variable to 600mm <sup>4</sup>
Provide key opportunities for frog breeding	Wetland fringe	NA	NA	NA	NA	NA	12	2	2-6	NA	Spring – Autumn <sup>5</sup>	1284	Variable to 600mm

1. Red Gums have been used as the main indicator plants for this watering regime. They should not be wet for more than two consecutive summers (Barlow, 2011). 18 months is the suggested maximum period of inundation that should allow the survival of veteran River Red Gums (Cook, 2011).
2. Rogers and Ralph 2011; Young 2003.
3. Filling wetland from dry based on calculations
4. Water depth should be kept fairly consistent if waterbirds are nesting/ breeding to avoid nests being abandoned (Young, 2003).
5. ARC, 2010, Appendix 10.



### 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. 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.

The optimal, minimum and maximum watering regimes for Doctors Swamp are described below. The optimum regimes involve filling five to seven years in ten; however duration of watering may vary between these hydrological regimes. Due to 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.

#### ***Minimum watering requirement***

*Provide two to three flooding events in ten years. Fill wetland to variable depths up to 600mm to maintain River Red Gum EVC to assist survival of existing vegetation.*

#### ***Optimum watering requirement***

*Provide five to seven flooding events every ten years. Fill wetland to variable depths to provide the River Red Gum EVC with appropriate watering requirements, allow regeneration and recruitment of species and encourage breeding opportunities for aquatic biota.*

#### ***Maximum watering requirement***

*Provide ten flooding events in ten years. Fill wetland to variable depths up to 600mm to maintain the Red Gum EVC vegetation or encourage breeding opportunities for aquatic biota.*



Flooding Doctors Swamp for a maximum of period of 18 months inundation should assist with veteran River Red Gums survival (Cook, 2011). The potential for natural rainfall events to prolong environmental watering must be considered. As a precaution, if environmental water is delivered to Doctors Swamp in Autumn it should only be filled to 50 per cent capacity. If no natural inflows top up the wetland by November it could then be filled to 90 per cent and allowed draw down over summer (Cook, 2011). Flooding Doctors Swamp to variable depths will promote an increased plant diversity and drawing down the wetland slowly will allow the habitat to change in its natural state, resulting in different vegetation communities establishing within the wetland body. This will assist in maintaining the EVC benchmarks for Doctors 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 10.

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 10).

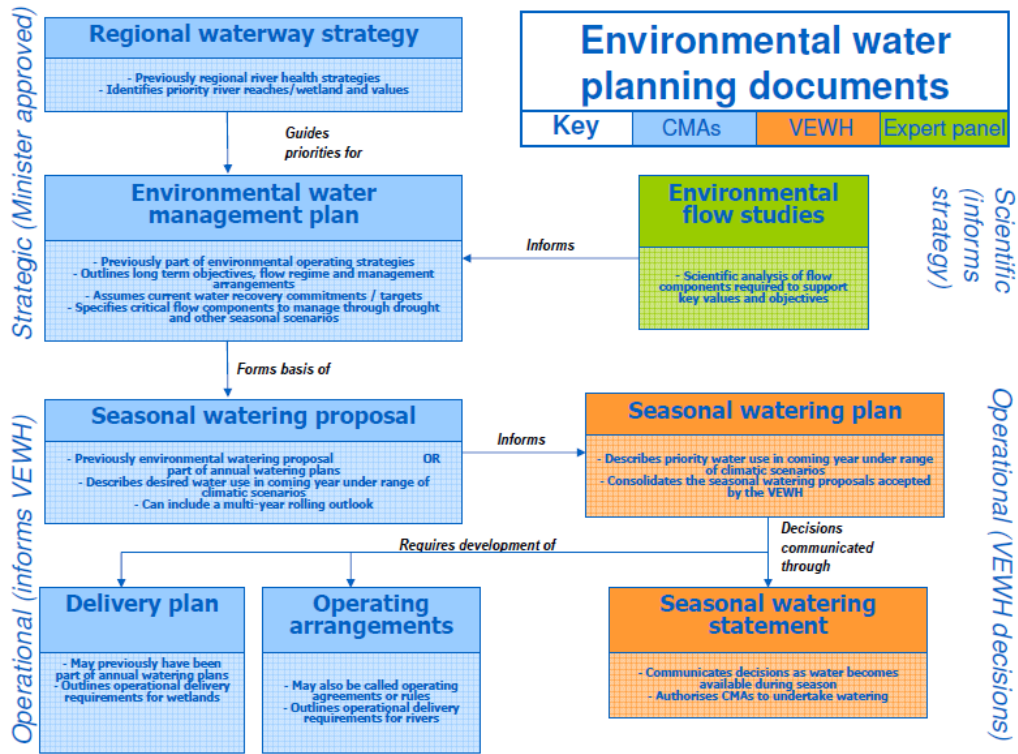


Figure 10: Flow chart for Environmental water planning



**Table 10: 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 priority river reaches and wetlands has been maintained or improved	The health and resilience of priority rivers and wetlands has been improved
Annual Management Agreements	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 base flows 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
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	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 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 OF AND MITIGATION MEASURES OF ENVIRONMENTAL WATERING

Potential risks associated with impacts from the application of environmental water to Doctors Swamp are listed in Table 11. 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 risks of environmental water delivery to Doctors Swamp include:

- Flood duration is too long or too short. If watering is too short birds breeding may abandon nests and aquatic flora may not self-seed.
- Flood timing is too late or early. Environmental water can only be delivered during the irrigation season when there is sufficient space capacity in the Cattanach Canal, which may not coincide with the desired timing.
- Flooding 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 is too long or short. This may occur if a significant rainfall event occurs after an environmental water delivery, prolonging flooding of the wetland, or water cannot be delivered within a sufficient time frame. The Cattanach Canal has to exceed flows of 2500ML/day before environmental water delivery can occur to Doctors Swamp. If flows need to be reduced or increased within the Canal water delivery to Doctors Swamp may be affected.
- Poor water quality. Water quality in the Cattanach Canal may be turbid, or have high nutrient levels when adding environmental water to Doctors Swamp. Flooding wetlands that have accumulated large amounts of organic material can also lead to low dissolved oxygen if water does not flow or is stagnant for large periods of time.
- Pest plant and animal invasion. Pest plants and animals such as Carp (*C. carpio*) can be introduced via environmental water delivery. Flooding can also stimulate the growth of pest plants and animals if it at the wrong time or duration.
- Impacts to social and economic values such as reduced public access or degradation of cultural heritage sites if flooding is too high.



Table 11: Potential risks associated with environmental water delivery

#	Risk	Description	Potential Impacts							Mitigation	
			Environmental					Social	Economic		
			<b>Fish</b> <i>Water regime does not support breeding and feeding</i>	<b>Birds</b> <i>Water regime does not support breeding and feeding</i>	<b>Amphibians</b> <i>Water regime does not support breeding and feeding</i>	<b>Invertebrate</b> <i>Water regime does not support breeding and feeding</i>	<b>Native aquatic flora</b> <i>Watering requirement does not support establishment</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		✓	✓		✓				Determine environmental water requirements based on seasonal conditions and to support potential bird breeding events  Monitor flood duration to inform environmental water delivery  Monitor the ecological response of the wetland to flooding  Add or drawdown water where appropriate
		Flood timing too late or early		✓	✓		✓	✓			Liaise with Goulburn-Murray Water to seek optimum timing of water delivery  Monitor flood timing to inform environmental water delivery  Monitor the ecological response of the wetland to flooding
		Flooding depth too shallow or deep		✓			✓	✓	✓	✓	Determine environmental water requirements based on seasonal conditions and to support potential bird breeding events  Monitor flood depth to inform environmental water delivery  Liaise with adjoining landowners prior to and during the delivery of environmental water to discuss and resolve potential or current flooding issues  Add or drawdown water where appropriate
		Flood frequency too long or short	✓ (too short only)	✓	✓	✓	✓	✓			Prioritise water requirements of wetlands in seasonal watering proposals according to their required water regimes and inundation history





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



## 8. ENVIRONMENTAL WATER DELIVERY INFRASTRUCTURE

### 8.1 CONSTRAINTS

Environmental water can be delivered to Doctors Swamp via the Cattanach Canal when flows exceed 2500ML/day. Delivery of environmental water can be constrained by the following:

- Flow volume - inflows into the Goulburn Weir need to be sufficient for diverting adequate water flow capacity down the canal to allow gravity fed delivery into Doctors Swamp.
- Flow duration – flow in the Cattanach Canal may be too low for commence to flow options or the possibility of channel running at near capacity for maximum delivery days to fill the wetland may be limited. Under severe dry conditions, alternative supply methods to a gravity feed from a near capacity Cattanach Canal may need to be considered. Pumping from the canal into the wetland may achieve environmental water delivery without requiring a near capacity Cattanach Canal, or help complete watering if the canal drops below the level required for gravity inflow. Alternatively, a temporary stop in the Cattanach Canal could be used to raise the water level to a sufficient height to allow a gravity inflow to the swamp.
- Irrigation demands and availability – Doctors Swamp does not have a delivery share, therefore environmental water can only be delivered when there is spare capacity to carry water in the Cattanach Canal.

### 8.2 IRRIGATION MODERNISATION

The Northern Victorian Irrigation Renewal Project (NVIRP) is a \$2 billion works program to upgrade ageing irrigation infrastructure across the Goulburn-Murray Irrigation District and to save water lost through leakage, evaporation and system inefficiency. Works will include lining and automating channels, building pipelines and installing new, modern metering technology. The impact of NVIRPs planned water savings is not expected to impact upon the Cattanach Canal and the ability of the Goulburn Broken CMAs capacity to deliver environmental water to Doctors Swamp.

### 8.3 INFRASTRUCTURE RECOMMENDATIONS

In 2004, investigations into upgrading the structure on the Cattanach Canal that lets water into Doctors Swamp was undertaken by Department of Primary Industries, Goulburn Broken Catchment Management Authority, Department of Sustainability and Environment, Goulburn-Murray Water (G-MW) and Parks Victoria. G-MW tested the inlet structure on the Cattanach Canal and the outlet structure (north west of the inlet structure), which allows excess water in the swamp to flow under the Cattanach Canal and continue down the catchment and discovered that water flowed in through the inlet and directly toward the outlet without moving into the main body of the wetland. A channel to direct the water into the body of the wetland was proposed, however works did not proceed. In 2009, a trial environmental water allocation of



40ML was delivered via the inlet structure. This proved successful in delivering water to the wetland without any ground works needing to be undertaken.

## 9. KNOWLEDGE GAPS AND RECOMMENDATIONS

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

The following list describes recognised knowledge gaps that may assist with a more efficient environmental water delivery to Doctors Swamp:

1. A detailed study on fish species and macroinvertebrate species present within the wetland.
2. Review the existing wetland capacity and survey the wetland bed (once site has dried).
3. Complete an additional Index of Wetland Condition survey for its current wet phase.
4. Develop a long and short-term monitoring program to be used in conjunction with environmental watering proposals and delivery plans.
5. Develop an alternative method report for the delivery of environmental water to Doctors Swamp if capacity in the Cattanach Canal cannot be achieved via gravity feeding.
6. Monitoring of the sites environmental conditions and issues that may pose threats. This includes monitoring species such as exotic species when conditions are deemed favourable for their prolific growth and collection of water quality data from Goulburn-Murray Water regarding Cattanach Canal if it inflows into Doctors Swamp. This monitoring should continue on a long-term basis ensuring control of these plants. Pest animals should be monitored and prevention/eradication should occur where possible. Investigation of management options for exotic fish species entering Doctors Swamp should occur.



## 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).



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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 AND WETLAND CATEGORIES

A system of wetland classification developed by Corrick and Norman (1980) 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 4 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 usually 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 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 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

**The Living Murray Initiative** – Established in 2002 as a partnership of the Commonwealth, NSW, Victoria and South Australian and ACT Governments. The long-term goal of this program is to achieve a healthy working Murray River system for the benefit of all Australians.

In 2004, under the “First Steps” decision, Ministers from TLM partner governments committed to recover a long-term average of 550GL of water to improve environmental outcomes at six icon sites. The six icon sites include Barmah-Millewa Forest, Gunbower and Koondrook-Perricoota Forests, Hattah Lakes, Chowilla Floodplain, Lower Lakes, Coorong and Murray Mouth and River Murray Channel.

**Goulburn Living Murray Bulk Entitlement** – The Environmental Entitlement was made by the Minister in 2007 and is held by the Minister for Environment and Climate Change so that water may be retained in the Goulburn River system to provide increased environmental flows in the River Murray System as part of the Living Murray Initiative. Peak use annual entitlement. Availability is proportional to the availability of low-reliability water shares.

**Broken Living Murray Bulk Entitlement** – Peak use annual entitlement. Availability is proportional to the availability of low-reliability water shares.

**Goulburn System - Snowy Environmental Reserve** – The Bulk Entitlement was first made by the Minister for Water on June 2004 to grant a bulk entitlement of 3,600ML per year to the Minister administering the *Catchment and Land Protection Act 1994*, resulting from water saving for the Snowy River from the Normanville Pipeline project. It is currently now an allocation of 16,812ML with additions from water savings in the Goulburn sub-system and Campaspe system under Improved Measurement of Small volumes Supplied to Irrigation Districts Programs and Goulburn Strategic Measurement Project. This reserve may contribute to summer flows in the Lower Goulburn and Broken Rivers. An additional 4,800ML is expected to become available in the near future as a result of water savings created from the Tungamah pipeline.

**Broken System - Snowy Environmental Reserve** – May contribute to summer flows in the Lower Goulburn and Broken Rivers. An additional 4,800ML is expected to become available in the near future as a result of water savings created from the Tungamah pipeline.

**Barmah-Millewa Environmental Water Allocation** – Victoria’s annual contribution towards the Barmah-Millewa EWA was established with NSW to provide flows for the forest. 50GL is allocated to the account annually and 25GL of low reliability when available. These are the maximum entitlement volumes. The actual volumes available depend upon the seasonal allocations. Water can be carried over into the account up to a volume of 50GL in total. Rules tied to this allocation enable consumptive users to borrow from the account in dry years.

**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** – 112 ML of water entitlement held by DSE.



**Goulburn River Additional Passing Flows** – Only available in November when the last two years of storage inflows have been good and storage inflows in September and October are low.

**One Tree Swamp Bulk Entitlement** – Can only be deployed in the supply networks of the Goulburn River, Lower Broken Creek and Murray River Systems.

**Gaynor Swamp Bulk Entitlement** – 24ML bulk entitlement managed by Parks Victoria

**Goulburn Water Quality Reserve** – The Goulburn Water Quality reserve is a provision in the Eildon-Goulburn Weir bulk Entitlement. Up to 30,000ML is available every financial year to maintain water quality in the Goulburn River and Broken Creek. For the Broken Creek, water is diverted at Goulburn Weir through the Shepparton Irrigation Area channels to Broken Creek. This water can be consumed or passed to the River Murray (GBCMA, 2010).

**Surplus (unregulated)** - Surplus River Murray flows under the Murray-Darling Agreement have been used in the past to supply water to Barmah Forest and surplus Broken Creek flows with agreement from Goulburn-Murray Water have been used in the past to supply water to Moodies Swamp on the Broken Creek. Surplus flows on the Broken and Goulburn Rivers could be used in the future to supply water to wetlands with agreement from Goulburn-Murray Water.

Victorian Environmental Water Holder (VEWH) – The Victorian Environmental Water Holder (VEWH) is to be established in July 2011. VEWH will be responsible for holding and managing Victorian environmental water entitlements and allocations and deciding upon their best use throughout the State. The environmental entitlements held by the VEWH that could potentially be made available to this site include:

- The Victorian River Murray Flora and Fauna Bulk Entitlement
- The Stockyard Plain entitlement
- One Tree Swamp entitlement
- Gaynor Swamp entitlement and;
- Future NVIRP environmental entitlement.

**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. 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, streams and wetlands in northern Victoria (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.



## APPENDIX 4: LEGISLATIVE FRAMEWORK

### Acts and Agreements

**Ramsar Convention on Wetlands (Ramsar)** – The Australian Government is a Contracting Party to the convention, 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.”

**Japan Australia Migratory Bird Agreement 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.

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

**China Australia Migratory Bird Agreement 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.

These agreements require that parties protect migratory birds by:

- Limiting the circumstances under which migratory birds are taken or traded;
- Protecting and conserving important habitats;
- Exchanging information; and
- Building cooperative relationships.

**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.

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

**ENVIRONMENT PROTECTION AND 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.

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



**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.

## **ACTS AND AGREEMENTS (VICTORIA)**

**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.

**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.

**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.

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

**Advisory lists of rare and threatened species in Victoria (DSE)** – Three advisory lists are maintained by DSE for use in a range of planning processes and in setting priorities for actions to conserve biodiversity. Unlike other threatened species lists, there are no legal requirements or consequences that flow from inclusion of a species on an advisory list. The advisory list comprises:

- Advisory list of Rare and Threatened Plants in Victoria – 2005
- Advisory list of Threatened Vertebrate Fauna in Victoria – 2007
- Advisory list of Threatened Invertebrate Fauna in Victoria - 2009

### **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 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

**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.

**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).

**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.



## APPENDIX 5: FAUNA SPECIES LIST

Fauna list of Doctors Swamp –counts by D. Cook *et al* 2010-11 surveys; Weber 2009 and O’Connor 2009; Brisbane 2011.

E – Listed as endangered under the *Environmental Protection Biodiversity Conservation Act (1999)*

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 Water dependant species or Waterbirds

b Observed breeding at the Swamp

Common Name	Scientific Name	EPBC	FFG	VROTS	Origin
Australasian Dater	<i>Anhinga novaehollandiae</i>				w
Australasian Grebe	<i>Tachybaptus novaehollandiae</i>				w
Australasian Shoveller	<i>Anas rhynchotis</i>			vul	w
Australian Magpie	<i>Gymnorhina tibicen</i>				
Australian Pelican	<i>Pelecanus conspicillatus</i>				w
Australian Raven	<i>Corvus coronoides</i>				
Australian Reed Warbler	<i>Acrocephalus australis</i>				w
Australian Shelduck	<i>Tadorna tadornoides</i>				w
Australian White Ibis	<i>Threskiornis molucca</i>				w
Australian Wood Duck	<i>Chenonetta jubata</i>				w
Barn Owl	<i>Tyto javanica</i>				
Black Swan	<i>Cygnus atratus</i>				w
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>				
Black Fronted Dotteral	<i>Euseyornis melanops</i>				w
Blue-billed Duck	<i>Oxyura australis</i>			en	w
Blue-faced Honeyeater	<i>Entomyzon cyanotis</i>				
Brolga	<i>Grus rubicunda</i>		L	vul	w
Brown Falcon	<i>Falco berigora</i>				
Brown Thornbill	<i>Acanthiza pusilla</i>				
Brown Treecreeper (South-Eastern sp.)	<i>Climacteris picumnus victoriae</i>		L	nt	
Brown-headed Honeyeater	<i>Melithreptus brevirostris</i>				
Brush Cuckoo	<i>Cacomantis variolosus</i>				w
Bush-stone Curlew	<i>Burhinus grallarius</i>				
Caspian Tern	<i>Hydroprogne caspia</i>		L	nt	w
Chestnut Teal	<i>Anas gracilis</i>				w
Crimson Rosella	<i>Platycercus elegans</i>				
Cockatiel	<i>Nymphicus hollandicus</i>				
Common Bronzewing	<i>Phaps chalcoptera</i>				
Crested Bellbird	<i>Oreica gutturalis</i>		L	nt	
Crested Pigeon	<i>Ocyphaps lophotes</i>				
Crested Shrike-tit	<i>Falcunculus frontatus</i>				
Dollarbird	<i>Eurystomus orientalis</i>				
Dusky Moorhen	<i>Gallinula tenebrosa</i>				w



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Dusky Woodswallow	<i>Artamus cyanopterus</i>				
Eastern Great Egret	<i>Ardea modesta</i>		L	vu	w
Eastern Rosella	<i>Platycecus eximius</i>				
Eurasian Coot	<i>Fulica atra</i>				w
Fairy Martin	<i>Hirundo ariel</i>				
Flame Robin	<i>Petroica phoenicea</i>				
Galah	<i>Eolophus roseicapillus</i>				
Goshawk	<i>Unknown sp</i>				
Great Cormorant	<i>Phalacrocorax carbo</i>				w
Grey Butcherbird	<i>Cracticus torquatus</i>				
Grey-crowned Babbler	<i>Pomatostomus temporalis</i>		L	en	
Grey Currawong	<i>Strepera versicolor</i>				
Grey Fantail	<i>Rhipidura albiscapa</i>				
Grey Shrike-thrush	<i>Colluricincla harmonica</i>				
Grey Teal	<i>Anas gracilis</i>				w
Hardhead	<i>Aythya australis</i>			vu	w
Hoary-headed Grebe	<i>Poliiocephalus poliocephalus</i>				w
Hooded Robin	<i>Melanodryas cucullata</i>				
Jacky Winter	<i>Microeca fascians</i>				
Latham's Snipe	<i>Gallinago hardwickii</i>			nt	w
Laughing Kookaburra	<i>Dacelo novaeguineae</i>				
Little Black Cormorant	<i>Phalacrocorax sulcirostris</i>				w
Little Corella	<i>Cacatua sanguinea</i>				
Little Friarbird	<i>Philemon citreogularis</i>				
Little Grassbird	<i>Megalurus gramineus</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-lark	<i>Grallina cyanoleuca</i>				
Masked Lapwing	<i>Vanellus miles</i>				w
Mistletoebird	<i>Dicaeum hirundinaceum</i>				
Musk Duck	<i>Biziura lobata</i>			vu	w
Musk Lorikeet	<i>Glossopsitta concinna</i>				
Nankeen Kestrel (Australian)	<i>Falco cenchroides</i>				
Nankeen Night Heron	<i>Nycticorax caledonicus</i>			nt	w
New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>				
Noisy Miner	<i>Manorina melanocephala</i>				
Olive-backed Oriole	<i>Oriolus sagittatus</i>				
Pacific Black Duck	<i>Anas superciliosa</i>				w
Pacific Heron (White Necked Heron)	<i>Ardea pacifica</i>				w
Peaceful Dove	<i>Geopelia striata</i>				
Peregrine Falcon	<i>Falco peregrinus</i>				
Pied Currawong	<i>Strepera graculina</i>				
Pink-eared Duck	<i>Malacorhynchus membranaceus</i>				w
Purple Swamphen	<i>Porphyrio porphyria</i>				w
Red Wattlebird	<i>Anthochaera carunculata</i>				
Red-Capped Robin	<i>Petroica goodenovii</i>				
Red-kneed Dotteral	<i>Erythronys cinctus</i>				w



Red-rumped Parrot	<i>Psephotus haematonotus</i>				
Regent Parrot	<i>Polytelis anthopeplus</i>	V	L	vu	
Restless Flycatcher	<i>Myiagra inquieta</i>				
Royal Spoonbill	<i>Platalea regia</i>			vu	w
Rufous Whistler	<i>Pachycephala rufiventris</i>				
Sacred Kingfisher	<i>Todiramphus sanctus</i>				w
Silver Gull	<i>Chroicocephalus novaehollandiae</i>				w
Silveryeye	<i>Zosterops lateralis</i>				
Southern Boobook	<i>Ninox novaeseelandiae</i>				
Spotted Pardalote	<i>Pardalotus punctatus</i>				
Straw-necked Ibis	<i>Threskiornis spinicollis</i>				w
Striated Pardalote	<i>Pardalotus striatus</i>				
Striated Thornbill	<i>Acanthiza apicalis</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>				
Tree Martin	<i>Petrochelidon nigricans</i>				w
Wedge-tailed Eagle	<i>Aquila audax</i>				
Weebill	<i>Smicromis brevirostris</i>				
Welcome Swallow	<i>Hirundo sphenurus</i>				w
Western Gerygone	<i>Gerygone fusca</i>				
Whistling Kite	<i>Haliastur sphenurus</i>				w
White-bellied Cuckoo-shrike	<i>Coracina papuensis</i>				
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>		L	vu	
White-breasted Woodswallow	<i>Artamus leucorhynchus</i>				
White-browed Woodswallow	<i>Artamus superciliosus</i>				
White-browed Babbler	<i>Pomatostomus superciliosus</i>				
White-faced Heron	<i>Egretta novaehollandiae</i>				w
White-napped Honeyeater	<i>Melithreptus lunatus</i>				
White-plumed Honeyeater	<i>Lichenostomus penicillatus</i>				
White-throated Treecreeper	<i>Cormobatus leucophaeus</i>				
White-winged Chough	<i>Corcorax melanorhamphos</i>				
White-winged Triller	<i>Lalage suerii</i>				
Willie Wagtail	<i>Rhipidura leucophrys</i>				
Yellow-billed Spoonbill	<i>Platalea flavipes</i>				w
Yellow-rumped Thornbill	<i>Acanthiza chrysorrhoa</i>				
Yellow Thornbill	<i>Acanthiza nana</i>				
<b>FROGS</b>					
Common Froglet	<i>Crinia signifera</i>				
Perons Tree Frog	<i>Litoria peronii</i>				
Plains Froglet	<i>Crinia parinsignifera</i>				
Pobblebonk	<i>Limnodynastes dumerili</i>				
Spotted Marsh Frog	<i>Limnodynastes tasmaniensis (NCR)</i>				
<b>MAMMALS</b>					
Black Wallaby (Swamp Wallaby)	<i>Wallabia bicolor</i>				
Common Brushtail Possum	<i>Trichosaurus vulpecular</i>				
Eastern Grey Kangaroo	<i>Macropus giganteus</i>				
Echidna	<i>Tachyglossus aculeatus</i>				



Koala	<i>Phascolarctos cinereus</i>				
Ring-tailed Possum	<i>Pseudochieridae peregrinus</i>				
Swamp Wallaby	<i>Wallabia bicolour</i>				
White-stripe Freetail Bat	<i>Tadarida australis</i>				
White-tailed Water Rat	<i>Hydromys chrysogaster</i>				
Yellow-footed Antechinus	<i>Antechinus flavipes</i>				
<b>REPTILES</b>					
Common Long-necked Tortoise	<i>Chelodina longicollis</i>				
Eastern Brown Snake	<i>Pseudonaja textillis</i>				
Lace Monitor	<i>Varanus varius</i>				vul
Red-bellied Black Snake	<i>Pseudechis porphyriacus</i>				
Blind Snake	<i>Ramphotyphlops sp.</i>				
<b>INTRODUCED SPECIES</b>					
Cat	<i>Felis cattus</i>				
Common Blackbird	<i>Turdus merula</i>				
Common Myna	<i>Acanthiza chrysorrhoa</i>				
Common Starling	<i>Sturnus vulgaris</i>				
Domestic Mouse	<i>Mus musculus</i>				
Domestic Rat	<i>Rattus sp.</i>				
European Goldfinch	<i>Carduelis carduelis</i>				
European Rabbit	<i>Oryctolagus cuniculus</i>				
Hare	<i>Lepus capensis</i>				
House Sparrow	<i>Passer domesticus</i>				
Red Fox	<i>Vulpes vulpes</i>				

EPBC: V = listed as Vulnerable

FFG: L = listed as threatened

VROT (DSE advisory list): nt = Near threatened, end = Endangered, vul = Vulnerable

ORIGIN: W = WETLAND SPECIES



## 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 2006). Victoria's Framework for the Native Vegetation Management (DNRE 2002) utilises the notion of Ecological Vegetation Classes (EVCs). 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 (DSE 2006, section 3.1.1 - EVCs that occur in wetlands pg 5).

Below is a description of the EVCs found within and surrounding Doctors Swamp ([www.dse.gov.au](http://www.dse.gov.au)).

### **Red Gum Swamp [EVC #292]**

Woodland of swampy depressions of lowland plains, with sedgy-herbaceous understorey including aquatic species.

### **Plains Grassy Wetland [EVC #125]**

Grassy-herbaceous shallow seasonal wetlands of lowland plains, characteristically species-rich (at least on verges) when relatively intact. Zones interpreted as representing complexes between Plains Grassy Wetland and several other wetland EVCs are frequently present.

## **EVCs SURROUNDING DOCTORS SWAMP**

### **Plains Woodland [EVC # 803]**

An open, eucalypt woodland occurring on a number of geologies and soil types. Occupies poorly drained, fertile soils on flat or gently undulating plains at low elevations. The understorey consists of a few sparse shrubs over a species-rich grassy and herbaceous ground layer.

### **Plains Grassy Woodland [EVC# 55\_61]**

An open, eucalypt woodland to 15m tall. Occupies poorly drained, fertile soils on flat or gently undulating plains at low elevations. The understorey consists of a few sparse shrubs over a species-rich grassy and herbaceous ground layer. This variant occupies areas receiving approximately 500-700mm annual rainfall.



**APPENDIX 6: FLORA SPECIES LIST**

Flora list of Doctors Swamp – taken from DSE flora list and Cook *et al* 2010-11 survey. EVC information is based on surveys conducted by Cook *et al* 2010-11 only.

Note: EVC information is recorded only from D.Cook Surveys.

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

E = Listed as 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 292	EVC 125	EPBC	FFG	VROTS	Origin	Indigenous Use
Gold Dust Wattle	<i>Acacia acinacea</i>							
Spreading Wattle	<i>Acacia genistifolia</i>							
Mallee Wattle	<i>Acacia montana</i>							
Golden Wattle	<i>Acacia pycnantha</i>							Gum used for food and medicine
Sheep's Burr	<i>Acaena echinata</i>							
Lesser joyweed	<i>Alternanthera denticulata</i>						w	
Long-nosed Wallaby-grass	<i>Amphibromus macrorhinus</i>		✓				w	
Southern Swamp Wallaby-grass	<i>Amphibromus neesii</i>						w	
Common Swamp Wallaby-grass	<i>Amphibromus nervosus</i>	✓	✓				w	
Small Vanilla-lily	<i>Anthropodium minus</i>							
Small Chocolate-lily	<i>Anthropodium sp.3 (aff. strictum)</i>							
Slender Aphia	<i>Aphelia gracilis</i>							
Brush Wire-grass	<i>Aristida behriana</i>							
Small vanilla-lily	<i>Anthropodium minus</i>							
Lily	<i>Anthropodium sp</i>							
Small chocolate-lily	<i>Anthropodium sp3 (aff. strictum)</i>							
Common Woodruff	<i>Asperula conferta</i>						w	
Berry Saltbush	<i>Atriplex semibaccata</i>							
Lobed Wallaby-grass	<i>Austrodanthonia auriculata</i>							
Common Wallaby-grass	<i>Austrodanthonia caespitosa</i>							
Brown-back Wallaby-grass	<i>Austrodanthonia duttoniana</i>		✓				w	
Hill Wallaby-grass	<i>Austrodanthonia eriantha</i>							
Slender Wallaby-grass	<i>Austrodanthonia racemosa var. racemosa</i>							
Bristly Wallaby-grass	<i>Austrodanthonia setacea</i>							
Spurred Spear-grass	<i>Austrostipa gibbosa</i>							
Rough Spear-grass	<i>Austrostipa scabra</i>							
Pacific Azolla	<i>Azolla filiculoides</i>	✓					w	

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Marsh Club-sedge	<i>Bolboschoenus medianus</i>							w	
Red-leg Grass	<i>Bothriochloa macra</i>								
Woodland Swamp-daisy	<i>Brachyscome basaltica var. grailis</i>							w	
Bulbine Lily	<i>Bulbine bulbosa</i>								
Swamp Water-starwort	<i>Callitriche palustris</i>							k	w
Matted Water-starwort	<i>Callitriche sonderi</i>								w
Lemon Beauty-heads	<i>Calocephalus citreus</i>								
Riverina Bitter-cress	<i>Cardamine moirensis</i>		✓						w
Tall Sedge	<i>Carex apressa</i>								w
Knob Sedge	<i>Carex inversa</i>								w
Poong'ort	<i>Carex tereticaulis</i>							w	Stems for string and fibre
Drooping Cassinia	<i>Cassinia arcuata</i>								
Common Sneezeweed	<i>Centipeda cunninghamii</i>							w	Medicinal Tonic
Flat Spurge	<i>Chamaesyce drummondii</i>								Milk sap used for medicine
Stonewort	<i>Chara sp.</i>		✓					w	
Frosted Goosefoot	<i>Chenopodium desertorum</i>								
Windmill Grass	<i>Chloris truncata</i>								
Pink Bindweed	<i>Convolvulus erubescens spp.agg</i>								Tap roots made into dough
Common billy-buttons	<i>Craspedia glauca spp.agg</i>								
Swamp Billy-buttons	<i>Craspedia paludicola</i>		✓					w	
Spreading Crassula	<i>Crassula decumbens var. decumbens</i>							w	
Stalked Crassula	<i>Crassula peduncularis</i>		✓					w	
Bear's-ear	<i>Cymbonotus sp</i>								
Star Fruit	<i>Damasonium minus</i>		✓	✓				w	
Australian Carrot	<i>Daucus glochidinator</i>								
Broom Bitter-pea	<i>Daviesia genistifolia</i>								
Reed Bent-grass	<i>Deyeuxia quadriseta</i>								
Black-anther Flax-lily	<i>Dianella admixta</i>								
Saloop	<i>Einadia hastata</i>								
Nodding Saltbush	<i>Einadia nutans subsp.nutans</i>								
Waterwort	<i>Elatine gratioides</i>		✓	✓				w	
Common Spike-sedge	<i>Eleocharis acuta</i>		✓	✓				w	
Grey Spike-sedge	<i>Eleocharis macbarronii</i>		✓	✓				k	w
Small Spike-sedge	<i>Eleocharis pusilla</i>		✓	✓				w	
Tall Spike-sedge	<i>Eleocharis spaelata</i>		✓					w	
Common Wheat-grass	<i>Elymus scaber var. scaber</i>								
Ruby Saltbush	<i>Enchylaena tomentosa var. tomentosa</i>								Berries and leaves eaten
Spider Grass	<i>Enteropogon acicularis</i>								
Willow herb	<i>Epilobium spp.</i>								
Southern Cane-grass	<i>Eragrostis infecunda</i>							w	
Blue Devil	<i>Eryngium ovinum</i>								
Long Eryngium	<i>Eryngium paludosum</i>							v	
Prick Foot	<i>Eryngium vesiculosum</i>							w	
River Red Gum	<i>Eucalyptus camaldulensis</i>		✓					w	Seeds ground to make flour
Yellow Gum	<i>Eucalyptus leucoxylon</i>								
Grey Box	<i>Eucalyptus microcarpa</i>								
Common Eutaxia	<i>Eutaxia microphylla</i>								



Mud Mat	<i>Glossostigma sp.</i>		✓					w	
Australian Sweet-grass	<i>Glyceria australis</i>							w	
Indian Cudweed	<i>Gnaphalium polycaulon</i>							w	
Slender Goodenia	<i>Goodenia gracilis</i>		✓	✓				w	
Spreading Goodenia	<i>Goodenia heteromera</i>								
Swamp Goodenia	<i>Goodenia humilis</i>								
Cut-leaf Goodenia	<i>Goodenia pinnatifida</i>								
Common Heliotrope	<i>Heliotropium europaeum</i>								
Stinking Pennywort	<i>Hydrocotyle laxiflora</i>								
Plain Quillwort	<i>Isoetes drummondii</i>			✓				w	
Club Sedge	<i>Isolepis sp.</i>			✓				w	
Finger Rush	<i>Jucus subsecundus</i>								
Hollow Rush	<i>Juncus amabilis</i>								
Toad Rush	<i>Juncus bufonius</i>								
Gold Rush	<i>Juncus flavidis</i>			✓				w	
Joint-leaf Rush	<i>Juncus holoschoenus</i>				✓				
Hoary Rush	<i>Juncus radula</i>								
Plains Rush	<i>Juncus semisolidus</i>							w	
Common Blown-grass	<i>Lachnagrostis filiformis</i>			✓				w	
Bottle Daisy	<i>Lagenophora spp.</i>								
Common Duckweed	<i>Lemna disperma</i>		✓					w	
Scaly Buttons	<i>Leptorhynchos squamatus</i>								
Wiry Buttons	<i>Leptorhynchos tenuifolius</i>								
Poison Pratia	<i>Lobelia concolor</i>							w	
Poison Lobelia	<i>Lobelia pratioides</i>		✓	✓				w	
Wimmera Rye-grass	<i>Lolium rigidum</i>				✓				
Wattle Mat-rush	<i>Lomandra filiformis</i>								
Small Loosestrife	<i>Lythrum hyssopifolia</i>			✓				w	
Black Cotton-bush	<i>Maireana decalvans</i>								
Narrow-leaf Nardoo	<i>Marsilea costulifera</i>							w	
Smooth Nardoo	<i>Marsilea mutica</i>		✓				k	w	
Weeping Grass	<i>Microlaena stipoides var. stipoides</i>								
Yam Daisy	<i>Microseris sp.3</i>								
Minura	<i>Minura sp.</i>								
Water Blinks	<i>Montia Fontana subsp. chondrosperma</i>							w	
Creeping Mistletoe	<i>Muellerina eucalyptoides</i>								
Mousetail	<i>Myosurus australis</i>							w	
Upright Water-milfoil	<i>Myriophyllum crispatum</i>			✓				w	
Clustered Water-milfoil	<i>Myriophyllum glomeratum</i>			✓				w	
Tiny Water-milfoil	<i>Myriophyllum integrifolium</i>			✓				w	
Amphibromus Water-milfoil	<i>Myriophyllum simulans</i>		✓	✓				w	
Water-milfoil	<i>Myriophyllum sp.</i>		✓					w	
Varied Water-milfoil	<i>Myriophyllum variifolium</i>		✓						
Stonewort	<i>Nitella sp.</i>		✓					w	
Marshwort	<i>Nymphoides geminata</i>		✓				r	w	
Swamp Lily	<i>Ottelia ovalifolia subsp. Ovalifolia</i>		✓					w	
Yellow Wood-sorrel	<i>Oxalis corniculata s.l</i>								
Grassland Wood-sorrel	<i>Oxalis perennans</i>			✓				w	
Water Pepper	<i>Persicaria hydropiper</i>							w	Stems and leaves eaten



Common Reed	<i>Phragmites australis</i>						w	Multiple uses
Austral Pillwort	<i>Pilularia novae-hollandiae</i>		✓				w	
Common Rice-flower	<i>Pimelea humilis</i>							
Shade Plantain	<i>Plantago debilis</i>							
Narrow Plantain	<i>Plantago gaudichaudii</i>							
Hairy Plantain	<i>Plantago hispida</i>							
Variable Plantain	<i>Plantago varia</i>							
Forde Poa	<i>Poa fordeana</i>						w	
Red Pondweed	<i>Potamogeton cheesemanii</i>	✓	✓				w	
Twiggy Bush-pea	<i>Pultenaea largiflorens</i>							
Drumsticks	<i>Pycnosorus globosus</i>		✓				w	
Ferny Small-flower Buttercup	<i>Ranunculus pumilio</i>		✓				w	
Slender Dock	<i>Rumex brownii</i>							
Narrow-leaf Dock	<i>Rumex tenax</i>						w	
Common Bog-sedge	<i>Schoenus apogon</i>							
Cotton Fireweed	<i>Senecio quadridentatus</i>							
Smooth Solenogyne	<i>Solenogyne dominii</i>							
Trigger Plant	<i>Stylidium sp.</i>		✓					
Broughton Pea	<i>Swainsona procumbens</i>						w	
Slender Water-ribbons	<i>Triglochin dubia</i>	✓				r	w	
Northern Water-ribbons	<i>Triglochin multifructa</i>	✓					w	
Water-ribbons	<i>Triglochin sp.</i>						w	
Trithuria	<i>Trithuria submersa</i>		✓					
Narrow-leaf Cumbungi	<i>Typha domingensis</i>						w	Multiple uses
Yellow Bladderwort	<i>Utricularia australis</i>	✓					w	
Purple Bladderwort	<i>Utricularia beaugleholei</i>		✓				w	
Trailing Speedwell	<i>Veronica plebeian</i>							
Running Marsh-flower	<i>Villarsia reniformis</i>	✓					w	
Fuzzy New-Holland Daisy	<i>Vittadinia cuneata</i>							
Wooly New Holland Daisy	<i>Vittadinia gracilis</i>							
Bluebell	<i>Wahlenbergia sp.</i>							
Rigid Panic	<i>Walwhalleya prolata</i>		✓				w	
Common Early Nancy	<i>Wurmbea dioica</i>							
Swamp Early Nancy	<i>Wurmbea dioica subsp. lacunaria</i>					k	w	
<b>EXOTIC SPECIES</b>								
Cape Weed	<i>Arctotheca calendula</i>		✓					
Aster Weed	<i>Aster subulatas</i>						w	
Thread Water-starwort	<i>Callitriche hamulata</i>		✓				w	
Square Cicendia	<i>Cicendia quadrangularis</i>							
Spear Thistle	<i>Cirsium vulgare</i>		✓					
Couch	<i>Cynodon dactylon var. dactylon</i>							
Stinkwort	<i>Dittrichia graveolens</i>	✓						
Reed Sweet-grass	<i>Glyceria maxima</i>							
Ox-tongue	<i>Helminthotheca echioides</i>							
Rough Cat's-ear	<i>Hypochoeris radicata</i>		✓					
Awned Club-sedge	<i>Isolepis hystrix</i>		✓				w	
Willow-leaf Lettuce	<i>Lactuca saligna</i>							
Burr Medic	<i>Medicago polymorpha</i>		✓					
Paspalum	<i>Paspalum dilatatum</i>							





Water Couch	<i>Paspalum distichum</i>							w
Buck's-horn Plantain	<i>Plantago coronopus</i>		✓					
Ribwort	<i>Plantago lanceolata</i>		✓					
Curled Dock	<i>Rumex crispus</i>	✓						w
Pepper Tree	<i>Schinus mollee</i>							
Common Sow-thistle	<i>Sonchus oleraceus</i>							
Narrow-leaved Clover	<i>Trifolium angustifolium var. angustifolium</i>							
Bathurst Burr	<i>Xanthium spinosum</i>							

VROTS (DSE advisory list): k = poorly known, v = vulnerable, r = rare

Origin: w = wetland species



**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 12 IWC subindices and measures**

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

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 14). Weightings are then applied to the scores (Table 15). The maximum possible total score for a wetland 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 13 Weights of each subindex**

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

Five wetland condition categories have been assigned to the subindex scores (Table15) 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 14 Wetland condition categories assigned to subindex scores.**

Sub-index score range (all except biota)	Biota sub-index score range	Wetland 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 15 Wetland condition categories assigned to total IWC scores**

IWC total score range	Wetland 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 Wetland 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 DOCTORS SWAMP

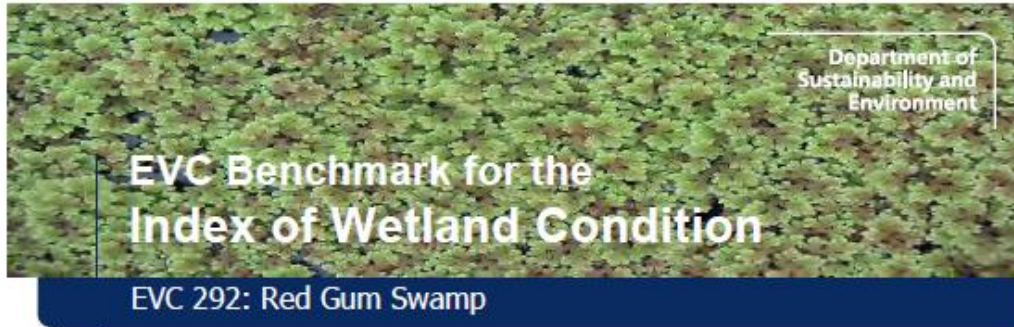
EVC benchmarks have been determined for Doctors Swamp by monitoring the site between 2010-2011.

Benchmarks for the Red Gum Swamp EVC at Doctors Swamp include: Trees (aim to have 5-10% cover).

Medium to large sedges (aim to have at least 2 species and >10% cover around verges).

Medium to large grasses (aim to have at least 3 species and >10% cover in the zone where dominant around verges)

Aquatic Herbs (aim to have >8 species and >10% cover) Refer below.



**Description:**

Woodland of swampy depressions of lowland plains, with sedgy-herbaceous understorey including aquatic species. Scattered on lowland plains, principally in the Riverina and south-west of Wimmera, extremely rare on the western volcanics.

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

Scientific name	Common name
<i>Carex tereticaulis</i>	Poong'ort
<i>Eleocharis acuta</i>	Common Spike-sedge
<i>Eucalyptus camaldulensis</i>	River Red-gum
<i>Marsilea drummondii</i>	Common Nardoo
<i>Myriophyllum crispatum</i>	Upright Water-milfoil

**Conditions when the EVC should not be assessed**

None recognised subject to visibility of attached vegetation within wetland shallows. Discretion can be required during prolonged dry periods.

**1. CRITICAL LIFEFORMS**

**Conditions when specific critical lifeform groupings should not be assessed**

None recognised.

**General comments on assessing critical lifeform groupings**

None.

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

Critical lifeform	No. spp.	% Cover	Comments
Trees	1	5	substantially modified if absent or change in cover
Aquatic herbs	2	5	
Medium to tall grasses	3	10	around dry verges
Medium to tall sedges	2	10	



## EVC 292: Red Gum Swamp

### 2. WEEDS

#### High threat weed species

Scientific name	Common name
<i>Cirsium vulgare</i>	Spear Thistle
<i>Holcus lanatus</i>	Yorkshire Fog
<i>Paspalum distichum</i>	Water Couch
<i>Phalaris aquatica</i>	Toowoomba Canary-grass
<i>Phyla canescens</i>	Fog-fruit
<i>Sagittaria</i> spp.	Sagittaria

Conditions where weeds are considered to have a negligible impact  
None recognised.

### 3. INDICATORS OF ALTERED PROCESSES

Indicator of altered process	Cover	Scale of severity
	5-10%	Minor
Dense River Red-gum <i>Eucalyptus camaldulensis</i> regeneration	10-25%	Moderate
	>25%	Severe

Circumstances where some critical lifeform groupings may not be evident  
None recognised.

### 4. VEGETATION STRUCTURE AND HEALTH

Structural dominant	Benchmark cover
River Red-gum <i>Eucalyptus camaldulensis</i>	10%

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**EVC 125: Plains Grassy Wetland**

**Description:**

Grassy-herbaceous shallow seasonal wetlands of lowland plains, characteristically species-rich (at least on verges) when relatively intact. Zones interpreted as representing complexes between Plains Grassy Wetland and several other wetland EVCs are frequently present. Formerly widespread in lowland plains areas.

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

Scientific name	Common name
<i>Amphibromus nervosus</i>	Common Swamp Wallaby- grass
<i>Amphibromus</i> spp.	Swamp Wallaby-grass
<i>Austrodanthonia duttoniana</i>	Brown-back Wallaby-grass
<i>Eleocharis acuta</i>	Common Spike-sedge
<i>Eleocharis pusilla</i>	Small Spike-sedge
<i>Eragrostis infecunda</i>	Southern Cane-grass
<i>Glyceria australis</i>	Australian Sweet-grass
<i>Lachnagrostis filiformis</i> var. 2	Wetland Blown-grass
<i>Poa labillardierei</i>	Common Tussock-grass

**Herbs on the verge zones of relatively intact sites**

<i>Brachyscome cardiocarpa</i>	Swamp Daisy
<i>Craspedia paludicola</i>	Swamp Billy-buttons
<i>Eryngium vesiculosum</i>	Prickfoot
<i>Helichrysum</i> aff. <i>rutidolepis</i> (Lowland Swamps)	Pale Swamp Everlasting
<i>Microseris</i> sp. 1	Plains Yam-daisy
<i>Neopaxia australasica</i>	White Purslane
<i>Potamogeton tricarinatus</i> s.l.	Floating Pondweed
<i>Villarsia reniformis</i>	Running Marsh-flower

**Notes on indicator species**

*Eragrostis infecunda* occurs in drier versions (e.g. Wimmera and rainshadow basalt plains west of Melbourne).

**Conditions when the EVC should not be assessed**

None recognised (subject to water quality adequate to view attached vegetation in wetland shallows).

**1. CRITICAL LIFEFORMS**

**Conditions when specific critical lifeform groupings should not be assessed**

None recognised.

**General comments on assessing critical lifeform groupings**

None



## EVC 125: Plains Grassy Wetland

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

Critical lifeform	No. spp.	% Cover	Comments
Medium to tall herbs	2	+	of fringing zone, species of deep soils rather than true aquatics
Medium to tall aquatic to semi-aquatic herbs	3	1	
Small to prostrate semi-aquatic herbs	3	5	
Medium to tall tufted grasses	3	15	sometimes also including cane grass
Small (to medium) non-tufted graminoids	2	5	

+ denotes presence

**2. WEEDS**

**High threat weed species**

Scientific name	Common name	Scientific name	Common name
<i>Agrostis capillaris</i> s.l.	Brown-top Berit	<i>Lilaea scilloides</i>	Lilaea
<i>Alopecurus lanceolatus</i>	Water Plantain	<i>Mentha pulegium</i>	Pennyroyal
<i>Alopecurus</i> spp.	Fox Tail	<i>Nassella neesiana</i>	Chilean Needle-grass
<i>Cirsium vulgare</i>	Spear Thistle	<i>Paspalum</i> spp.	Paspalum
<i>Cotula coronopifolia</i>	Water Buttons	<i>Phalaris aquatica</i>	Toowoomba Canary-grass
<i>Hemithoea echinoides</i>	Ox-tongue	<i>Plantago lanceolata</i>	Ribwort
<i>Holcus lanatus</i>	Yorkshire Fog	<i>Rumex conglomeratus</i>	Clustered Dock
<i>Juncus articulatus</i>	Jointed Rush	<i>Rumex crispus</i>	Curled Dock
<i>Juncus bulbosus</i>	Bulbous Rush	<i>Trifolium repens</i> var. <i>repens</i>	White Clover
<i>Leontodon taraxacoides</i> subsp. <i>taraxacoides</i>	Hairy Hawkbit		

**Conditions where weeds are considered to have a negligible impact**

None recognised.

**3. INDICATORS OF ALTERED PROCESSES**

Indicator of altered process	Scale of severity
Invasion of woody species, principally tea-tree/paperbark	Incidental regeneration of shrubs within open area of wetland Invasion front evident around margins of open area Regeneration conspicuous on wetland floor
	Minor Moderate Severe

**Circumstances where some critical lifeform groupings may not be evident**

None recognised.

**4. VEGETATION STRUCTURE AND HEALTH**

Structural dominant	Benchmark cover
Perennial native grasses, various combinations of Brown-back Wallaby-grass <i>Austrodanthonia duttoniana</i> , Wetland Wallaby-grass <i>Austrodanthonia semilanceolata</i> , Southern Cane-grass <i>Eragrostis infecunda</i> , Australian Sweet-grass <i>Glyceria australis</i> , Swamp Wallaby-grass <i>Amphibromus</i> spp., Common Tussock-grass <i>Poa labillardierei</i>	30%

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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