



# Black Swamp Environmental Water Management Plan 2011

Goulburn Broken Catchment  
Management Authority

IN





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### MANAGEMENT

Prepared by Goulburn Broken Catchment Management Authority  
 PO Box 1752 Shepparton Vic 3632  
 Telephone: (03) 5820 1100

Contact Jo Wood and Simon Casanelia

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## EXECUTIVE SUMMARY

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

Black Swamp is a shallow and intermittent open water red gum swamp. It is located 2 km east of Wunghnu Township in northern Victoria. The wetland contains a significant population of the Environment Protection Biodiversity Conservation Act (1999) listed River swamp Wallaby-grass. The wetland is managed by Parks Victoria and is listed as bioregionally significant by the National Land and Water Audit.

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

- Improve the diversity of native wetland flora species consistent with ecological vegetation classes;
- reduce the cover and diversity of exotic flora species;
- provide opportunities for waterbird that utilise the site for breeding and feeding; and
- provide opportunities for native frog breeding.

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 Regimes for Black Swamp

**Minimum** – *Provide one to two flooding events in ten years, filling the wetland to variable depths up to 500mm to maintain EVCs t assist survival of existing vegetation.*

**Optimum** – *Provide three to four flooding events in ten years, filling the wetland to variable depths up to 500mm to provide EVCs with appropriate watering requirements, allow regeneration and recruitment of 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 up to 500mm to maintain EVCs and to encourage breeding opportunities for aquatic biota.*

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



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## ABBREVIATIONS

CAMBA	China Australia Migratory Bird Agreement
CEWH	Commonwealth Environmental Water Holder
CG	Central Goulburn Channel
CMA	Catchment Management Authorities
DSE	Department of Sustainability and Environment
EC	Electrical Conductivity
EG	East Goulburn Channel
EPBC	<i>Environment Protection Biodiversity Act 1999</i>
EVC	Ecological vegetation community
EWA	Environmental Water Allocation
EWMP	Environmental Water Management Plan
EWR	Environmental water reserve
FFG	<i>Flora and Fauna Guarantee Act 1988</i>
GB CMA	Goulburn Broken Catchment Management Authority
GIS	Geographic Information System
GMID	Goulburn-Murray Irrigation District
G-MW	Goulburn-Murray Water
IWC	Index of Wetland Condition
JAMBA	Japan Australia Migratory Birds Agreement
ML	Megalitre (one million litres)
NVIRP	Northern Victoria Irrigation Renewal Project
ROKAMBA	Republic of Korea Australia Migratory Bird Agreement
SKM	Sinclair Knight Mertz
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 availability of environmental water availability is providing new opportunities to preserve, restore, reinstate and maintain high value ecosystems throughout northern Victoria. The spatial coverage of environmental watering has expanded considerably in recent years and this trend will continue into the future.

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

### 1.2 PURPOSE

The Victorian Catchment Management Authorities (CMAs), Department of Sustainability and Environment (DSE) and the Victorian Environmental Water Holder (VEWH) are working together to develop new Environmental Water Management Plans 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 CMAs to the Victorian Environmental Water Holder (VEWH) annually. The Plans describe:

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

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



### 1.3 SITE LOCATION

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

Black Swamp is a 16.5 hectare seasonal shallow freshwater marsh within the larger Goulburn Broken Catchment (Figure 1). The Swamp is situated on the Nine Mile Creek floodplain two kilometres east of Wunghnu township (Figure 2). Black Swamp is managed by Parks Victoria (section 2.3 – Wetland Characteristics). It contains a significant population of the *Environment Protection Biodiversity Conservation Act* (1999) listed River-swamp Wallaby-grass (*Amphibromus fluitans*).

Prior to European settlement, Black Swamp was a seasonal open River Red Gum Swamp filling on a near annual basis in winter-spring from rainfall and flooding of the Nine Mile Creek and run-off from 200 hectare catchment to the north of the swamp (DCE 1991). It is supported by an aquatic understory of Spike-rush (*Eleocharis spp.*), Water Milfoils (*Myriophyllum spp.*), and Water Ribbons (*Triglochin spp.*), with fringes of Juncus (*Juncus spp.*), Sedges (*Carex spp.*), Lignum (*Muehlenbeckia spp.*) and Cane-grass (*Eragrostis infecunda*). The swamp would dry out over the summer-autumn period.

Black Swamp has been altered from its natural condition due to the utilisation of the Nine Mile Creek as an irrigation channel and drain in the 1960s (DCE 1991), when irrigation was introduced to the area. The use of the Nine Mile Creek as a supply channel altered the ecology of the stream as constant high flows were maintained throughout the irrigation season (August–May). Prolonged high flows over the irrigation season caused prolific growth of Cumbungi (*Typha spp.*) and the exotic Arrowhead (*Sagittaria graminea*) within the creek (DCE 1991). The creek was dredged in the late 1960s to allow a more rapid flow of irrigation water. These high creek flows entered into Black Swamp causing the death of River Red Gums (*Eucalyptus camaldulensis*) and some of the Grey Box (*Eucalyptus microcarpa*) on the lower part of the floodplain. 1971 saw the construction of a water supply channel from the creek to the swamp by a local Field and Game Association, to ensure flooded conditions occurred during duck hunting season. Culverts were placed within the channel to provide level control and allow vehicle access, but were repeatedly washed out. The high flows and illegal manipulation of the channel caused the swamp to become virtually permanently inundated.

To restore a more natural hydrological regime the existing drop bars in the regulator at Black Swamp were replaced in 2008 by the Goulburn Broken CMA with a new head and discharge gate to more effectively



regulate flows into the wetland complex and reduce the illegal manipulation of the structure (section 4 – Hydrology and System Operations; Figure 8).



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



## 1.4 CONSULTATION

This plan was prepared by the Goulburn Broken Catchment Management Authority with input from a Scientific Technical Committee. The Scientific Technical Committee developed ecological and hydrological goals for Kinnairds Swamp at a workshop based on the local history of the swamp, knowledge of past and present watering regimes, the water requirements to support existing ecological values and the current condition of the swamp (Appendix 1). Members of the Scientific Technical Committee included Keith Ward (Goulburn Broken CMA), Sam Green (Goulburn-Murray Water), Damien Cook (Australian Ecosystems), Doug Frod (Pathways Bushland and Environment), Rolf Weber (Department of Sustainability and Environment), Gary Deayton (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:

- Black Swamp Wildlife Reserve DRAFT Interim Management Statement (DCE 1991).
- Goulburn Broken Regional River Health Strategy (GBCMA 2005).
- Broken, Boosey and Nine Mile Creek Wetland Implementation Plan (Hale, Roberts *et al.* 2006).
- Broken-Boosey State Park and Nathalia, Numurkah, Tungamah and Youarang Natural Features Reserves Management Plan (PV 2006).
- Black Swamp Flood Regime Determination (SKM 2007).
- Ecological Monitoring of flora and fauna response to environmental water delivery in 2008 and 2010 (Cook, Bayes *et al.* 2009; Jolly and Osler 2011).
- Lower Broken Creek and Nine Mile Creek Environmental Watering Plan (GBCMA 2010)
- Workshop booklet from the Scientific Committee Technical Workshop (Committee 2011).

This information was supplemented by discussions with people with an intimate knowledge of the swamp area, its environmental values, and the management and operation of Black Swamp and the Nine Mile Creek.

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

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



## 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 regimes for Black Swamp discussed in this Plan was developed using local knowledge, technical experts, field observations and scientific literature on the water requirements 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 intends to be a live document and will be amended as new information becomes available.



## 2. SITE OVERVIEW

### 2.1 CATCHMENT HISTORY

Black Swamp is located on the Nine Mile Creek floodplain within the Broken Creek Catchment (Figure 2). The Broken, Boosey and Nine Mile Creeks are the key waterways in the Catchment and have a combined total length of approximately 450km. The Broken Creek and its associated floodplain are listed in *A Directory of Important Wetlands in Australia* (EA 2001) and stretches of the Broken and Nine Mile Creeks have been reserved as State Park and Natural Features Reserve.

Over 60 per cent of the Goulburn Broken Catchment has been cleared for agricultural purposes (Miles, McLennan *et al.* 2010). 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 horticulture, 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 fringing the Nine Mile, Broken and Boosey Creeks form an important corridor in the Catchment and are a stronghold for native flora and fauna.

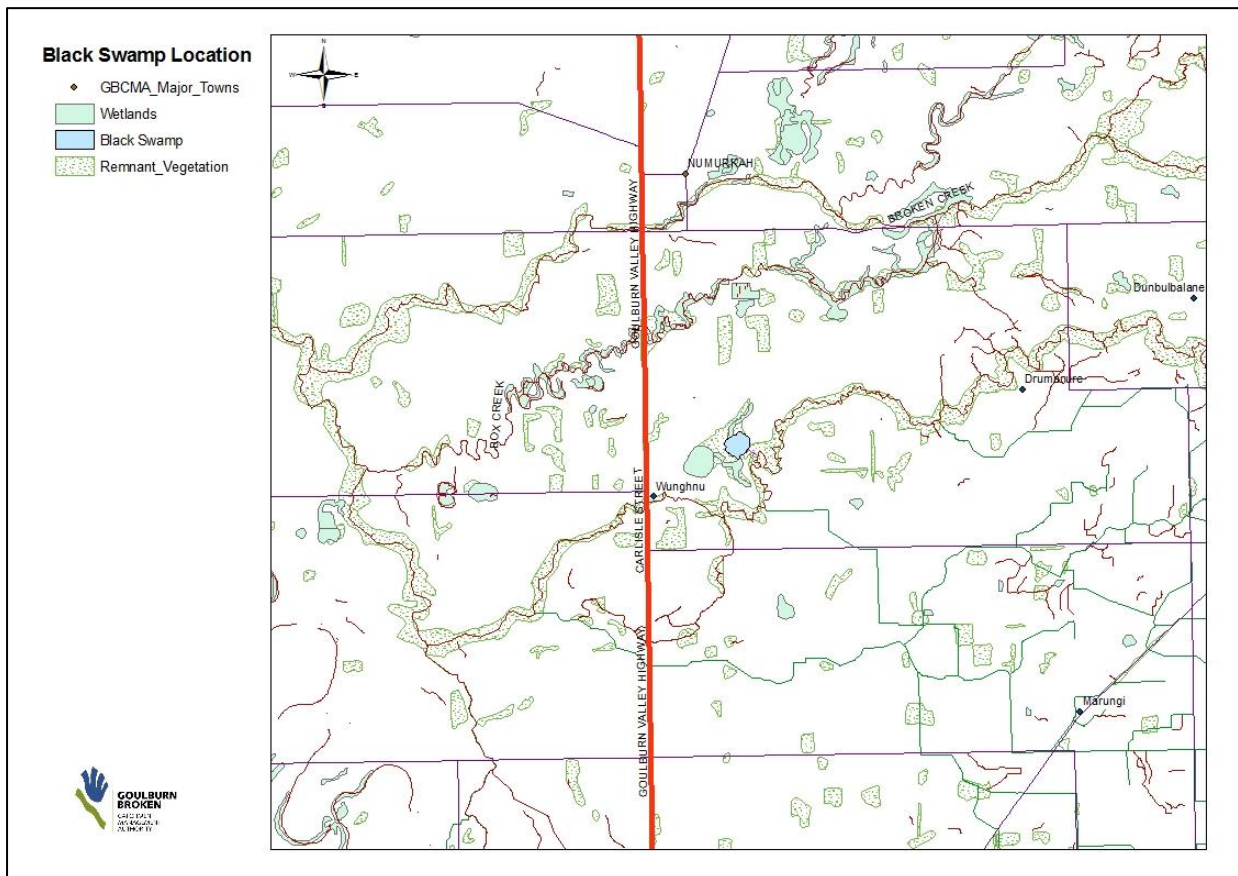


Figure 2: Black Swamp connection to Nine Mile Creek





## 2.2 LAND STATUS AND MANAGEMENT

Black Swamp is located within the Black Swamp Wildlife Reserve managed by Parks Victoria (Section 2.3 – Wetland Characteristics). A range of management agencies are responsible for ensuring that management of the site 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 People (Section 3.4.1 - Cultural heritage), Landcare and recreational users such as Field and Game also have an interest and role in Black Swamp. The successful management of the site therefore relies on effective cooperation and partnership between the government agencies and the broader community.

**Table 1: Lead government agencies and their key site responsibilities**

Agency	Responsibility
Aboriginal Affairs Victoria	Promote knowledge and understanding within the wider community of Aboriginal people and their history. Administer legislation protecting Aboriginal heritage sites ( <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.
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 seasonal watering proposals to VEWH for consideration, and managing the delivery of environmental water in accordance with VEHWs watering plan.
Goulburn-Murray Water	Manages 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.
Moira Shire	Regulate local development through the planning scheme, on-ground works, and management of local roads and urban drainage.
Parks Victoria	Management of the site.
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; Appendix 2) which includes information on water depth, permanency and salinity (Corrick and Norman 1980). Wetlands throughout Victoria were mapped and classified between 1975 and 1994 and developed into spatial GIS layers (DSE 2007b). Black Swamp is classified as a shallow freshwater marsh in the Department of Sustainability and Environment wetlands 1994 layer. Black Swamp has an approximate depth of 0.5m and has a calculated capacity of approximately 53ML<sup>1</sup>.

Black Swamp is situated in the Victorian Riverina bioregion and is located within the Black Swamp Wildlife Reserve and the surrounding Nine Mile Creek floodplain is reserved as State Park. The wetland is managed by Parks Victoria and is part of a larger 70 hectare wetland complex (Table 2). Black Swamp is surrounded by irrigated agricultural properties to the north, Purdies Swamp to the west and the Nine Mile Creek to the South East (Figure 3). Environmental water can currently be delivered to Black Swamp via the Nine mile Creek connection channel.

**Table 2: Black Swamp site characteristics**

Characteristics	Description
<b>Name</b>	Black Swamp
<b>Mapping Id</b>	7925607991
<b>Area (ha)</b>	16.5
<b>Bioregion</b>	Victorian Riverina
<b>Conservation Status</b>	Bioregionally Significant*
<b>Land Status</b>	Natural Features Reserve – Wildlife Reserve
<b>Land Manager</b>	Parks Victoria
<b>Surrounding Land Use</b>	Irrigated Agriculture/ Conservation area
<b>Water Supply</b>	Nine Mile Creek
<b>1788 Wetland Category</b>	Shallow freshwater marsh
<b>1994 Wetland Category</b>	Shallow marsh
<b>Wetland Capacity (ML)</b>	53
<b>Wetland depth at Capacity (mm)</b>	Varies to 500mm

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



Figure 3: Black Swamp and surrounding land use which is primarily agricultural land.



## 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 entitlements are held by the Minister for Environment, who delegates management to the Victorian Environmental Water Holder.

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

**Table 3: Environmental Water Entitlements**

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

Future water reserves that may also be used in Black 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 management of the site. Those with particular relevance to the site and the management of its environmental and cultural values are listed below. For the functions and major elements, 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:

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



Victorian policy, codes of practice, charters and strategies:

- Goulburn Broken Catchment Regional Catchment Strategy (GBCMA 1997).
- Our Water Our Future (DSE 2004).
- Goulburn Broken Catchment Regional River Health Strategy (GBCMA 2005).
- Land and Water Biodiversity Paper. Securing our Natural Future (DSE 2009a) .
- Northern Region Sustainable Water Strategy (DSE 2009b).
- Biodiversity Strategy for the Goulburn Broken Catchment, Victoria 2010-2015 (Miles, Mc Lennan *et al.* 2010).
- Lower Broken Creek and Nine Mile Creek Environmental Watering Plan (GBCMA 2010).



## 2.6 RELATED PLANS AND ACTIVITIES

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

1. Black Swamp Wildlife Reserve. Draft Interim Management Statement (DCE 1991).
2. Broken-Boosey State Park Management Plan (PV 2006).
3. Broken Boosey and Nine Mile Creeks Wetland Implementation Plan (Hale, Roberts *et al.* 2006).
4. Black Swamp Flood Regime Determination Project Report (SKM 2007).
5. Lower Broken Creek and Nine Mile Creek Environmental Watering Plan (GBCMA 2010).

Recommendations from these documents that have been implemented and have assisted with the protection and enhancement of Black Swamp natural values and a more efficient environmental water delivery include:

1. Upgrading the channel inlet and channel door to allow more efficient environmental water delivery and control.
2. Environmental water delivery for drought refuge in 2008 and 2010 (Section 4.1.4 – Environmental Water).
3. Monitoring of the ecological response of flora and fauna to environmental water delivery in 2008 and 2010 (Cook, Bayes *et al.* 2009; Jolly and Osler 2011).
4. Assessment of Black Swamps condition using the Index of Wetland Condition methodology (Section 5.2 – Current condition)
5. Nest box construction and installation by Field and Game Australia.
6. Fencing around the wetland boundary to control stock and vehicle access.
7. Pest plant and animal control such as fox (*Vulpes vulpes*) baiting and weed eradication such as mechanical removal of arrowhead (*Sagittaria platyphylla*) .
8. Revegetation of the degraded areas in the surrounding terrestrial zone.



### 3. WATER DEPENDENT VALUES

#### 3.1 ENVIRONMENTAL - FAUNA

##### 3.1.1 FAUNA LISTINGS AND SIGNIFICANCE

Black Swamp Wildlife Reserve provides habitat for a wide variety of wetland and terrestrial fauna species. To date 135 fauna species have been recorded at the site and surrounding Black Swamp Wildlife Reserve (Appendix 5). These include 102 bird species (62 non-wetland species and 46 wetland species), six frog species, six reptile species and ten mammal species (six native species and four introduced species). Of these species eight are listed under the FFG Act (Figures 4 and 5), 19 are considered rare or threatened in Victoria (Table 4), two are listed under the Bonn Convention and two bird species are listed under the CAMBA (Figure 4). Between 2008 and 2010, ten wetland bird species and 12 non-wetland bird species were observed breeding at the site (Appendix 5) (Cook, Bayes *et al.* 2009; Jolly and Osler 2011).

A number of birds use Black Swamp as a breeding and feeding site. Birds that have been recorded breeding at Black Swamp include Australian Shelduck (*Tadorna tadornides*), Australasian Reed Warbler (*Acrocephalus stentoreus*), Australian Wood Duck (*Chenonetta jubata*), Black Swans (*Cygnus atratus*), Grey Teal (*Anas gracilis*), Pacific Black Duck (*Anas superciliosa*) and Purple Swamphens (*Porphyrio porphyrio*). Bitterns, Crakes, egrets, Ibis, Herons, and Spoonbills also utilise the swamp as a roosting and feeding site.

A number of threatened native fish have been recorded in the Nine Mile Creek including Murray cod (*Macullachella peelii peelii*), golden perch (*Macquaria ambigua*), un-specked hardyhead (*Craterocephalus stercusmuscarum fulvus*) and the crimson-spotted rainbow fish (*Melanotaenia fluviatilis*) (PV 2006). These native fish may utilise the site for feeding and breeding while it is holding water, particularly the small bodied un-specked hardyhead and the crimson-spotted rainbow fish.

Aquatic invertebrates have only been sampled once at Black Swamp in April 2011. The majority of species collected were members of the predator functional feeding group (Appendix 5). This could be a result of the basic vegetation structure and type having an effect on at the time of sampling caused by extended and deep flooding from high rainfall between September 2010 – March 2011. Predatory macroinvertebrates are more predominant in areas with basic vegetation structure (Hornung and Foote 2006). The swamp will be sampled again when the water level recedes and the vegetation structure changes.





**Table 4: Conservation status of fauna species recorded at Black Swamp**

Common Name	Scientific Name	Type	International Agreements	EPBC	FFG	DSE status
Australasian Bittern	<i>Botaurus poiciloptilus</i>	B		EN	L	End
Australasian Shoveler	<i>Anas rhynchotus</i>	B				Vul
Australian Little Bittern	<i>Ixobrychus dubius</i>	B			L	End
Ballion’s Crake	<i>Porzana pusilla palustris</i>	B			L	Vul
Brown Treecreeper	<i>Climacteris picumnus</i>	B				NT
Eastern Great Egret	<i>Ardea modesta</i>	B	J,C,R,B		L	Vul
Glossy Ibis	<i>Plegadis falcinellus</i>	B	C, B			NT
Hardhead	<i>Aythya australis</i>	B				Vul
Intermediate Egret	<i>Ardea intermedia</i>	B			L	CEn
Little Bittern	<i>Ixobrychus minutus</i>	B				End
Little Button-quail	<i>Turnix velox</i>	B				NT
Magpie Goose	<i>Anseranas semipalmata</i>	B			L	NT
Nankeen Night Heron	<i>Nycticorax caledonicus</i>	B				NT
Royal Spoonbill	<i>Platalea regia</i>	B				Vul
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>	B	C		L	Vul

**Legend**

Type: Bird

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

EPBC: Listed as Endangered (EN)

FFG Status: Listed as threatened (L)

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

Pest animals that pose major threat to Black Swamp include Carp (*Cyprinus carpio*) and Goldfish (*Carassius auratus*) as they compete for food, decrease water quality by foraging on the bottom of the wetland causing water to become turbid, can reproduce in large numbers and feed on native fish (Section 5.1 – Water dependent threats).

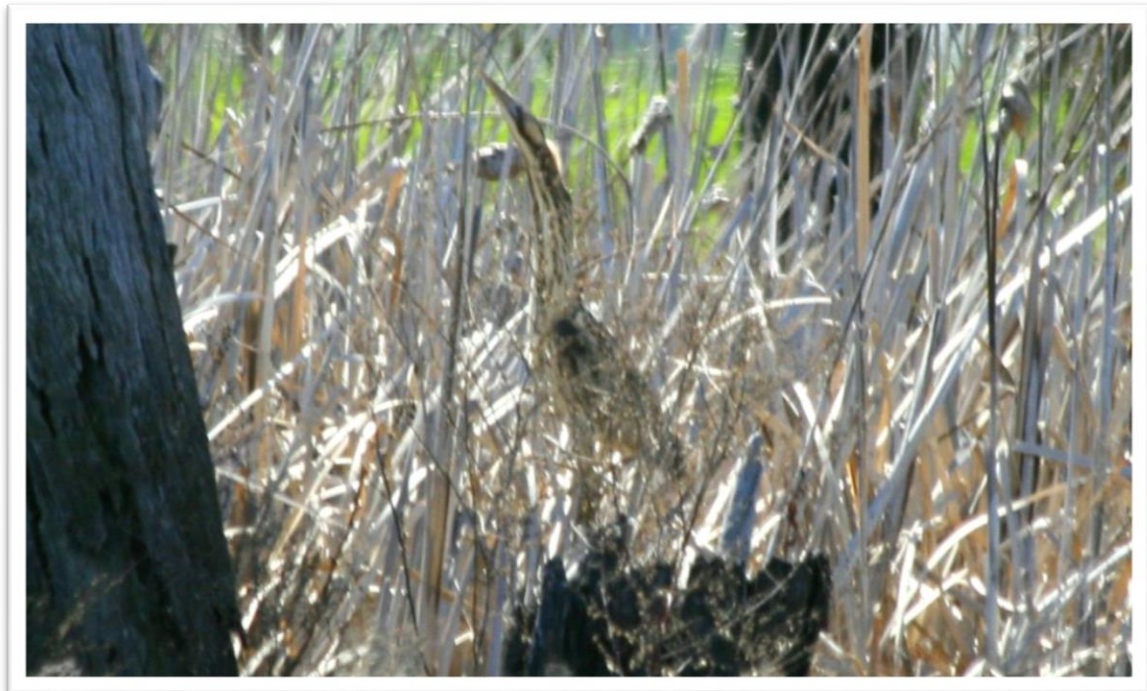


Figure 4: FFG listed Australasian bittern photographed at Black Swamp during environmental water delivery in 2008

Photo: P. O'Connor, DSE 2008



Figure 5: FFG listed White bellied Sea-eagle photographed at Black Swamp during environmental water delivery in 2008

Photo: P. O'Connor, DSE 2008



### 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.

Black Swamp is located in the Victorian Riverina bioregion. Within this bioregion the EVC Red Gum Swamp has a vulnerable conservation status, the EVC Tall Marsh has a depleted conservation status (Appendix 6) and the EVC Aquatic Grassy Wetland has not yet been assigned a conservation status (Table 5).

Black Swamp has experienced more regular, unseasonal and prolonged flooding due to the regulation of the Nine Mile Creek to supply water for irrigation, stock and domestic use (Section 4 - Hydrology and System Operations). As a result, the mature river red gums (*Eucalyptus camaldulensis*) that once covered the swamp are now largely dead. In addition, the composition, structure and diversity of the understorey has been modified by the establishment of flora species adapted to more permanent inundation including cumbungi (*Typha orientalis*) and giant rush (*Juncus ingens*). Currently, only a fringe of the original Red Gum Swamp EVC exists around the edge of the wetland dominated by river red gum, common swamp wallaby-grass (*Amphibromus nervosus*), common spike-rush (*Eleocharis acuta*), rush sedge (*Carex tereticaulis*), Red Pondweed (*Potamogeton cheesemanii*), southern cane-grass (*Eragrostis infecunda*) and common nardoo (*Marselia drummondii*) (Cook, Bayes *et al.* 2009). The EVCs Aquatic Grassy Wetland and Tall Marsh have also been recorded in the site and have established over the main body of the wetland under the altered hydrological regime. Aquatic Grassy Wetland is dominated by the indicator species river swamp wallaby-grass (*Amphibromus fluitans*) and common swamp wallaby-grass, and the EVC Tall Marsh is dominated by the indicator species cumbungi and giant rush. However, a variety of native flora species are common across both EVCs including pacific azolla (*Azolla filiculoides*), water primrose (*Ludwigia peploides subsp. montevidensis*), red milfoil (*Myriophyllum verrucosum*) and pale knotweed (*Persicaria lapathifolia*) (Cook, Bayes *et al.* 2009).

Since 2008, the Goulburn Broken CMA with the cooperation of Parks Victoria have restored a more natural hydrological regime to Black Swamp by upgrading its regulating structure and managing the delivery of environmental water to the site. This has increased the abundance, distribution and diversity of native wetland species in the wetland. In the long term, it is hoped 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.

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

EVC number	EVC Name	Bioregional Conservation Status
292	Red Gum Swamp	Vulnerable
821	Tall Marsh	Depleted
306	Aquatic Grassy Wetland	Not yet assigned



3.2.1 FLORA – SPECIES LISTING AND SIGNIFICANCE

A total of 180 native flora species have been recorded at the site including 63 wetland species (Appendix 7). Of these species six are considered rare or threatened in Victoria and river swamp wallaby-grass is considered to be vulnerable within Australia (Table 6; Figure 6).

Table 6: Conservation Status of Fauna species recorded at Black Swamp

Common Name	Scientific Name	EPBC Status	FFG Status	DSE Status
Riverina bitter-cress	<i>Cardamine moirensis</i>			r
River swamp Wallaby-grass	<i>Amphibromus fluitans</i>	V		k
Smooth minuria	<i>Minuria integrima</i>			r
Waterbush	<i>Myoporum montanum</i>			r
Winged water starwort	<i>Callitriche umbonata</i>			r

Legend

EPBC Status: Vulnerable (V)

FFG Status: Listed as threatened (L)

DSE Status: Rare (r) Poorly Known (k)



Figure 6: Swamp wallaby-grass in Black Swamp 2008

Photo: P. O'Connor, DSE 2008



A total of 50 exotic flora species have been recorded at the site comprising nine wetland species and 41 terrestrial species (Appendix 7). Of these species water couch (*Pastpalum distichum*) and Arrowhead (*Sagittaria platyphylla*) pose the greatest risk to the site due to their ability outcompete native flora species. Arrowhead once dominated large areas of the site. However, it is no longer found in the main body of the wetland due to the recent introduction of a more natural wetting and drying regime (Section 4 – Hydrology and System Operations). Arrowhead is now confined to its inlet channel and the adjacent Nine Mile Creek, but continues to pose a significant threat to the site.

### 3.3 WETLAND DEPLETION

Victoria's wetlands are currently mapped and are contained within a state wetland database using an accepted state wide classification system, developed by Corrick and Norman from Authur Rylah Institute, Department of Sustainability and Environment. Mapping was undertaken from 1981 using 1:25,000 colour aerial photographs, along with field assessments. The database is 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, referred to 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 the comparison of wetland extent between 1788 and 1994 wetland layers.

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

Black Swamp is classified as a shallow freshwater marsh. Shallow freshwater marshes within the Goulburn Broken Catchment have declined by 40 per cent since settlement (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, Schreiber *et al.* 2002).



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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).

Black 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 Conditions).



## 3.4 SOCIAL VALUES

### 3.4.1 CULTURAL HERITAGE

The site and the surrounding catchment have a long history of traditional owner occupation by the Yorta Yorta Peoples and are an important part of their cultural and spiritual heritage. The site 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). Two artefact scatters and a scarred tree have been recorded in or adjacent to the site. However, the site has not been intensively surveyed for Aboriginal archaeological sites and more are likely to be present. 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 site. However, the exclusion of the site from this agreement does not preclude the active involvement of the Yorta Yorta Peoples in its management.

Black Swamp is identified as a culturally sensitive area (Figure 7). Cultural sensitive areas are classified under the *Aboriginal Heritage Act 2006* (Vic) as waterways or land within 200m of a waterway.

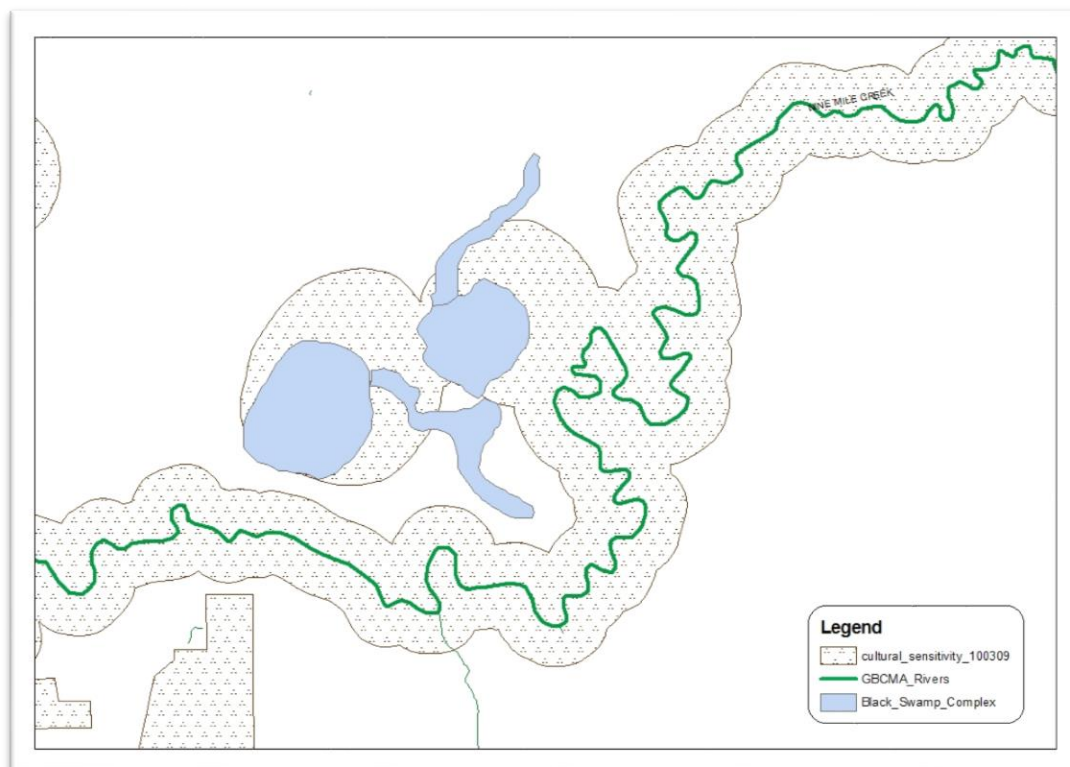


Figure 7: Cultural sensitive areas within and around Black Swamp complex

### 3.4.2 RECREATION



Activities enjoyed by visitors to the site include bird watching, picnicking, bike riding and walking. Camping is a relatively low level activity at the wetland. Recreational hunting of ducks, quails and other game species in season is permitted at the site by licenced game shooters.

### 3.5 ECONOMIC VALUES

Wetlands provide both direct and indirect and economic values to the Goulburn Broken Catchment (O'Connor 2010). The direct economic values that Black Swamp provides to the Goulburn Broken Catchment include consumptive uses such as hunting and non-consumptive uses such as tourism and recreation to the area. Indirect economic values that Black Swamp provide to the Goulburn Broken Catchment include water filtration, flood protection, water storage, 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 2005b). A wetlands hydrology is determined by surface and groundwater inflows and outflows in addition to precipitation and evapotranspiration (Mitsch & Gosselink 2000 cited in DSE 2005b). Duration, frequency, seasonality (timing) and depth are the main components of a wetlands hydrological regime.

### 4.1 WATER MANAGEMENT AND DELIVERY

#### 4.1.1 PRE-REGULATION

Under natural conditions, Black Swamp received flood water from the Nine Mile Creek to its east. When the Swamp filled it spilled water to the west into Purdies Swamp before returning back to the Nine Mile Creek (Figure 8). The wetland would have flooded most years during late winter and spring. Given the variable depth of the wetland it would have also dried out most years over the summer-autumn period.

#### 4.1.2 POST-REGULATION

The natural hydrological regime of the wetland has been significantly altered since European settlement. High flows have been maintained in the Nine Mile Creek during summer and autumn to supply water for irrigation, stock and domestic use. In addition, a supply channel has been constructed to Black Swamp from the Nine Mile Creek. This has resulted in more regular, unseasonal and prolonged flooding of the wetland. This change to the natural hydrology of the wetland has reduced the diversity and abundance of biota by favouring species adapted to permanent inundation including Cumbungi (*Typha spp*) species and Common Carp (*Cyprinus carpio*).

River Red Gums within the wetland body of Black Swamp and Grey Box (*Eucalyptus microcarpa*) on the surrounding floodplain have died as a result of water logging. To restore a more natural hydrological regime the existing drop bars in the regulator at Black Swamp were replaced in 2008 by the Goulburn Broken CMA with a new head and discharge gate to more effectively regulate flows into the wetland complex and reduce the illegal manipulation of the structure (Figure 9).



Figure 8 : Flooding in February 2011 from the Nine Mile Creek enters Black Swamp (right) and overflows into Purdies Swamp (left)

Photo: K. Ward, GBCMA 2011



Figure 9: Upgraded inlet structure at Black Swamp 2008

Photo: P. O'Connor, DSE 2008



#### 4.1.3 WETLAND VOLUME

Based on field measurements taken by the Goulburn Broken CMA in 2010, the site is 16.5 hectares in size and has an average depth of approximately 320mm (variable between 0-500mm). Therefore, the volume of the wetland equates to approximately 53ML at maximum ponding level. When dry, the amount of water required to inundate the wetland to the desired depth is approximately 90ML. This is due to delivery losses and the water required to saturate the soil profile of the wetland.

Environmental water can be delivered to Black Swamp when flows in Nine Mile Creek are greater than 100ML/d. This regularly occurs during the irrigation season, which is August to May. Black Swamp can only receive water from the Nine Mile Creek which is situated in the 2B Water Trading Zone.

#### 4.1.4 ENVIRONMENTAL WATER

Environmental Water has been delivered to Black Swamp on two occasions. In 2008, 90ML of Environmental Water was pumped into Black Swamp from the Nine Mile Creek (Figure 10). In March 2010, 80ML of Environmental Water was delivered to Black Swamp by gravity feeding water from the Nine Mile Creek. Both deliveries were successful in providing habitat for aquatic dependent fauna and flora and encouraged 22 bird species to breed (Appendix 5).



Figure 10: Environmental Water delivery to Black Swamp in 2008



## 5. THREATS AND CONDITION

### 5.1 WATER DEPENDENT THREATS

The key threats to the values of Black Swamp are outlined below. These threats result from activities in the wetland, on adjoining land and in the surrounding catchments. To address these threats and the impacts an integrated approach is therefore 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 and System Operations, the natural hydrological regime of Black Swamp has been significantly altered by the regulation of the Broken and Nine Mile Creeks. This in turn has modified the structure and composition of the aquatic vegetation. However, a more natural hydrological regime is being reinstated through the delivery and management of environmental water.

**Altered physical form** – Physical form relates to the area and bathymetry of a wetland. The area of Black Swamp has been physically reduced by past drainage and excavation activities and the construction of a levee on its western margin. In addition, the construction of a road between Black and Purdies Swamp has reduced the area of the broader wetland complex. Impacts on the bathymetry on the wetland have not 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 Black Swamp may be impacted by:

- Carp (*C. carpio*) feeding in the sediment which can increase turbidity.
- Run-off containing high nutrient loads entering Black Swamp from surrounding agricultural land.
- Pollutants entering Nine Mile Creek from urban, irrigation and dryland drainage.

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

- Pugging by illegal livestock and feral animals.
- Human visitation (wading within or walking around the edge of the wetland).
- Driving of vehicles within the wetland especially if it is wet.
- Carp 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 the regeneration or establishment of native plant species, altering the composition and structure of indigenous communities. Modifications to the composition and structure of indigenous vegetation as a result of pest plant invasion can modify the abundance of indigenous fauna, geomorphological process, hydrological cycles, the nutrient content of soil and disturbance regimes including fire, grazing and insect activity (PV 2003).

As discussed in section 3.2.1 – Flora – Species listings and significance, a total of 50 exotic flora species have been recorded at the site comprising nine wetland species and 41 terrestrial species (Appendix 7). Of these species, Aster-weed (*Aster subulatus*) listed under *the DSE Advisory list of Environmental Weeds* (DSE 2009a), Water couch (*Pastpalum distichum*) and Arrowhead pose the greatest risk to the site due to their ability outcompete native flora species. Arrowhead once dominated large areas of the site. However, it is no longer found in the main body of the wetland due to the recent introduction of a more natural wetting and drying regime (see Section 4 – Hydrology and System Operations). Arrowhead is now confined to the inlet channel and the adjacent Nine Mile Creek, but continues to pose a significant threat to the site.

Terrestrial weeds found within the surrounding area of Black Swamp include Spear thistle (*Cirsium vulgare*), listed under the *Catchment and Land Protection Act* (1994), Ox-tongue (*Helminthotheca echioides*), Wimmera Rye-grass (*Lolium rigidum*) and Prostrate Knotweed (*Polygonum aviculare*), listed under *the DSE Advisory list of Environmental Weeds* (DSE 2009a).

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 Black Swamp include:

- Foxes (*V. vulpes*). Fox predation is listed as a threatening process under the *EPBC Act* (1999) and Schedule 3 of the *FFG Act* (1988).
- Carp and Eastern Gambusia (*Gambusia holbrooki*).
- 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 by licenced game shooters. 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 2006).



## 5.2 CURRENT CONDITION

The condition of Black 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 2005b).

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

The overall IWC score for Black Swamp in December 2010 was six out of ten, which is considered to be moderate (Table 7). Of note the subindices hydrology and biota were considered to be in very poor and poor condition respectively. Hydrology was considered to be very poor due to the significant impact the regulation of Nine Creek has on the natural wetting and drying cycle of Black Swamp (refer to Section 4 – Hydrology and System Operations). The regulation of the Nine Mile Creek in turn has significantly modified the wetland vegetation (see vegetation communities). The Red Gum Swamp EVC that once dominated the site has been largely displaced by vegetation communities. This vegetation is more diverse and complex since first assessed in 2005 (Roberts 2006) probably as a result of a more natural wetting and drying regime due to the upgrade of the inlet structure.

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

IWC subindex	Score	Condition category
Wetland catchment	11/20	Moderate
Physical form	20/20	Excellent
Hydrology	0/20	Very poor
Water properties	20/20	Excellent
Soils	20/20	Excellent
Biota	10.5/20	Poor
<b>Overall IWC Score</b>	<b>6/10</b>	<b>Moderate</b>



### 5.3 CONDITION TRAJECTORY

With an increasing drying climate, natural watering events may occur less frequently. This may cause loss of species diversity and terrestrialisation of vegetation within the wetland. However, the recent introduction of a more natural hydrological regime at Black Swamp has increased the abundance, distribution and diversity of native wetland species in the site, and the original Red Gum Swamp EVC is expected to be restored in the long-term (Cook, Bayes *et al.* 2009). Ongoing management including the delivery of environmental water and consistent monitoring of the site is critical to protecting ecological values at Black Swamp.



## 6. MANAGEMENT OBJECTIVES

### 6.1 MANAGEMENT GOAL

The management goal of Black Swamp is derived from a variety of sources including technical documents, historic management goals, local expertise and knowledge and by a scientific technical advisory group. The goal considers the values the wetland supports. This includes consideration of the aquatic dependent values the swamp has historically supported and the likely aquatic dependent values it could support into the future considering climate change.

#### Black Swamp water management goal

*“To provide a hydrological regime that supports a Red Gum Swamp EVC and provides breeding opportunities for a diverse range of native wetland biota”*

The goal for Black Swamp recommends a drier hydrological regime than managed previously to environmental water delivery. The drier operating regime is based on the need for the goal to be achievable and for the Environmental Watering Management Plan to support the desired ecological outcomes of the site.

### 6.2 ECOLOGICAL AND HYDROLOGICAL OBJECTIVES

#### 6.2.1 ECOLOGICAL OBJECTIVES

Ecological objectives are the desired ecological outcomes of the site. In line with 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 are expressed as the target condition or functionality for each key value and are expressed as one of the following trajectories for 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 natural values that can no longer be found in the area.





The following ecological objectives for Black Swamp include:

- Improve the diversity of native wetland flora species consistent with Red Gum Swamp EVC benchmarks.
- Reduce the cover and diversity of exotic flora species.
- Provide opportunities for waterbirds that utilise the site for breeding and feeding.
- Provide opportunities for native frog breeding.

Justification for these ecological objectives are discussed in Table 8 and Appendices 9 and 10.

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

Ecological Objective	Justification (Value based)
Improve the diversity of native wetland flora species consistent with Red Gum Swamp EVC benchmarks*.	Increase habitat and food sources for native fauna. Increase biodiversity.
Reduce the cover and diversity of exotic flora species.	Exotic plant species present at Black Swamp notably Aster Weed and the highly invasive native Water couch, are believed to be outcompeting native wetland plants. Arrowhead poses a significant threat as it is present in the inlet channel connected to Black Swamp.
Provide opportunities for waterbird breeding and feeding at least five in every ten years^.	Black Swamp supports a large number of waterbird species populations that utilise the swamp as both a breeding and feeding site.
Provide opportunities for native frog breeding at least five in every ten years.	Black Swamp is rich in frog species as six species have been recorded at the site.

\* Refer to Appendix 9, ^ Refer to Appendix 10



6.2.2 HYDROLOGICAL OBJECTIVES

Consistent with the management goal and the ecological objectives above, the water regime for Black 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). This coincides with a majority of waterbird breeding events, hence water delivery may need to be extended into summer in order to avoid birds abandoning nests and drawdown should be slow. 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 and Ecological Objectives for Black Swamp

Ecological Objectives	Water management area	Hydrological Objectives											
		Recommended number of events in 10 years			Tolerable interval between events once wetland is dry (months)			Duration of ponding (months)			Preferred timing of inflows	Volume to fill to target supply level (ML)	Depth (mm)
		Min	Opt	Max	Min	Opt	Max	Min	Opt	Max			
Improve the diversity of native wetland flora species consistent with Red Gum Swamp EVC benchmarks	Wetland body and riparian zone	2	5-7	10	3	6	54	2	6	18 <sup>1</sup>	Late Autumn – Spring or spring summer for more growth <sup>2</sup>	90	Variable to 500mm
Provide opportunities for waterbird breeding	Wetland body	3	10	10	6	9	12	6	8	NA	Spring <sup>3</sup>	90 <sup>4</sup>	Variable to 500mm <sup>4</sup>
Provide key opportunities for frog breeding	Wetland fringe	NA	NA	NA	NA	NA	NA	1	2-6	NA	Spring – Autumn <sup>6</sup>	90	Variable to 500mm

1. Red Gums have been used as the main indicator plant for this watering regime. Red Gums should not be wet for more than two consecutive summers (Barlow 2011).
2. More growth achieved for Red Gums if flooded during spring-summer (Roberts and Marston 2011).
3. (Rogers and Ralph 2011; Young 2003)
4. Filling wetland from dry based on monitoring of past environmental water deliveries to Black Swamp.
5. Water depth should be kept fairly consistent if waterbirds are nesting/ breeding to avoid nests being abandoned (Young, 2003).
6. (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 are described below. All regimes involve three fillings in ten years on average, however the duration of watering may vary between these hydrological regimes. Due to the inter-annual variability of these estimates (particularly the climatic conditions), determination of the predicted volume requirements in any given year will need to be undertaken by the environmental water manager when watering is planned.

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

*Provide one to two flooding events every ten years. Fill wetland to variable depths up to 500mm to maintain River Red Gum EVC to assist survival of existing vegetation.*

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

*Provide three to four flooding events every ten years. Fill wetland to variable depths up to 500mm 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 an annual flood event over a ten year period. Fill wetland to variable depths up to 500mm to maintain the Red Gum EVC vegetation or encourage breeding opportunities for aquatic biota.*



Filling the wetland to full supply level is not always desired. Flooding Black Swamp to variable depths promotes 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. This will assist in obtaining the EVC benchmarks required to restore Black 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 11).

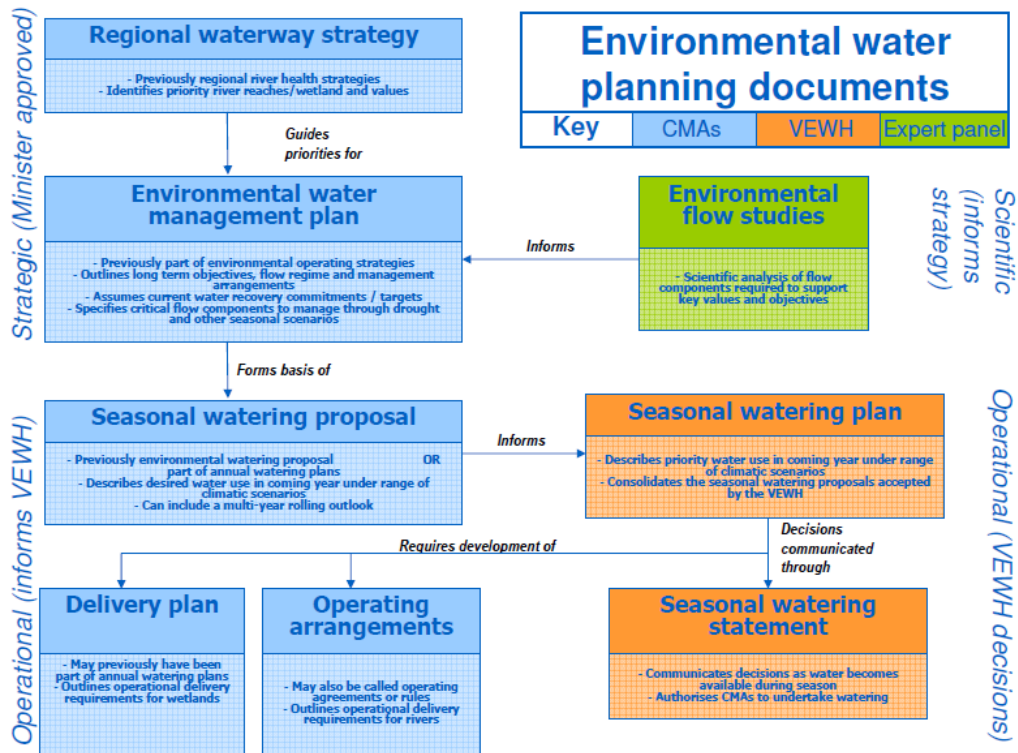


Figure 11: Flowchart for Environmental water planning



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



## 7. POTENTIAL RISKS AND MITIGATION MEASURES

Potential risks associated with impacts from the application of environmental water to Black Swamp are listed in Table 11. These risks may not occur at any site obtaining an environmental water delivery. In addition, a detailed risk assessment process will be developed prior to delivering environmental water in any given season and will be provided in the site watering proposal. Mitigation measures will also be implemented during environmental water delivery to address any potential risks.

Potential risk of environmental water delivery to Black Swamp include:

- Flood duration is too long or short. If watering is too short birds breeding may abandon nests and aquatic flora may not set-seed. If duration is too long, vegetation composition may be lost or become less diverse due to water logging.
- 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 Nine Mile Creek which may not coincide with the desired timing
- Flood depth is too shallow or deep. This may occur if environmental water allocations cannot be achieved due to delivery constraints, or a high rainfall event occurs after delivery causing deeper flooding than required.
- Flood frequency 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.
- Poor water quality. Water in the Nine Mile Creek may have low dissolved oxygen, high turbidity, increased salinity and nutrient levels when adding environmental water to Black Swamp. Flooding wetlands that have accumulated large amounts of organic material can also lead to low dissolved oxygen.
- Pest plant and animal invasion. Pest plants and animals such as Carp and Arrowhead can be introduced via environmental water delivery. Flooding can also stimulate the growth of pest plants and animals if it is at the wrong time or duration.
- Impacts to social and economic values such as reduced public access or degradation of cultural heritage sites 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 requirements</i>	<b>Birds</b> <i>Water regime does not support breeding and feeding requirements</i>	<b>Amphibians</b> <i>Water regime does not support breeding and feeding requirements</i>	<b>Invertebrate</b> <i>Water regime does not support breeding and feeding requirements</i>	<b>Native aquatic flora</b> <i>Watering requirement does not support establishment and growth.</i>	Reduced public access and use	Degradation of cultural heritage sites		Flooding of adjacent land
1	Required watering regime not met	Flood duration too long or short		✓	✓		✓				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 or practical
		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





2	Poor water quality									Add or drawdown water where appropriate or practical	
		Flood frequency too long or short	✓	✓	✓	✓	✓	✓			<p>Prioritise water requirements of wetlands in seasonal watering proposals according to their required water regimes and inundation history</p> <p>Monitor the condition of the wetland</p> <p>Monitor the ecological response of the wetland to flooding</p>
		Low dissolved oxygen	✓	✓				✓			<p>Monitor dissolved oxygen levels and the ecological response of the wetland to flooding</p> <p>Add or drawdown water where appropriate or practical</p>
		High turbidity	✓					✓			<p>Monitor turbidity levels and the ecological response of the wetland to flooding</p> <p>Add or drawdown water where appropriate or practical</p>
		High water temperature	✓					✓			<p>Monitor water temperature and the ecological response of the wetland to flooding</p> <p>Add or drawdown water where appropriate or practical</p>
		Increased salinity levels	✓		✓	✓	✓				<p>Monitor salinity levels and the ecological response of the wetland to flooding</p> <p>Add or drawdown water where appropriate or practical</p>
		Increased nutrient levels									
		Increased organic matter	✓				✓			Implement the required water regime	



3	Pest aquatic flora and fauna invasion	Introduction of pest fish	✓		✓	✓	✓				<ul style="list-style-type: none"> <li>Monitor the ecological response of the wetland to flooding</li> <li>Install a carp screen</li> <li>Implement an appropriate drying regime</li> </ul>
		Growth and establishment of aquatic pest flora	✓	✓	✓	✓	✓				<ul style="list-style-type: none"> <li>Monitor the abundance of native and pest aquatic flora</li> <li>Control pest flora in connected waterways</li> <li>Spray or mechanically remove pest flora</li> <li>Implement an appropriate drying regime</li> </ul>



## 8. ENVIRONMENTAL WATER DELIVERY INFRASTRUCTURE

### 8.1 CONSTRAINTS

Environmental water can be delivered to Black Swamp via the Nine Mile creek. However, delivery is constrained by:

- Flow volume – flow in the Nine Mile Creek needs to be greater than 100ML/day before water enters the wetland.
- Flow duration – flow in the Nine Mile Creek needs to be greater than 100ML/day long enough for the required volume of water to enter the wetland.
- Irrigation demands – Black Swamp does not have a delivery share, therefore environmental water can only be delivered when there is spare capacity to carry the water in the Nine Mile Creek.

### 8.2 IRRIGATION MODERNISATION

The Northern Victoria Irrigation Renewal Project 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 inefficiencies. Works will include lining and automating channels, building pipelines and installing new, modern metering technology. The impact of NVIRPs planned water saving initiatives on flow in the Broken and Nine Creeks were recently examined, and they are not expected to impact on the Goulburn Broken CMAs capacity to deliver environmental water to Black Swamp (Water Technology 2010).

### 8.3 INFRASTRUCTURE RECOMMENDATIONS

Investigations into reinstating the natural meander of Nine Mile Creek have been undertaken. This may reduce the commence to flow level of the wetland. This may increase native wetland habitat and decrease pest plant habitat such as arrowhead. The Goulburn Broken CMA is also planning to investigate reinstating the natural hydrological connection between Black Swamp and Purdies Swamp. This will allow environmental water to be delivered to Purdies Swamp via Black Swamp.



## 9. KNOWLEDGE GAPS AND RECOMMENDATIONS

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

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

1. Monitoring River swamp Wallaby-grass (*Amphibromus fluitans*) and its response to prolonged inundation.
2. Monitoring of the sites environmental conditions and issues that may pose threats. This includes monitoring species such as the native water couch and exotic species such as arrowhead and aster weed when conditions are deemed favourable for their prolific growth. This monitoring should continue on a long-term basis ensuring control of these plants.
3. Pest animals should be monitored and prevention/eradication should occur where possible. Investigation of management options for exotic fish species entering Black Swamp should occur.
4. Simulating the natural hydrological regime to provide ecological benefits by delivering environmental water on average five –seven years in ten years if conditions prevail.
5. Monitoring water quality in Black Swamp during environmental water delivery to ensure nutrient loads do not reach critical levels.
6. Undertaking a risk management matrix before delivering environmental water to Black Swamp.
7. Observing scientific knowledge gaps and working toward filling these gaps. This includes modelling of flows within the wetland if infrastructure upgrades are proposed and continuation of monitoring of the wetland during an environmental water delivery and thereafter.
8. Modelling the impact of reinstating the Nine Mile Creek natural meander on commence to flow levels at Black Swamp.
9. Continue to expand existing monitoring to include fish and macroinvertebrate data at the wetland during environmental water delivery and thereafter.



## 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, Nielsen *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 OF WETLAND CATEGORIES

A system of wetland classification developed by Corrick and Norman (1980) is used to describe wetlands in Victoria. Under this system six naturally occurring wetland types are described based on water depth, frequency of inundation, salinity and dominant vegetation.

### **Freshwater meadow**

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

### **Shallow freshwater marsh**

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

### **Deep freshwater marsh**

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

### **Permanent open freshwater**

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

### **Semi-permanent saline**

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

### **Permanent saline**

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



## APPENDIX 3: ENVIRONMENTAL WATER SOURCES

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

**Stockyard plain Bulk Entitlement** – 112 ML of water entitlement held by DSE.

**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

**Victorian Environmental Water Holder (VEWH)** – The Victorian Environmental Water Holder (VEWH) is to be established in June 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; and
- Future Northern Victoria Irrigation Renewal Project Environmental Entitlement.

In 1987 an annual allocation of 27,600ML of high security water was committed to flora and fauna conservation in Victorian Murray wetlands. In 1999, this became a defined entitlement for the environment called the Victorian River Murray Flora and Fauna Bulk 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. This water will be released into stressed rivers and streams when required. The NVIRP water savings are predicted to provide up to 75GL as a statutory environmental entitlement, which will be used to help improve the health of priority stressed rivers and wetlands in northern Victoria(2008). The entitlement will have properties which enable the water to be used at multiple locations as the water travels downstream (provided losses and water quality issues are accounted for); meaning that the water can be called out of storage at desired times to meet specific environmental needs.

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

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

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



### **Commonwealth Environmental Water Holder (CEWH)**

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

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



## APPENDIX 4: LEGISLATIVE FRAMEWORK

### Acts, Agreements and Conventions

**Convention of Wetlands of International Importance (Ramsar) 1971** - 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.

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

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

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

**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.

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

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

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

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



**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.

These agreements require that the 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.

### **ACTS, AGREEMENTS AND ADVISORY LISTS (VICTORIA)**

**Environmental Effects Act 1978** – Potential environmental impacts of a proposed development are subject to assessment and approval under this Act. A structural works program and any associated environmental impacts would be subject to assessment and approval under the Act.

**Planning and Environment Act 1987** – Controls the removal or disturbance to native vegetation within Victoria by implementation of a three-step process of avoidance, minimisation and offsetting.

**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.

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

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

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

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



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

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

**Advisory lists of rare or 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 (EWP) by the Murray Darling Basin Authority, and be adapted in accordance with the EWP once that is available.

### **Policy and Frameworks (Victoria)**

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

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

### **Reports Applicable to the Environmental Watering Plan**

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

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

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

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



**Lower Broken Creek and Nine Mile Creek EWP 2010** - This Environmental Watering Plan assesses the hydrologic impact of the NVIRP on the creek system downstream of Katamatite and reviews the likely impact of the hydrologic modification on the high value environmental assets.





APPENDIX 5: FAUNA SPECIES LIST

Fauna list of Black Swamp – taken from Victorian Fauna Database 2010, P O’Connor 2008-2009 counts and D. Cook 2008-2011 counts.

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

cr = Listed as critically endangered 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)

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

w = wetland species

b = breeding at site during environmental water delivery 2008-2010

Common Name	Scientific Name	EPBC	FFG	VROTS	Origin
BIRDS					
Australasian Bittern	<i>Botaurus poiciloptilus</i>		L	en	w
Australasian Darter	<i>Anhinga novaehollandiae</i>				w
Australasian Grebe	<i>Tachybaptus novaehollandiae</i>				w
Australasian Shoveler	<i>Anas rhynchotis</i>			vu	w
Australian Hobby	<i>Falco longipennis</i>				
Australian Little Bittern	<i>Ixobrychus dubius</i>		L	en	w
Australian Magpie	<i>Gymnorhina tibicen</i>				b
Australian Pelican	<i>Pelecanus conspicillatus</i>				w
Australian Raven	<i>Corvus coronoides</i>				
Australian Shelduck	<i>Tadorna tadornoides</i>				w b
Australian White Ibis	<i>Threskiornis molucca</i>				w
Australian Wood Duck	<i>Chenonetta jubata</i>				w b
Ballion’s Crake	<i>Porzana pusilla palustris</i>		L	vu	w
Barn Owl	<i>Tyto alba</i>				
Black Swan	<i>Cygnus atratus</i>				w b
Black-chinned Honeyeater	<i>Melithreptus gularis</i>			nt	
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>				
Black-fronted Dotteral	<i>Eseyornis melanops</i>				w
Black-shouldered Kite	<i>Elanus axillaris</i>				
Black-tailed Native Hen	<i>Gallinula ventralis</i>				w
Black-winged Stilt	<i>Himantopus himantopus</i>				w
Brown Falcon	<i>Falco berigora</i>				
Brown Goshawk	<i>Accipiter fasciatus</i>				
Brown Treecreeper (south-eastern ssp.)	<i>Climacteris picumnus victoriae</i>			nt	b
Bush Stone-curlew	<i>Burhinus grallarius</i>		L	en	
Chestnut Teal	<i>Anas castanea</i>				w
Clamorous Reed Warbler	<i>Acrocephalus stentoreus</i>				w b
Cockatiel	<i>Nymphicus hollandicus</i>				
Collared Sparrowhawk	<i>Accipiter cirrocephalus</i>				
Crested Pigeon	<i>Ocyphaps lophotes</i>				
Crested Shrike-tit	<i>Falcunculus frontatus</i>				

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Dusky Moorhen	<i>Gallinula tenebrosa</i>				w
Dusky Woodswallow	<i>Artamus cyanopterus</i>				
Eastern Great Egret	<i>Ardea modesta</i>		L	vu	w
Eastern Rosella	<i>Platycercus eximius</i>				
Eurasian Coot	<i>Fulica atra</i>				w
Fairy Martin	<i>Hirundo ariel</i>				
Flame Robin	<i>Petroica phoenicea</i>				
Galah	<i>Eolophus roseicapilla</i>				b
Glossy Ibis	<i>Plegadis falcinellus</i>			nt	w
Golden Whistler	<i>Pachycephala pectoralis</i>				
Great Cormorant	<i>Phalacrocorax carbo</i>				w
Great Egret	<i>Ardea alba</i>			en	w
Grey Fantail	<i>Rhipidura albiscarpa</i>				
Grey Shrike-thrush	<i>Colluricincla harmonica</i>				
Grey Teal	<i>Anas gracilis</i>				w b
Hardhead	<i>Aythya australis</i>			vu	w
Hoary Headed Grebe	<i>Poliiocephalus poliocephalus</i>				w
Horsefield's Bronze Cuckoo	<i>Chrysococcyx basalis</i>				
Intermediate Egret	<i>Ardea intermedia</i>		L	cr	w
Jacky Winter	<i>Microeca fascians</i>				
Laughing Kookaburra	<i>Dacelo novaeguineae</i>				
Little Bittern	<i>Ixobrychus minutus</i>			en	w
Little Black Cormorant	<i>Phalacrocorax sulcirostris</i>				w
Little Button-quail	<i>Turnix velox</i>			nt	
Little Corella	<i>Cacatua sanguinea</i>				
Little Grassbird	<i>Megalurus gramineus</i>				w
Little Pied Cormorant	<i>Microcarbo melanoleucos</i>				w
Little Raven	<i>Corvus mellori</i>				
Long-billed Corella	<i>Cacatua tenuirostris</i>				
Magpie Goose	<i>Anseranas semipalmata</i>		L	nt	w
Magpie-lark	<i>Gallina cyanoleuca</i>				b
Masked Lapwing	<i>Vanellus miles</i>				w
Masked Wood-swallow	<i>Artamus personatus</i>				b
Nankeen Kestrel	<i>Falco cenchroides</i>				b
Nankeen Night Heron	<i>Nycticorax caledonicus</i>			nt	w
Noisy Friarbird	<i>Philemon corniculatus</i>				
Noisy Miner	<i>Manarina melanocephala</i>				b
Pacific Black Duck	<i>Anas superciliosa</i>				w b
Peregrine Falcon	<i>Falco peregrinus</i>				b
Pied Butcherbird	<i>Cracticus nigrogularis</i>				b
Pied Currawong	<i>Strepera graculina</i>				
Pink-eared Duck	<i>Malacorhynchus membranaceus</i>				w
Purple Swamphen	<i>Porphyrio porphyrio</i>				w b
Red-rumped Parrot	<i>Psephotus haematonotus</i>				b
Restless Flycatcher	<i>Myiagra inquieta</i>				
Royal Spoonbill	<i>Platalea regia</i>			vu	w
Rufous Songlark	<i>Cincloramphus mathewsi</i>				
Rufous Whistler	<i>Pachycephala rufiventris</i>				



Sacred Kingfisher	<i>Todiramphus sanctus</i>				w
Scarlet Robin	<i>Petroica boodang</i>				
Silver Gull	<i>Chroicocephalus novaehollandiae</i>				w
Southern Boobook	<i>Ninox novaeseelandiae</i>				
Spotless Crake	<i>Porzana pusilla</i>				w
Straw-necked Ibis	<i>Threskiornis spinicollis</i>				w
Striated Pardalote	<i>Pardalotus striatus</i>				b
Sulphur-crested Cockatoo	<i>Cacatua galerita</i>				
Superb Fairy Wren	<i>Malurus cyaneus</i>				
Swamp Harrier	<i>Circus approximans</i>				w b
Tawny Frogmouth	<i>Podargus strigoides</i>				
Tree Martin	<i>Hirundo nigricans</i>				
Wedge Tail Eagle	<i>Aquila audax</i>				
Weebill	<i>Smicromis brevirostris</i>				
Welcome Swallow	<i>Hirundo neoxena</i>				b
Whistling Kite	<i>Haliastur sphenurus</i>				b
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>		L	vu	w
White-breasted Woodswallow	<i>Artamus leucorhynchus</i>				
White-browed Woodswallow	<i>Artamus superciliosus</i>				
White-faced Heron	<i>Egretta novaehollandiae</i>				w
White-naped Honeyeater	<i>Meliphreptus lunatus</i>				
White-necked Heron	<i>Ardea pacifica</i>				w
White-plumed Honeyeater	<i>Lichenostomus penicillatus</i>				
White-winged Chough	<i>Corcorax melanorhamphos</i>				
Willie Wagtail	<i>Rhipidura leucophrys</i>				
Yellow Thornbill	<i>Acanthiza nana</i>				
Yellow-billed Spoonbill	<i>Platalea flavipes</i>				w
Yellow-rumped Thornbill	<i>Acanthiza chrysorrhoa</i>				
Zebra Finch	<i>Taeniopygia guttata</i>				
<b>AQUATIC INVERTEBRATES</b>					
Backswimmer	Family Notonectidae				
Creeping Waterbug	<i>Naucoris sp</i>				
Damselfly larvae	<i>Ischnura sp</i>				
Dragonfly larvae	<i>Hemicordulia sp</i>				
Dragonfly larvae	<i>Hemianax sp</i>				
Predaceous Diving Beetle	<i>Eretes australis</i>				
Small water strider	Family Veliidae				
Water boatman	<i>Sigara sp</i>				
Water Scavenger Beetle	<i>Berosus discolour</i>				
<b>FROGS</b>					
Barking Marsh Frog	<i>Limnodynastes fletcheri</i>				
Common Froglet	<i>Crinia signifera</i>				
Perons Tree Frog	<i>Litoria peronii</i>				
Plains Froglet	<i>Crinia parinsignifera</i>				
Pobblebonk	<i>Limnodynastes dumerilii</i>				
Spotted Marsh Frog	<i>Limnodynastes tasmaniensis (NCR)</i>				
<b>MAMMALS</b>					
Common Brushtail Possum	<i>Trichosaurus vulpecular</i>				



Common Ringtail Possum	<i>Pseudocheirus peregrinus</i>				
Eastern Grey Kangaroo	<i>Macropus giganteus</i>				
Swamp Wallaby	<i>Wallabia bicolor</i>				
White-stripe Freetail Bat	<i>Tadarida australis</i>				
<b>REPTILES</b>					
Boulenger's Skink	<i>Morethia boulengeri</i>				
Eastern Brown Snake	<i>Pseudonaja textilis</i>				
Eastern Long-necked Turtle	<i>Chelodina longicollis</i>				
Lace Goanna	<i>Varanus varius</i>			vu	
Large Striped Skink	<i>Ctenotus robustus</i>				
Tiger Snake	<i>Notechis scutatus</i>				
<b>INTRODUCED SPECIES</b>					
Cat	<i>Felis catus</i>				
Common Starling	<i>Sturnus vulgaris</i>				
European Carp	<i>Cyprinus carpio</i>				
Eastern Gambusia	<i>Gambusia holbrooki</i>				
European Rabbit	<i>Oryctolagus cuniculus</i>				
Hare	<i>Lepus capensis</i>				
House Sparrow	<i>Passer domesticus</i>				
Red Fox	<i>Vulpes vulpes</i>				



## APPENDIX 6: ECOLOGICAL VEGETATION CLASSES

The following information has been cited from the *Index of Wetland Condition Assessment of Wetland Vegetation Update- September 2009* (DSE 2009). 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 2009).

Below is a description of the EVCs found within and surrounding Black 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.

### **Tall Marsh [EVC #821]**

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

### **Aquatic Grassy Wetland [EVC #306]**

Seasonal wetland on plains, dominated by rhizomatous to stoloniferous floating grasses, in association with mainly aquatic species. Turf grassland under drier conditions. Treeless or with scattered River Red-gum (*E. camaldulensis*) present.

## **EVCs SURROUNDING BLACK 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.

### **Riverine Swampy Woodland [EVC #815]**

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



**APPENDIX 7: FLORA SPECIES LIST**

Flora list of Black Swamp – taken from Victorian Flora Database 2010 and D. Cook 2008-2011 survey.

Note: EVC information is recorded from D.Cook Surveys between 2008-2011.

V = Listed as Vulnerable on the Environmental Protection Biodiversity Conservation Act (1999)

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

r = Listed as Rare on the DSE Advisory list of rare and threatened plants (2005)

k = Listed as Poorly Known on the DSE Advisory list of rare and threatened plants (2005)

w = wetland species

p = planted

# = Native to Victoria but grows outside natural range

Common Name	Scientific Name	EVC 306	EVC 292	EVC 821	EPBC	FFG	VROTS	Origin	Indigenous Use
Gold-dust Wattle	<i>Acacia acinacea s.l.</i>								
Silver Wattle	<i>Acacia dealbata</i>							p	Wood used for handles. Gums eaten or used to make water-proof paste
Black Wattle	<i>Acacia meamsii</i>							p	Gum multiple uses.
Mallee Wattle	<i>Acacia montana</i>								
Golden Wattle	<i>Acacia pycnantha</i>								Gum used for drink, food and medicine,
Water Plaintain	<i>Alisma plantago-aquatica</i>							w	
Buloke	<i>Allocasuarina luehmannii</i>					L			Weapons made from wood
Lesser Joyweed	<i>Alternanthera denticulata</i>	✓	✓	✓				w	
River Swamp Wallaby-grass	<i>Amphibromus fluitans</i>	✓			V		k	w	
Common Swamp Wallaby-grass	<i>Amphibromus nervosus</i>	✓	✓	✓				w	
Nodding Chocolate-lily	<i>Arthropodium fimbriatum</i>								Tubers Eaten
Small Vanilla-lily	<i>Arthropodium minus</i>								Tubers Eaten
Common Woodruff	<i>Asperula conferta</i>								
Berry Saltbush	<i>Atriplex semibaccata</i>								
Common Wallaby-grass	<i>Austrodanthonia caespitosa</i>		✓						
Brown-back Wallaby-grass	<i>Austrodanthonia duttoniana</i>		✓					w	
Hill Wallaby-grass	<i>Austrodanthonia eriantha</i>								
Bristly Wallaby-grass	<i>Austrodanthonia setacea</i>		✓						
Bristly Wallaby-grass	<i>Austrodanthonia setacea var. setacea</i>								
Plump Spear-grass	<i>Austrostipa aristiglumis</i>								
Crested Spear-grass	<i>Austrostipa blackii</i>								
Feather Spear-grass	<i>Austrostipa elegantissima</i>								

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Spear-grass	<i>Austrostipa gibbosa</i>								
Spurred Spear-grass	<i>Austrostipa gibbosa</i>								
Knotty Spear-grass	<i>Austrostipa nodosa</i>								
Rough Spear-grass	<i>Austrostipa scabra subsp. falcata</i>								
Rough Spear-grass	<i>Austrostipa scabra subsp. scabra</i>								
Pacific Azolla	<i>Azolla filiculoides</i>	✓	✓	✓				w	
Swamp Daisy	<i>Brachyscome basaltica var. gracilis</i>							w	
Woodland Swamp-daisy	<i>Brachyscome basaltica var. gracilis</i>								
Variable Daisy	<i>Brachyscome ciliaris</i>								
Variable Daisy	<i>Brachyscome ciliaris var. subintegrifolia</i>								
Brome	<i>Bromus spp.</i>								
Bulbine Lily	<i>Bulbine bulbosa</i>								Tubers eaten
Sweet Bursaria	<i>Bursaria spinosa subsp. spinosa</i>							p	
Bottlebrush	<i>Callistemon sp</i>							p	
Winged Water Starwort	<i>Callitriche umbonata</i>						r	w	
Lemon Beauty-heads	<i>Calocephalus citreus</i>								
Cut-leaf Burr-daisy	<i>Calotis anthemoides</i>								
Tufted Burr-daisy	<i>Calotis scapigera</i>							w	
Burr Daisy	<i>Calotis spp.</i>								
Riverina Bitter-cress	<i>Cardamine moirensis</i>		✓				r	w	
Fen Sedge	<i>Carex gaudichaudiana</i>							w	
Common Sedge	<i>Carex inversa</i>		✓					w	
Poong'ort	<i>Carex tereticaulis</i>		✓					w	Stems used to make string and fibre
Rush Sedge	<i>Carex tereticaulis</i>		✓					w	
Drooping Cassinia	<i>Cassinia arcuata</i>								
Common Sneezeweed	<i>Centipeda cunninghamii</i>		✓					w	Used to make medicinal tonic.
Flat Spurge	<i>Chamaesyce drummondii</i>							#	Milk sap used for medicinal purposes.
Narrow Rock-fern	<i>Cheilanthes sieberi subsp. sieberi</i>								
Rock Fern	<i>Cheilanthes spp.</i>								
Small-leaf Goosefoot	<i>Chenopodium desertorum subsp. microphyllum</i>								
Clammy Goosefoot	<i>Chenopodium pumilio</i>	✓	✓						
Windmill Grass	<i>Chloris truncata</i>								
Common Everlasting	<i>Chrysocephalum apiculatum s.l.</i>								
Clustered Everlasting	<i>Chrysocephalum semipapposum</i>								
Pink Bindweed	<i>Convolvulus erubescens spp. agg.</i>								Tap roots made into dough.
Grass Bindweed	<i>Convolvulus remotus</i>								
Dense Crassula	<i>Crassula colorata</i>								
Dense Crassula	<i>Crassula colorata var. acuminata</i>								
Spreading Crassula	<i>Crassula decumbens var. decumbens</i>	✓	✓						
Sieber Crassula	<i>Crassula sieberiana s.l.</i>								
Australian Stonecrop	<i>Crassula sieberiana ssp. tetramera</i>								
Sweet Hound's-tongue	<i>Cynoglossum suaveolens</i>								

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Variable Flat-sedge	<i>Cyperus difformis</i>							w	
Star-fruit	<i>Damasonium minus</i>							w	
Black-anther Flax-lily	<i>Dianella admixta</i>								
Pale Flax-lily	<i>Dianella longifolia s.l.</i>								Leaves used for cord and making baskets
Black-anther Flax-lily	<i>Dianella revoluta s.l.</i>								Leaves used for string. Berries eaten or used for dye.
Black-anther Flax-lily	<i>Dianella revoluta var. revoluta s.l.</i>								Leaves used for string. Berries eaten or used for dye.
Grey Parrot-pea	<i>Dilwynia cinerascens s.l.</i>								
Wedge-leaf Hop-bush	<i>Dodonaea viscosa subsp. cuneata</i>								
Yellow Twin-heads	<i>Eclipta platyglossa</i>							# w	
Saloop	<i>Einadia hastata</i>								
Nodding Saltbush	<i>Einadia nutans subsp. nutans</i>								
Waterwort	<i>Elatine gratioloides</i>	✓						w	
Common Spike-sedge	<i>Eleocharis acuta</i>	✓	✓					w	
Slender Spike-sedge	<i>Eleocharis gracilis</i>		✓					w	
Small Spike-sedge	<i>Eleocharis pusilla</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>		✓						
Grey Willow-herb	<i>Epilobium billarierianum var. cinerum</i>		✓						
Willow Herb	<i>Epilobium spp.</i>							w	
Southern Cane-grass	<i>Eragrostis infecunda</i>							w	
Turkey Bush	<i>Eremophila deserti</i>								
Blue Devil	<i>Eryngium ovinum</i>								
River Red-gum	<i>Eucalyptus camaldulensis</i>		✓					w	Used to make canoes, shields, shelter and water vessels.
Grey Box	<i>Eucalyptus microcarpa</i>								
Red Ironbark	<i>Eucalyptus tricarpa</i>							p	
Annual Cudweed	<i>Euchiton sphaericus</i>		✓						
Common Eutaxia	<i>Eutaxia microphylla</i>								
Spreading Eutaxia	<i>Eutaxia microphylla var. diffusa</i>								
Common Eutaxia	<i>Eutaxia microphylla var. microphylla</i>								
Grassland Crane's-bill	<i>Geranium retrorsum s.l.</i>								
Slender Goodenia	<i>Goodenia gracilis</i>							w	
Cut-leaf Goodenia	<i>Goodenia pinnatifida</i>								
Rough Raspwort	<i>Haloragis aspera</i>								
Bluish Raspwort	<i>Haloragis glauca</i>							k	



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Jersey Cudweed	<i>Helichrysum luteoalbum</i>	✓							Leaves used in tea to fix illness
Tiny Star	<i>Hypoxis glabella</i> var. <i>glabella</i>								
Hypoxis	<i>Hypoxis</i> spp.								
Hollow Rush	<i>Juncus ambilis</i>		✓					w	
Tussock Rush	<i>Juncus aridicola</i>	✓	✓					w	
Toad Rush	<i>Juncus bufonius</i>		✓					w	
Gold Rush	<i>Juncus flavivus</i>		✓						
Giant Rush	<i>Juncus ingens</i>							w	
Hoary Rush	<i>Juncus radula</i>								
Rush	<i>Juncus</i> spp.							w	
Finger Rush	<i>Juncus subsecundus</i>							w	
Billabong Rush	<i>Juncus usitatus</i>							w	
Common Blow-grass	<i>Lachnagrostis filiformis</i>	✓	✓	✓				w	
Woolly Buttons	<i>Leiocarpa panaetioides</i>								
Stalked Plover-daisy	<i>Leiocarpa websteri</i>								
Common Duckweed	<i>Lemna disperma</i>	✓	✓	✓				w	
Austral Mudwort	<i>Limosella australis</i>							w	
Native Flax	<i>Linum marginale</i>								Used for fish nets and cord. Seeds eaten.
Poison Pratia	<i>Lobelia concolor</i>							w	
Poison Lobelia	<i>Lobelia pratioides</i>							w	
Scented Mat-rush	<i>Lomandra effusa</i>							w	
Wattle Mat-rush	<i>Lomandra filiformis</i>								
Clove-strip	<i>Ludwigia peploides</i> subsp. <i>montevidensis</i>	✓	✓	✓				w	
Small Loosestrife	<i>Lythrum hyssopifolium</i>		✓					w	
Black Cotton-bush	<i>Maireana decalvans</i>								
Wingless Bluebush	<i>Maireana enchylaenoides</i>								
Bluebush	<i>Maireana</i> spp.								
Common Nardoo	<i>Marsilea drummondii</i>							w	Sporocarp eaten.
Short-fruit Nardoo	<i>Marsilea hirsuta</i>							w	
Moonah	<i>Melaleuca lanceolata</i>							p	Used for blankets, bandages and roofing.
Creeping Mint	<i>Mentha saturoides</i>								Leaves used as medicine
Smooth Minuria	<i>Minuria integerrima</i>							r	
Tangled Lignum	<i>Muehlenbeckia florulenta</i>							w	Fruits ground into flour
Waterbush	<i>Myoporum montanum</i>							r	
Upright Water-milfoil	<i>Myriophyllum crispatum</i>							w	
Robust Water-milfoil	<i>Myriophyllum papillosum</i>							w	
Red Water-milfoil	<i>Myriophyllum verrucosum</i>							w	
Swamp Lilly	<i>Ottelia ovalifolia</i> subs. <i>ovafolia</i>	✓						w	
Grassland Wood-sorrel	<i>Oxalis perennans</i>		✓						
Native Millet	<i>Panicum decompositum</i> var. <i>decompositum</i>								Seeds ground into flour.

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Water Pepper	<i>Persicaria hydropiper</i>		✓					w	Stems and leaves eaten
Pale Knotweed	<i>Persicaria lapathifolia</i>	✓		✓				w	
Common Reed	<i>Phragmites australis</i>							w	Multiple uses.
Picris	<i>Picris spp.</i>								
Curved Rice-flower	<i>Pimelea curviflora s.s.</i>								
Weeping Pittosporum	<i>Pittosporum angustifolium</i>								
Narrow Plantain	<i>Plantago gaudichaudii</i>								
Variable Plantain	<i>Plantago varia</i>							w	
Forde Poa	<i>Poa fordeana</i>	✓	✓					w	
Common Tussock-grass	<i>Poa labillardierei</i>								Used for string or making baskets
Grey Tussock-grass	<i>Poa sieberiana</i>								Used for sting and making baskets
Tussock Grass	<i>Poa spp.</i>								
Red Pondweed	<i>Potamogeton cheesemanii</i>	✓						w	
Blunt Pondweed	<i>Potamogeton ochreatus</i>	✓						w	
Spiny Mud Grass	<i>Pseudoraphis spinescens</i>	✓	✓					w	
Pussy Tails	<i>Ptilotus spathulatus f. spathulatus</i>								Tap roots eaten.
Drumsticks	<i>Pycnosorus globosus</i>							#	
Ferny Small-flower Buttercup	<i>Ranunculus pumilio var. pumilio</i>		✓					w	
Slender Dock	<i>Rumex brownii</i>		✓					w	
Narrow-leaf Dock	<i>Rumex tenax</i>		✓					w	
Black Roly-poly	<i>Sclerolaena muricata</i>								
Cotton Fireweed	<i>Senecio quadridentatus</i>								
Desert Cassia	<i>Senna artemisioides spp. agg.</i>								
Variable Sida	<i>Sida corrugata</i>								
Smooth Solenogyne	<i>Solenogyne dominii</i>								
Sea-spurrey	<i>Spegularia brevifolia</i>								
Large Duckweed	<i>Spirodela polyrhiza</i>		✓	✓				w	
Broughton Pea	<i>Swainsona procumbens</i>							w	
Leafy Templetonia	<i>Templetonia stenophylla</i>								
Grey Germander	<i>Teucrium racemosum s.l.</i>								
Kangaroo Grass	<i>Themeda triandra</i>								Made into string and fish nets.
Narrow-leaf Cumbungi	<i>Typha domingensis</i>			✓				w	Multiple uses
Cumbungi	<i>Typha orientalis</i>			✓				w	
Eel Grass	<i>Vallisneria americana var. americana</i>	✓						w	
Annual New Holland Daisy	<i>Vittadinia cervicalis</i>								
Fuzzy New Holland Daisy	<i>Vittadinia cuneata</i>								
Fuzzy New Holland Daisy	<i>Vittadinia cuneata var. cuneata</i>								
Tufted Bluebell	<i>Wahlenbergia communis s.l.</i>								
River Bluebell	<i>Wahlenbergia fluminalis</i>								
Sprawling Bluebell	<i>Wahlenbergia gracilis</i>								
Bronze Bluebell	<i>Wahlenbergia luteola</i>								

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Rigid Panic	<i>Walwhalleya prolata</i>	✓	✓					w	Seeds ground to flour.
Tiny Duckweed	<i>Wolffia australiana</i>	✓		✓				w	
<b>EXOTIC SPECIES</b>									
Cape Weed	<i>Arctotheca calendula</i>		✓						
Aster-weed	<i>Aster subulatus</i>	✓	✓	✓				w	
Hastate Orache	<i>Atriplex prostrata</i>								
Bearded Oat	<i>Avena barbata</i>								
Wild Oat	<i>Avena fatua</i>								
Oat	<i>Avena spp.</i>								
False Brome	<i>Brachypodium distachyon</i>								
Thread Water Starwort	<i>Callitriche hamulata</i>	✓						w	
Water Starwort	<i>Callitriche stagnalis</i>							w	
Spear Thistle	<i>Cirsium vulgare</i>	✓	✓	✓					
Eastern Larkspur	<i>Consolida ajacis</i>								
Tall Fleabane	<i>Conyza bonariensis</i>	✓							
Ferny Cotula	<i>Cotula bipinnata</i>								
Water Crassula	<i>Crassula natans var. minus</i>							w	
Couch	<i>Cynodon dactylon var. dactylon</i>		✓						
Drain flat-sedge	<i>Cyperus eragrostis</i>	✓	✓					w	
Gazania	<i>Gazania spp.</i>								
Ox-tongue	<i>Helminthotheca echioides</i>		✓						
Smooth Cat's-ear	<i>Hypochoeris glabra</i>	✓	✓						
Cat's Ear	<i>Hypochoeris radicata</i>		✓						
Prickly Lettuce	<i>Lactuca serriola</i>	✓	✓						
Common Peppergrass	<i>Lepidium africanum</i>								
Lilaea	<i>Lilaea scilloides</i>							w	
Perennial Rye-grass	<i>Lolium perenne</i>								
Wimmera Rye-grass	<i>Lolium rigidum</i>		✓						
African Box-thorn	<i>Lycium ferocissimum</i>								
Scotch Thistle	<i>Onopordum acanthium subsp. acanthium</i>								
Paspalum	<i>Paspalum diotatum</i>								
Water Couch	<i>Paspalum distichum</i>	✓	✓					w	
Lesser Canary-grass	<i>Phalaris minor</i>								
Paradoxical Canary-grass	<i>Phalaris paradoxa</i>								
Prostrate Knotweed	<i>Polygonum aviculare</i>	✓	✓						
Sharp Buttercup	<i>Ranunculus muricatus</i>			✓					
Celery Buttercup	<i>Ranunculus sceleratus subsp. sceleratus</i>			✓					
Onion Grass	<i>Romulea rosea</i>								
Onion Grass	<i>Romulea spp.</i>								
Curled Dock	<i>Rumex crispus</i>		✓	✓					
Sagittaria	<i>Sagittaria platyphylla</i>							w	
Silver-leaf Nightshade	<i>Solanum elaeagnifolium</i>								
Rough Sour Thistle	<i>Sonchus asper</i>		✓						
Common Sow-thistle	<i>Sonchus oleraceus</i>		✓						
Lesser Sand-spurrey	<i>Spergularia diandra</i>								
Red Sand-spurrey	<i>Spergularia rubra s.l.</i>								
Hare's-foot Clover	<i>Trifolium arvense var. arvense</i>								

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Suckling Clover	<i>Trifolium dubium</i>								
Cluster Clover	<i>Trifolium glomeratum</i>								
Rough Clover	<i>Trifolium scabrum</i>								
Squirrel-tail Fescue	<i>Vulpia bromoides</i>								
Wall Fescue	<i>Vulpia muralis</i>								
Rat's-tail Fescue	<i>Vulpia myuros</i>								



**APPENDIX 8: INDEX OF WETLAND CONDITION METHOD**

Table 13 below shows what is measured for each of the six subindices and how they are scored. For more detail on the scoring refer below.

**Table 12: IWC subindices and measures**

IWC subindex	What is measured	How it is scored
<b>Wetland catchment</b>	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>
<b>Physical form</b>	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>
<b>Hydrology</b>	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>
<b>Water properties</b>	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>
<b>Soils</b>	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>
<b>Biota</b>	9. The diversity, health and weediness of the native wetland vegetation	<ul style="list-style-type: none"> <li>The lower the diversity and poorer health of native wetland vegetation, the lower the score</li> <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 15). Weightings are then applied to the scores (Table 14). 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 (Table 14) 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 info 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 BLACK SWAMP

EVC benchmarks have been determined for Black Swamp by monitoring the site between 2008-2011. Benchmarks for the Red Gum Swamp EVC at Black 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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**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 parasignifera</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