Mansfield Swamp Environmental Water Management Plan 2012

Goulburn Broken Catchment Management Authority

GOULBURN BROKEN
CATCHMENT MANAGEMENT AUTHORITY

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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 for Mansfield Swamp. This information will inform the management of the wetlands and the development of seasonal watering proposal for wetlands in the Goulburn Broken Catchment for consideration by the VEWH.

Mansfield Swamp comprises a 92.06 ha deep freshwater marsh and 424.24 ha shallow freshwater marsh. It is located 7 km east of Corop Township in northern Victoria. The wetland provides important breeding habitat for Brolgas (*Grus rubicunda*) and contains the *Environment Protection Biodiversity Conservation Act* (1999) listed stiff groundsel (*Senecio beharianus*) within the Goulburn Broken Catchment and Victoria. The wetland is the last in a chain of wetlands called the Wanalta Wetlands. The wetland is managed by Parks Victoria and is valued for its rarity, species diversity and waterbird habitat.

The management for Mansfield Swamp is:

"To provide a watering regime that supports Red Gum Swamp and Lignum-Cane Grass Swamp EVCs, habitat for flora species and significant waterbirds such as Brolga".

To obtain this goal the following four ecological objectives have been established for the wetland:

- Improve the diversity of native wetland flora species to be consistent with EVC benchmarks;
- reduce the cover and diversity of exotic flora species;
- provide opportunities for waterbird breeding especially Brolga; 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 Regime for Mansfield Swamp

Minimum – *Provide two flooding events in ten years, filling the wetland to variable depths to maintain EVCs with minimum water requirements to allow survival of existing vegetation.*

Optimum – *Provide five to seven flooding events in ten years, filling the wetland to variable depths to provide EVCs with appropriate watering requirements, allow the regeneration and recruitment of species within the wetland body and encourage breeding opportunities for aquatic fauna.*

Maximum – *Provide an annual flooding event over a ten year period, filling the wetland to variable depths to encourage growth of EVCs or 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 wetland, and key environmental water management knowledge gaps including the flood regime tolerances of aquatic dependent ecological vegetation classes and their associated flora species such as stiff groundsel.

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ABBREVIATIONS

BE	Bulk Entitlement
CAMBA	China Australia Migratory Bird Agreement
CEWH	Commonwealth Environmental Water Holder
CMA	Catchment Management Authority
DPI	Department of Primary Industries
DSE	Department of Sustainability and Environment
EPA	Environment Protection Authority
EPBC	*Environment Protection Biodiversity Conservation Act 1999*
EVC	Ecological Vegetation Class
EWaMP	Environmental Water Management Plan
EWR	Environmental Water Reserve
FFG	*Flora and Fauna Guarantee Act 1988*
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
MDBA	Murray-Darling Basin Authority
ML	Megalitre (one million litres)
NVIRP	Northern Victoria Irrigation Renewal Project
ROKAMBA	Republic of Korea Australia Migratory Bird Agreement
SWMS	Surface Water Management System
VEWH	Victorian Environmental Water Holder

1. INTRODUCTION

1.1 BACKGROUND

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

Environmental watering in Victoria has historically been supported by management plans, which document key information such as the watering requirements of a site, predicted ecological responses and water delivery arrangements. State and Commonwealth environmental watering programs now have the potential to extend beyond those sites that 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 annually (section 6.3 – Implementation: Seasonally Adaptive Approach). The supporting information will include:

- lead management agencies and their management responsibilities;
- the water dependent environmental, social and economic values of the site;
- the site's environmental conditions 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 Mansfield Swamp in the Goulburn Broken Catchment. This watering plan is not a holistic management plan for the site. It is limited to issues related to the management of water dependent values and environmental water.

1.3 REGION

The Goulburn Broken Catchment comprises the catchments of the Goulburn and Broken 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 basins water resources. Within the Goulburn Broken Catchment approximately 2,000 natural wetlands have been recorded including a number of wetlands formally recognised for their conservation significance. These include the internationally significant Barmah Forest Ramsar site, ten wetlands of national significance listed in *A Directory of Important Wetlands in Australia* (EA, 2001) and 111 wetlands of bioregional significance identified for the *National Land and Water 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.

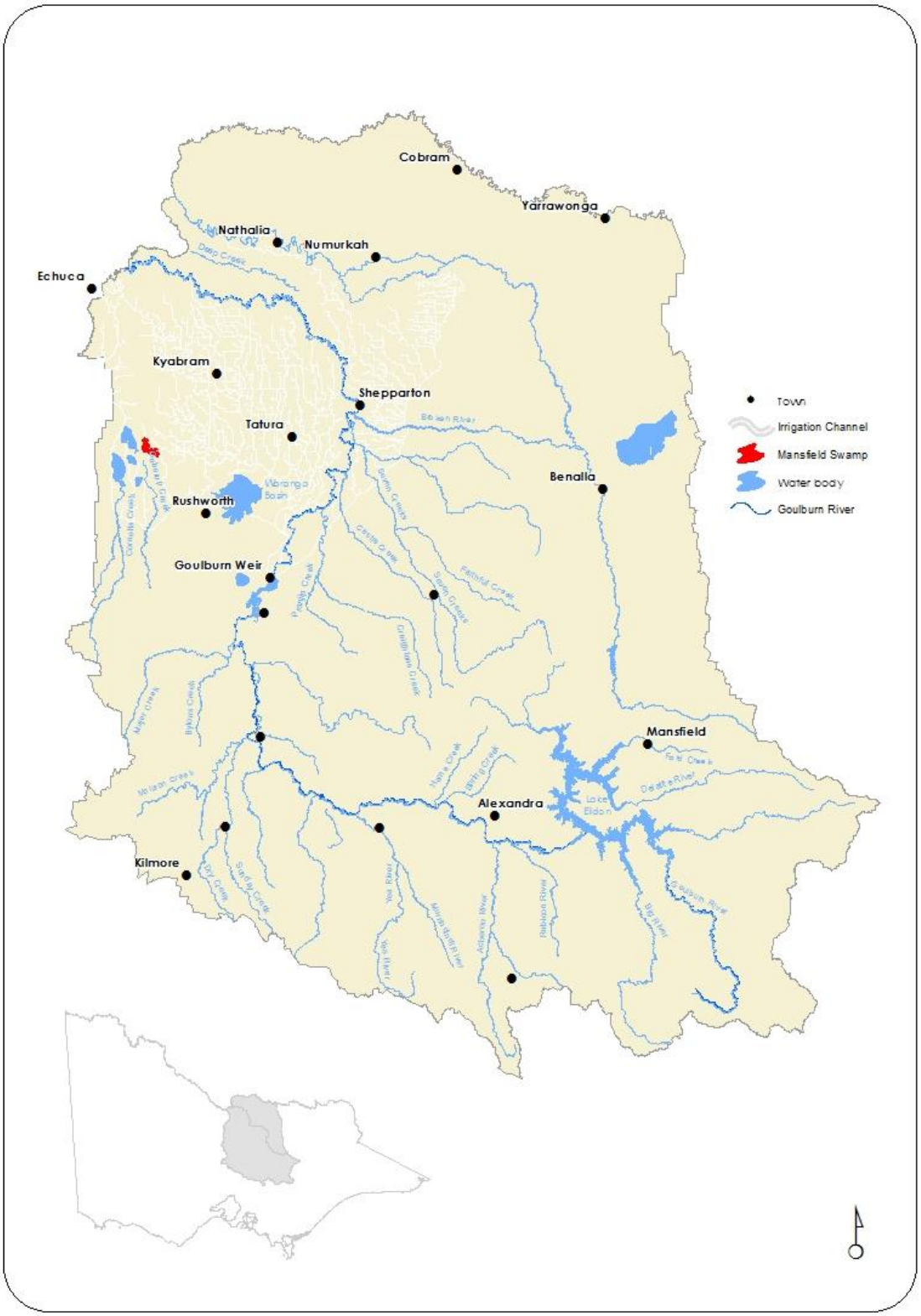

Figure 1: Location of Mansfield Swamp within the Goulburn Broken Catchment

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 the ecological and hydrological goals for Mansfield Swamp at a workshop held at the Goulburn Broken Catchment Management Authority on March 7th 2012. The workshop was 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, Timothy Barlow, Simon Casanelia and Jo Wood (Goulburn Broken Catchment Management Authority), Sam Green, (Goulburn-Murray Water), Damien Cook (Australian Ecosystems) and Doug Frood (Pathways Bushland and Environment). A draft plan was submitted to the members of the Goulburn Broken Wetland Management Group for comment. This group represents both industry and community members within the Goulburn Broken Catchment.

1.5 INFORMATION SOURCES

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

- Goulburn Broken Regional River Health Strategy (GBCMA, 2005).
- Mansfield Swamp Environmental Management Plan (DPI, 2007).
- Scoping Infrastructure Works for Priority Wetlands in the Shepparton Irrigation Region. Mansfield Swamp (Paynter, 2010).
- Monitoring ecological response to flooding. A study of One Tree, Two Tree, Wallenjoe and Mansfield Swamps in the Goulburn Broken Catchment (Cook and Jolly, 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 Mansfield Swamp.

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

- 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
- Campaspe Shire Aerial Photography (1999-2000 layers).

1.6 LIMITATIONS

The information sources used in the development of this report have a number of limitations. These limitations include the data contained in the Flora Information System and the Atlas of Victorian Wildlife comes from a combination of incidental records and systematic surveys. The data varies in accuracy and reliability due to the distribution and intensity of survey efforts. In addition, the lack of knowledge about the distribution and characteristics of invertebrates and non-vascular plant species means the data is weighted towards the less cryptic elements of flora and fauna, i.e. vascular flora and vertebrates. The water regime for Mansfield 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

Mansfield Swamp is part of the Corop Lakes drainage area situated in the Victorian Riverina Bioregion (Figure 2). The area is characterised by flat to gently undulating landscape on recent unconsolidated sediments with evidence of former stream channels and wide floodplain areas associated with major river systems and prior streams. Alluvium deposits from the Cainozoic period gave rise to the red brown earths and texture contrast soils which dominate Riverine Plain (DSE, 2011). The Corop Lakes area is characterised by the large meandering Timmering Depression and the Cornella, Woolwash and Wanalta Creeks. Mansfield Swamp is at the terminal end of the Wanalta Wetlands which are classified as nationally significant in A Directory of Important Wetlands – VIC 060 (EA, 2001). The Wanalta Creek catchment is approximately 284km^2 comprising Wanalta Creek, Nine Mile and Five Mile Creeks (Corrick and Cowling, 1978).

Over 60 per cent of the Goulburn Broken Catchment has been cleared for agricultural purposes (Miles et al., 2010). Mansfield Swamp lies within the Rochester Irrigation District where cropping and livestock production occurs. Drainage, land forming and river regulation have also significantly reduced the number and area of wetland habitats within the district. Therefore, the remnant vegetation and remaining wetlands within the Rochester Irrigation District are believed to be an important ecological corridor and a stronghold for native flora and fauna especially Brolgas (*Grus rubicunda*).

2.2 LAND STATUS AND MANAGEMENT

Following European settlement, Mansfield Swamp was used for cattle and sheep grazing and cropping. Grazing was ceased from the 99 hectare River Red Gum section of the swamp when it was purchased by the Crown in the 1970s. Grazing and cultivation continued in the other 417.3 hectares until 1990 when the area was purchased for a State Game Reserve (DPI, 2007).

Mansfield Swamp is currently managed by Parks Victoria and classified as a Natural Features Reserve - Wildlife Area under the VEAC investigation of 2008 (VEAC, 2008).

A range of management agencies are responsible for ensuring that management of the area complies with policy and legislation. Lead management agencies and their key responsibilities are summarised in Table 1. Adjacent landholders, Yorta Yorta Peoples and recreational users also have an interest and role in the management of the area. 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. The Yorta Yorta Nations in their draft Greater Regional Natural Resource Management Plan set out a number of objectives to protect the regions native ecosystems and biodiversity including:

- to restore, maintain and protect all native ecosystems; and
- to ensure the long term viability of populations and species considered rare and endangered, threatened or of special concern.

The successful management of the area therefore relies on effective cooperation and partnership between the government agencies and the broader community.

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

Agency	Responsibility
Aboriginal Affairs Victoria	Promote knowledge and understanding within the community of the study area's Aboriginal people and their history. Administer legislation protecting Aboriginal heritage sites within the study area (*State Aboriginal Heritage Act 2006* and Part IIA of the Commonwealth *Aboriginal Torres Strait Islander Heritage Protection Act 1984*).
Department of Environment and Primary Industries	Provide technical and extension support for the sustainable management of fisheries, agriculture, minerals and petroleum. Management of hunting licensing on public land. 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.
Environmental Protection Authority	Protect, restore and enhance air, land and water quality and control of unwanted noise.
Goulburn Broken Catchment Management Authority	Implementation of the Goulburn Broken Regional Catchment Strategy. Works on waterways, regional drainage and floodplain management, and co-ordinating Commonwealth and State natural resource management investment. Determining the environmental water requirements of swamps and streams, developing and submitting annual water proposals to DSE for consideration, and managing the delivery of environmental water in accordance with DSE's 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.
Parks Victoria	Management of Mansfield Swamp Wildlife Area.
Victorian Environmental Water Holder	Management of environmental water entitlements on behalf of the Minister for Environment.

2.3 WETLAND CHARACTERISTICS

Wetlands in Victoria are currently classified using a system developed by Corrick and Norman (1980, Appendix 2) based on water depth, permanency and salinity (Corrick and Norman, 1980). Wetlands through Victoria were mapped and classified between 1975 and 1994 and developed into spatial layers (DSE, 2007b).

Mansfield Swamp is a 516.3 hectare wetland, part of which is a deep freshwater marsh (92.06 ha) and part is a shallow freshwater marsh (424.24 ha) (Figure xx). It is situated in the Wanalta wetland system, a 1,588.3 ha wetland complex comprising One Tree Swamp (631 hectares), Two Tree Swamp (82 hectares), Wallenjoe Swamp (359 hectares) and Mansfield Swamp reserve (516.3 hectares). Mansfield Swamp is at the terminal end of the chain of Wanalta wetlands and usually only receives water from this system during high flow events.

The complex is managed by Parks Victoria and is listed under *A Directory of Important Wetlands in Australia* (EA, 2001) as part of the Wallenjoe Wetlands listing (ref.VIC060; Figure 2).

Mansfield Swamp is part of an extensive basin (Corop Lakes Drainage Area) formed by geological subsidence which occurred with the uplifting of the Mt Camel range to the South West of the area (Felton, 1993).

Mansfield Swamp in the Department of Environment and Primary Industries wetlands 1994 layer, is shown as partly a shallow freshwater marsh (SFWM) and is 424.24 hectares, and partly a deep freshwater marsh (DFWM) and is 92.06 hectares. The 1788 layer indicates that Mansfield Swamp would have been 643.82 hectares in total, thus 20% of the wetland has been lost to land clearing, irrigation and drainage.

Mansfield Swamp is crossed by remnants of numerous levees and cuttings designed to protect the higher ground from flooding and to direct drainage downstream. The levees and cuttings were installed when the land was privately owned (Paynter, 2010). These levees have since been cut to allow flow to return to the 92.06 ha Red Gum area of the swamp.

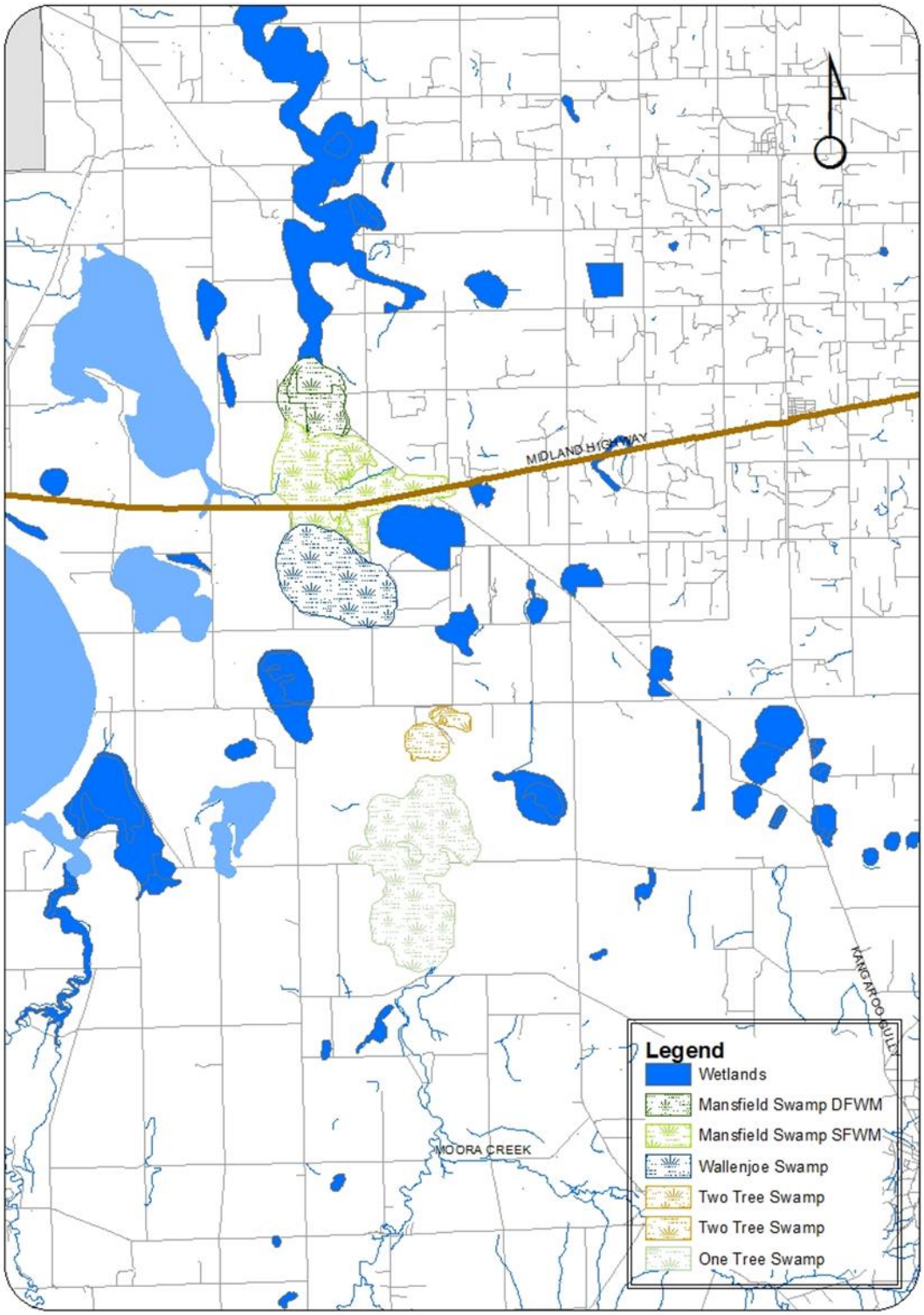

Figure 2: Wallenjoe Wetlands (VIC060)

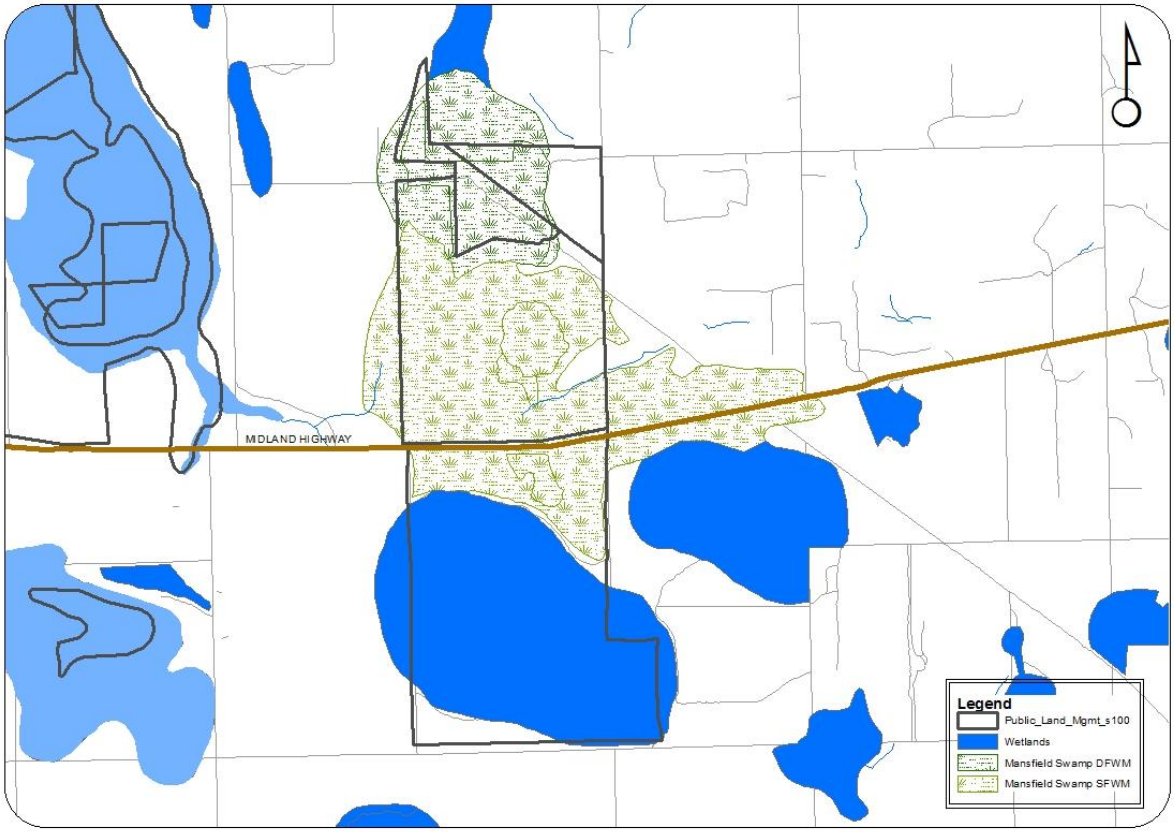

Figure 3: Shallow and Deep Freshwater Marsh areas within the public land boundary (black line) at Mansfield Swamp.

Table 2: Summary of site characteristics

Characteristics	Description
Name	Mansfield Swamp
Mapping Id	7825094647 7825098633
Area (ha)	7825098633 – 92.06 7825094647 – 424.24 Total = 516.3
Bioregion	Victorian Riverina
Conservation Status	National
Land Status	Public
Land Manager	Parks Victoria
Surrounding Land Use	Irrigated and Dryland Agriculture
Water Supply	Wanalta Depression, Woolwash Depression Cornella Creek Depression
1788 Wetland Category	7825094647- Shallow Freshwater Marsh 7825098633 – Deep Freshwater Marsh
1994 Wetland Category	7825094647- Shallow Freshwater Marsh 7825098633 – Deep Freshwater Marsh
Wetland Capacity (ML)	2582
Mean wetland depth at Capacity (m)	0.500m

2.4 ENVIRONMENTAL WATER SOURCES

The Environmental Water Reserve is the legally recognised amount of water set aside to meet environmental needs. The reserve includes minimum river flows, unregulated flows and specific environmental entitlements. Environmental entitlements are held in storage, and if available and required can be delivered to wetlands or streams to protect their environmental values and health. Environmental entitlements are held by the Victorian Environmental Water Holder.

Environmental water for Mansfield Swamp can be sourced from the Victorian River Murray Flora and Fauna Bulk Entitlement. This bulk entitlement has a source volume of 27,600ML and is managed by the Victorian Environmental Water Holder.

Future water reserves that may also be used in Mansfield Swamp include water savings from the Goulburn-Murray Water Connections Project and environmental water held by the Commonwealth Environmental Water Holder (CEWH) (Appendix 3).

2.5 LEGISLATIVE AND POLICY FRAMEWORK

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

International treaties, conventions and initiatives:

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

Commonwealth legislation and policy:

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

Victorian legislation:

- *Crown Land (Reserves) Act* 1978.
- *Flora and Fauna Guarantee Act* 1988.
- *Water Act* 1989.
- *Catchment and Land Protection Act* 1994.
- State Environment Protection Policy (Waters of Victoria) 2003.
- *Aboriginal Heritage Act* 2006.

Victorian policy, codes of practice, charters and strategies:

- Goulburn Broken Catchment Regional Catchment Strategy (GBCMA, 2003).
- Our Water Our Future (DSE, 2004).
- Northern Region Sustainable Water Strategy (DSE, 2009).
- Biodiversity Strategy for the Goulburn Broken Catchment, Victoria 2010-2015 (Miles et al., 2010).

2.6 RELATED PLANS AND ACTIVITIES

The key management document is the *Mansfield Swamp Environmental Management Plan* (DPI, 2007). This management plan presents the geo-morphological, biological, utilisation history, management history and current stakeholder's requirements. It focuses on the values as a breeding and feeding site for significant species, as a public amenity and as a flow retarding and nutrient assimilating wetland. Other key documents that have assisted with the development of this plan include One Tree and Two Tree Swamp Environmental Water Management Plan (GBCMA, 2011, GBCMA, 2012). These plans include information on lead management agencies and their management responsibilities, the water dependent environmental, social and economic values of the site, the site's environmental conditions 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 works.

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

1. Revegetation of the degraded areas in the swamp and surrounding terrestrial zone.
2. Pest plant and animal control.
3. Monitor and protect the *EPBC* listed Stiff groundsel (*Senecio behrianus*).
4. Protect and promote growth of Southern Cane-grass (*Eragrostis infecunda*).
5. Reinstate natural wetting and drying regimes.
6. Use of Brolga (*Grus rubicunda*) as a flagship species.
7. Fencing around the Wildlife Reserve, installation of gates and cattle grids to control stock and vehicle access.
8. Upgrade of the inlet structure on Primary Surface Water Management System (PSWMS) to control water inflows from the Timmering Depression.
9. Reinstate flows from Wallenjoe Swamp into Mansfield Swamp.

3. WATER DEPENDENT VALUES

3.1 ENVIRONMENTAL - FAUNA

3.1.1 FAUNA LISTINGS AND SIGNIFICANCE

Mansfield Swamp provides habitat for a variety of water dependent and terrestrial fauna species. To date 107 native and 7 alien species have been recorded at the Swamp (Appendix 5). The native fauna includes 94 bird species (63 wetland species and 31 non-wetland species), 2 native fish, five frog species, three species of mammals, four reptile species and seven exotic species.

At total of 23 species have some kind of conservation status (Table 3): seven are listed under the *Convention on the Conservation of Migratory Species* (Bonn 1979), one is listed under the *Environmental Protection Biodiversity Conservation Act* (EPBC 1999), nine are listed under the *Flora and Fauna Guarantee Act* (FFG 1988), 19 are considered critically endangered, endangered, vulnerable or near threatened on the *DSE Advisory list of threatened vertebrate fauna in Victoria* (2007). Six birds are listed under the Japan Australia Migratory Bird Agreement (JAMBA), eight under the China Australia Migratory Bird Agreement (CAMBA) and four under the Republic of Korea Australia Migratory Bird Agreement (ROKAMBA).

Many waterbirds utilise the swamp as a breeding and feeding ground. In September 2010 Pink-eared Ducks (*Malachorhynchus membranaceus*) were observed nesting in tree hollows, Black Swans (*Cygnus atratus*), Chestnut Teals (*Anas castanea*) and Australian Shelducks (*Tadorna tadornoides*) were courting. In November 2010, young Australian Shelduck, Hardhead (*Aythya australis*), Nankeen Night Heron (*Nycticorax caledonicus*) and Pink-eared Duck were observed (Cook and Jolly, 2011). Black-winged Stilt (*Himantopus himantopus*) were observed nesting with eggs.

The Mansfield Swamp Environmental Management Plan (DPI, 2007) recommends using Brolga (*Grus rubicunda*) as a flagship species by which to manage the hydrological regime of the swamp. This plan follows this recommendation (section 3.1.2 - Significant Fauna).

Amphibians thrive at Mansfield Swamp when it holds water due to the variety of aquatic habitat of fringing wetland to deeper water. Five species were observed at the Swamp between September 2010 and January 2011 (Appendix 5).

Table 3: Conservation status of fauna species recorded at Mansfield Swamp

Common Name	Scientific Name	Type	International agreements	EPBCA Status	FFG	DSE Status
Australasian Bittern	*Botaurus poiciloptilus*	B		En	L	End
Australasian Shoveler	*Anas rhynchotus*	B				Vul
Bar-tailed Godwit	*Limosa lapponica*	B	J,C,R,B			
Blue-billed Duck	*Oxyura australis*	B			L	End
Brolga	*Grus rubicundas*	B			L	Vul
Caspian Tern	*Hydroprogne caspia*	B	J, C			
Curlew Sandpiper	*Calidris ferruginea*	B	J,C,R,B			
Double-banded Plover	*Charadrius bicinctus*	B	B			
Eastern Great Egret	*Ardea modesta*	B	J,C,B		L	Vul
Flat-headed Galaxias	*Galaxias rostratus*	F				Vul
Freckled Duck	*Stictonetta naevosa*	B			L	End
Glossy Ibis	*Plegadis falcinellus*	B	C,B			NT
Hardhead	*Aythya australis*	B				Vul
Intermediate Egret	*Ardea intermedia*	B			L	CEnd
Latham's Snipe	*Gallinago hardwickii*	B	J,C,R,B			NT
Little Egret	*Egretta garzetta*	B			L	End
Marsh Sandpiper	*Tringa stagnatilis*	B	J,C,R,B			
Musk Duck	*Biziura lobata*	B				Vul
Nankeen Night Heron	*Nycticorax caledonicus*	B				NT
Pied Cormorant	*Phalacrocorax varius*	B				NT
Royal Spoonbill	*Platalea regia*	B				Vul
Whiskered Tern	*Childonias hybridus javanicus*	B				NT
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	B	C		L	Vul

Legend

Type: (Bird (B)

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

EPBC Status: Endangered (En)

FFG Status: Listed as threatened (L)

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

3.1.2 SIGNIFICANT FAUNA

Mansfield Swamp provides critical breeding habitat for the vulnerable Brolga (Figure 5). The protection of Southern Cane-grass (*Eragrostis infecunda*) in the swamp is required to ensure breeding habitat for the Brolga is maintained. Brolga numbers in Northern Victoria have diminished rapidly over the past few decades and it is imperative that these wetlands are managed to ensure successful breeding.

Brolga breed in response to flooding (Rogers and Ralph, 2011). Brolga flock together between December and May usually in areas with deep freshwater marshes. Greens Lake approximately 6km west of Mansfield Swamp is usually a popular flocking area for Brolga. This flocking behaviour may be the beginning of initial pair bonding (Arnol et al., 1984). Between May and August Brolgas scope areas for nesting sites and breeding pairs return to traditional nest swamps waiting for them to fill (Arnol et al., 1984). Nest construction begins around July and August when wetlands fill from winter rains. Egg laying and incubation occurs between August and December with nests being built in water less than 30cm deep (Arnol et al., 1984). Eggs are incubated for 31 days (Rogers and Ralph, 2011). Young are reared between October and December. One to two days after hatching the chicks leave the nest and are totally dependent on their parents for food, warmth and protection for two to three months (Arnol et al., 1984).

Figure 4: Juvenile Brolga sighted at One Tree Swamp, January 2011.

Photo: D. Cook, Australian Ecosystems 2011

3.2 FLORA - VEGETATION COMMUNITIES

A hierarchical system of classification of vegetation classes 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.

Mansfield Swamp is located in the Victorian Riverina Bioregion. EVCs recorded at Mansfield Swamp are Lignum-Cane Grass Swamp (EVC # 655) which is situated in the 424.24ha shallow freshwater marsh section of the wetland and Red Gum Swamp (EVC #292) which is situated in both the 92.06ha deep freshwater marsh and the 424.24ha shallow fresh water marsh (Figure xx). Red Gum Swamp EVC covers approximately 80% of the wetland with the other 20% being Lignum-Cane Grass Swamp characterised by Tangled Lignum (*Muehlenbeckia florulenta*) and Southern Cane-grass (*Eragrostis infecunda*). Table 4 shows the conservation status of these two EVCs.

Table 4: Conservation status of water-dependent Ecological Vegetation classes recorded at Mansfield Swamp

EVC C number	EVC Name	Bioregional Conservation Status
292	Red Gum Swamp	Vulnerable
655	Lignum Cane Grass Swamp	Endangered

3.2.1 SIGNIFICANT FLORA – LISTED SPECIES

A total of 104 native flora species have been recorded at Mansfield Swamp including 77 water-dependent species (Appendix 7). Of these species two are listed under the *Environment Protection Biodiversity Conservation Act* (1988), three are listed under the *Flora and Fauna Guarantee Act* (1999) and nine are considered rare, threatened, endangered or depleted in Victoria under the *Advisory list of Rare or Threatened Plants in Victoria* (2005) (Table 5, Appendix 7 for all flora species). Table 5 shows the conservation status of nine water-dependent species recorded at Mansfield Swamp.

Table 5: Conservation status of water-dependent flora species recorded at Mansfield Swamp

Common Name	Scientific Name	EPBC Status	FFG Status	DSE Status
Winged Water Starwort	*Callitriche umbonata*			r
Riverina Bitter-cress	*Cardamine moirensis*			r
Grey Spike-sedge	*Eleocharis macbarronii*			k
Dwarf Brooklime	*Gratiola pumilo*			r
Slender Water-milfoil	*Myriophyllum gracile var.lineare*		L	en
Water Nymph	*Najas tenuifolia*			r
Stiff Groundsel*	*Senecio behrianus*	En	L	en
Slender Darling-Pea	*Swainsona murrayana*	Vu	L	en
Slender Water-ribbons	*Triglochin dubia*			r

Legend: EPBC Status: Endangered (En), Vulnerable (V); FFG Status: Listed as threatened (L); DSE Status: Endangered (en), Vulnerable (v), Rare (r), Poorly Known (k). *Possibly planted at the site

Prior to 1976, Mansfield Swamp would have been an open River Red Gum canopy with an understory of water milfoil (*Myriophyllum spp*.), pondweed (*Potamogeton spp*.), ribbon weed (*Triglochin spp.)* and spike rush (*Juncus spp*.) (DPI, 2007). Large areas of Southern Cane-grass also occupied the floodways and minor depressions leading to and from the swamp with some pockets within the bed of the Swamp. The Reserve situated around the main body of the Swamp was predominantly open sedgeland and grassland with Tangled Lignum. Due to irregular flooding patterns in the 1970s and 1990s thickets of Red Gum began to form causing a number of issues such as encroachment into the Southern Cane-grass and Lignum Swamp areas. A thicket removal program, managed by Parks Victoria and conducted by Kyabram Field and Game, began in 2005.

Monitoring in 2010-2011 recorded more species in the Red Gum Swamp EVC than in the Lignum Swamp EVC. Species such as Waterwort (*Elatine gratioloides*), Small Spike-sedge (*Eleocharis pusilla*), Dwarf Brooklime (*Gratiola pumilo*) and Plain Quilwort (*Isoetes drummondii*) emerged. Common Nardoo (*Marsilea drummondii*) increased from 40% to 80% cover within the EVC between November 2010 and January 2011 (Cook and Jolly, 2011).

The Lignum Swamp EVC was poor in species richness throughout Cook and Jolly's (2011) survey period. Water dependent species such as Common Duckweed (*Lemna disperma*), Thin Duckweed (*Landoltia punctate*) and Water Nymph (*Najas tenuifolia*) were present in this EVC.

3.2.2 SIGNIFICANT FLORA – OTHER SPECIES

The Mansfield Swamp Environmental Management Plan (DPI, 2007) focuses on the protection of Stiff groundsel and Southern Cane-grass. This plan will also focus on these species (especially Southern Cane-grass) as Brolga rely on the growth of the Southern Cane-grass for nesting. Southern Cane-grass is found mainly within the Lignum Swamp (104) EVC.

Southern Cane-grass grows rapidly in response to rainfall or flooding (Figure 6). It flowers between September and May in response to rainfall (Roberts and Marston, 2011). It tolerates a flooding duration of 1-6 months at an approximate depth between 10-50cm and a flooding frequency of 2-3 years (Roberts and Marston, 2011).

Figure 5: Southern Cane-grass (*Eragrostis infecunda*).

Photo: D. Cook, Australian Ecosystems 2011

Stiff groundsel was presumed to be extinct until it was found in the Corop area in 1991 (Nevill and Camilleri, 2010). Its decline can be attributed to the clearance of habitat and/or a change in flooding regime at sites (DSE, 2005b). It is found in freshwater marsh areas that retains seasonal flooding and usually dominated by Cumbungi (*Typha sp*), Lignum and Common Nardoo (Alexander, 1999) with a flooding depth of approximately 30cm (Nevill and Camilleri, 2010). Sparse flowering occurs from January to May and stems can grow up to 1 metre in length in wet areas (Alexander, 1999). Populations spread by woody rhizome as there is no evidence of regeneration by seed. It is a short, woolly perennial forb usually 15 to 100cm high with grey-green leaves and yellow flower heads (Figure 7). Due to the small number of populations of Stiff groundsel, the known habitat requirements are limited to generalisations and are a significant knowledge gap.

Figure 6: Stiff Groundsel (*Senecio beharianus*).

Photo: D. Cook, Australian Ecosystems 2011

3.3 WETLAND DEPLETION AND RARITY

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

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

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

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

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

Mansfield Swamp is classified as a Deep (92.06 ha) and Shallow (424.24 ha) Freshwater Marsh (section 2.3 - Wetland Characteristics). Shallow and Deep Freshwater marshes within the Goulburn Broken Catchment tend to be smaller and less permanent than some other wetland types and are therefore more susceptible to changes in condition as a result of threats impacting on them including drainage and water regulation (GBCMA, 2006, Lyon et al., 2002).

The conservation and protection of Mansfield Swamp is imperative for the flora and fauna that rely on the site as breeding, feeding and roosting sites.

3.3.1 ECOSYSTEM FUNCTIONS

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

The Drainage area comprises three-sub catchments including the Cornella Creek system, Wanalta Creek and tributaries, and Woolwash Depression (DPI, 2007).The Wanalta Creek system has a catchment area of 28,400 hectares and terminates at One Tree Swamp, which flows into a larger wetland complex of Two Tree, Wallenjoe and Mansfield Swamps and forms part of the larger Timmering Depression (SKM, 2005).

These wetlands perform important functions including:

- enhancing water quality through filtering sediments and re-using nutrients;
- absorbing and releasing floodwaters;
- providing feeding, breeding and drought refuge sites for an array of flora and fauna, especially waterbirds.

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

3.4 SOCIAL VALUES

3.4.1 CULTURAL HERITAGE

Mansfield Swamp has been identified as culturally sensitive area (Figure 8) and the surrounding catchment has a long history of Indigenous occupation and is an important part of their cultural and spiritual heritage. Culturally sensitive areas are classified under the *Aboriginal Heritage Act 2006* (Vic) as waterways or land within 200m of a waterway.

Mansfield Swamp would have been a place of concentrated resources due to the abundance of bird life and terrestrial animals attracted by the wetland, as well as the wetland plants that could be harvested. Corop catchment contains an Aboriginal quarry on the Camel Ranges where greenstone was obtained for use in the manufacture of stone axes. Due to the location of Mansfield Swamp in close proximity to several Traditional Owner groups it is likely that the area was utilised as a shared resource when food sources were limited in the broader region' (Sutherland, 2011).

There are a total of 13 registered Aboriginal Archaeological sites identified by Aboriginal Affairs Victoria within a 5 km radius of the Mansfield Swamp Wildlife Reserve (DPI, 2007).

The wetlands would have provided a rich and diverse supply of plant (Appendix 7) and animal resources for food, medicines, shelter, clothing and tools. West (1962) refers to the aboriginals in the Corop/ Wanalta area using the wetlands to catch waterfowl. He quotes "*Aboriginals used swamps to catch waterfowl. A net was fixed to trees or held by people stationed in trees. A person moved the ducks to float towards the net then as they went to take off, another person would throw bark and call like a hawk to frighten the ducks causing them to fly into the net*" (West, 1962).

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).

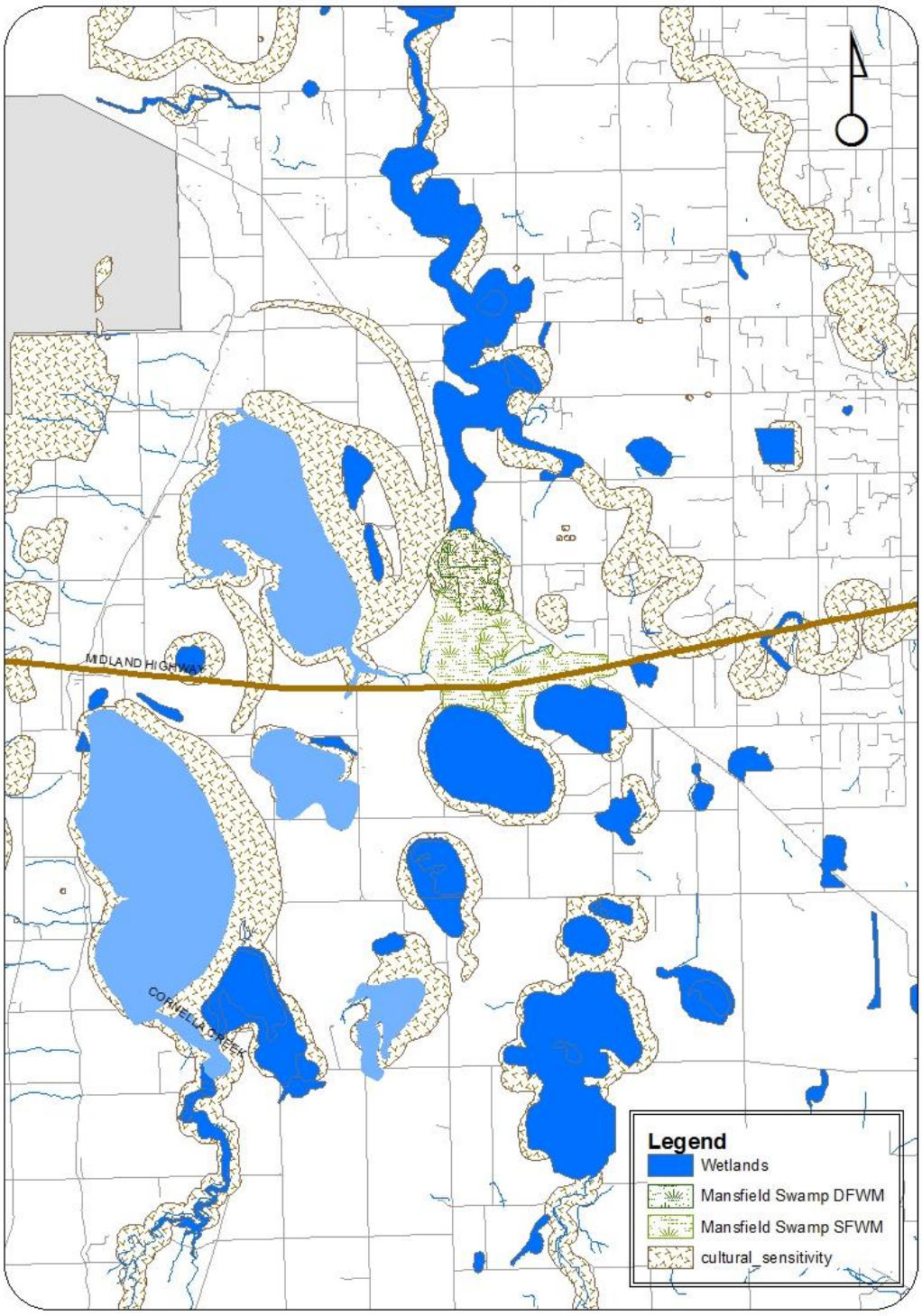

Figure 7: Culturally sensitive areas within and surrounding Mansfield Swamp sites.

3.4.2 RECREATION

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

3.5 ECONOMIC

Wetlands provide both direct and indirect economic values to Goulburn Broken Catchment (Cork et al., 2001) . The direct economic values are consumptive uses such as hunting and non-consumptive uses such as tourism and recreation. Indirect economic values that Mansfield Swamp provides 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, 2007b). A wetland's hydrology is determined by surface and groundwater inflows and outflows in addition to precipitation and evapotranspiration (DSE, 2007b). Duration, frequency and seasonality (timing) are the main components of a wetland's hydrological regime.

4.1 WATER MANAGEMENT AND DELIVERY

4.1.1 PRE-REGULATION

Prior to European settlement Mansfield Swamp was a seasonal open River Red Gum Swamp filling on a near annual basis in Winter-Spring from rainfall and run-off in the surrounding catchment and drying annually in summer and autumn (DPI, 2007). Mansfield Swamp is at the confluence of three depression systems (Woolwash, Wanalta and Cornella) and would have naturally received water from all three depressions during high rainfall events (Figure 8).

Before the construction of the Waranga Western Main Channel and Groves Weir, flows from the Wanalta Creek system would have flowed along the chain of wetlands of One Tree, Two Tree and Wallenjoe Swamp before ending up in Mansfield Swamp. . The Woolwash system would have also interconnected with the Wanalta flows under high flow events, contributing to the filling of Mansfield Swamp (DPI, 2007).

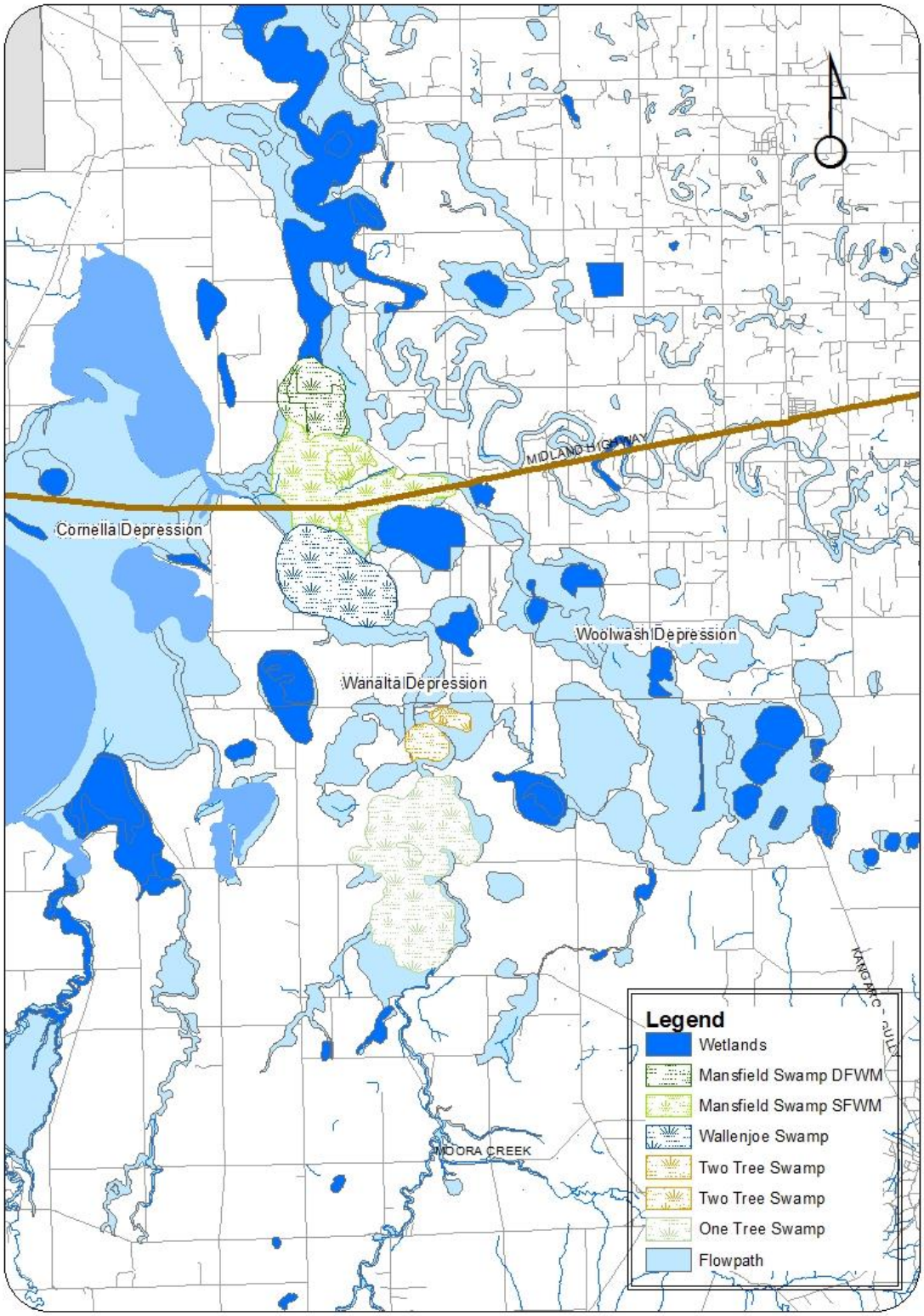

Figure 8: Mansfield Swamp at the confluence of three depression systems.

4.1.2 POST-REGULATION

The natural wetting and drying cycles of wetlands within this region have been significantly altered since regulation of the Wanalta Creek in 1909 when the Waranga Western Main Channel (WWMC) and Groves Weir were constructed (VEAC, 2008). The Wanalta Creek crosses the Waranga Western Main Channel at Groves Weir south of Wanalta and discharges northwards to One Tree Swamp. Groves Weir is a semi-permanent wetland associated with the Wanalta Creek pool created on the upstream side of the Waranga Western Main Channel (GHD, 2012). Flows into Groves Weir from Wanalta Creek are harvested by Goulburn-Murray Water and passed down the Waranga Western Main Channel for downstream irrigation use or storage at Greens Lake (Figure xx; GHD, 2012). During the irrigation off-season (15th May – 15th August) all doors on Groves Weir are opened to allow Wanalta Creek flows to pass through the Weir into the downstream section of Wanalta Creek (GHD, 2012).

Mansfield Swamp is at the confluence of three main depression systems (Cornella, Woolwash and Wanalta). Mansfield Swamp mainly receives water from Wanalta Creek via the chain of Wanalta Wetlands. This occurs during high flow events only when the Waranga Western Main Channel is filled and high inflows have to be passed through Groves Weir to lower water levels in the Channel or if high inflows pass through the Weir during the irrigation off season. This constriction of natural flows down the Wanalta Creek has seen medium to small flows be either diverted by licenced diverters, lost via evaporation or flows reaching Wallenjoe Swamp being diverted via a drain in the north-west corner to Greens Lake. These diversions have impacted upon flows needed for the habitat required by waterbirds to breed at the site, especially Brolga.

The Woolwash Depression enters Mansfield Swamp from the south-east however is largely intercepted by the Timmering Depression Drain.

During the Millennium Drought flows down Wanalta Creek were episodic and irregular, and resulted in minimal flows entering One Tree, Two Tree, Wallenjoe and Mansfield Swamps. As a result of wet conditions following the Millennium Drought, Mansfield Swamp flooded again in 2010, 2011 and 2012.

Add a map in here with Wanalta Creek

Groves Weir, Timmering Main Drain

4.1.3 WETLAND VOLUME

Based on field measurements Mansfield Swamp is 516.3 hectares in size and has an average depth of approximately 0.5m. The volume of the swamp equates to approximately 2582 ML. It is estimated, however that approximately 50 per cent more of this volume would be required to compensate against loss to the soil profile in the event that environmental water was to be released to fill the wetland from a dry state.

Delivery of water to Mansfield Swamp via the Wanalta Creek and through the chain of wetlands would require approximately 17,689ML of water. This volume includes wetting up soil profiles within each wetland(assuming the wetlands are dry) and each wetland being filled to maximum level before spilling into the next wetland, moving along the chain to Mansfield Swamp.

4.1.4 ENVIRONMENTAL WATER

Environmental water has not been delivered to Mansfield Swamp. Potential ways to deliver water to Mansfield Swamp includes: releases from the Western Waranga Main Channel via Wanalta Creek at Groves Weir and along the chain of One Tree, Two Tree and Wallenjoe Swamps or using Central Goulburn Channel 7/9 (section 8 – Environmental water delivery infrastructure). Environmental water can only be delivered to Wanalta Wetlands during the irrigation season (15th August- 15th May) when there is capacity in the channel system and the Wanalta Creek.

5. THREATS AND CONDITION

5.1 WATER DEPENDENT THREATS

The key threats to the values of Mansfield Swamp are outlined below. These threats result from activities in the wetland, on adjoining land and in the surrounding catchment. To address these threats and the impacts an integrated approach is 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 4.1.2 - Post Regulation, the natural hydrological regime Mansfield Swamp has been significantly altered by the construction of the Waranga Western Main Channel and Groves Weir cutting the natural flow of the Wanalta creek off and from the Timmering Main Drain. This has impacted upon flows needed for the habitat for waterbirds to breed especially Brolga. The constriction of natural flows down the Wanalta Creek has seen small to medium flows being passed down the creek. These flows may be diverted by licenced diverters down the Wanalta Creek or may be lost to evaporation before reaching Mansfield Swamp.

Altered physical form – Physical form means the area and bathymetry of a wetland. The area of Mansfield Swamp have been physically altered by past drainage and excavation activities and the construction of numerous levees and cuttings to protect higher ground from flooding (Paynter, 2010). In addition, the construction of a major highway between Wallenjoe Swamp and Mansfield Swamp has reduced the broader wetland complex. At the north-west corner of Wallenjoe Swamp, construction of a drain to push flows towards Greens Lake has prevented flows through Wallenjoe from reaching Mansfield Swamp. Impacts on the bathymetry of the wetland have not been identified, however construction such as the development of the Midland Highway, Timmering Main Drain and access roads may all have impacted upon the wetland. Future impacts on the physical form of the wetlands are unlikely to significantly vary over the foreseeable decades occur due to the protection provided by their current land status as Natural Feature Reserves – Wildlife Area. Sediment deposition rates are unknown entering Mansfield Swamp from the surrounding catchment.

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 Mansfield Swamp may be impacted by:

- Blackwater events.
- Carp (*Cyprinus carpio*) feeding in sediment which can increase turbidity.
- Run-off and irrigation drainage containing high nutrient loads entering Mansfield Swamp from surrounding dryland agriculture.
- Pollutants entering the Wanalta and Woolwash Depressions from irrigation and dryland agriculture 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 Mansfield Swamp include:

- Human visitation (walking off designated tracks into the wetland body)
- Driving vehicles illegally within the wetland drying both dry and wet phases; and
- Possible illegal excavation within the wetland bodies or fringes.

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 *Flora and Fauna Guarantee 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 native communities. Modifications to the composition and structure of native vegetation as a result of pest plant invasion can modify the abundance of native fauna, geomorphological process, the nutrient content of soil and disturbance regimes including fire, grazing and insect activity (PV, 2003).

A total of 39 environmental weeds have been recorded at the site comprising 14 wetland species (Cook and Jolly, 2011). Of these species, Thread Water-starwort (*Callitriche hamulata*) poses the greatest risk to the site due to its ability to outcompete native flora species. Water Couch (*Paspalum distichum*) also poses a threat to the wetland due to its ability to outcompete other native flora.

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

- Foxes (*Vulpes vulpes*) - Fox predation is listed as a threatening process under the *Environmental Protection Biodiversity Conservation Act* (1999) and Schedule 3 of the *Flora and Fauna Guarantee Act* (1988).
- Carp.

Invasive Native Flora – The invasion of native vegetation by other natives can also be a threatening process to a wetlands floral structure. River Red Gum saplings at Mansfield Swamp have reduced understory within the Red Gum Swamp and Lignum - Cane Grass Wetland EVCs. A survey of the wetland by Parks Victoria in 2005 found that canopy cover of the dense red gum saplings was 17% (benchmark for Red Gum Swamp EVC is 5%). The EVC benchmark for cover for medium non-graminoids (which could be including cane-grass) is 40%. Actual medium non-graminoid cover beneath the dense red gum saplings at Mansfield Swamp in July 2005 was 4%. Thinning of saplings is an option albeit slow, time consuming and costly.

5.2 CURRENT CONDITION

The condition of Mansfield Swamp was assessed in December 2009 using a method developed by DSE called the Index of Wetland Condition (IWC). The IWC defines wetland condition as the state of the biological, physical, and chemical components of the wetland ecosystem and their interactions (DSE, 2007b).

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

The overall IWC score for Mansfield Swamp in December 2009 was five out of ten, which is considered to be moderate (Table 6). Of note, the subindices hydrology and wetland catchment were considered to be in very poor condition. Hydrology was considered to be very poor due to the impacts of irrigation development and the construction of levees on the natural wetting and drying regime. Wetland catchment was considered poor as 100 per cent of the land surrounding Mansfield Swamp is used for medium intensity land use such as agriculture.

Monitoring of the swamp using the Index of Wetland Condition in 2009 indicated that the vegetation was in poor condition (section 5.2 – Threats and Condition). Cook (2011) surveyed the Swamp in 2010-11 and gave them a vegetation score of 2 (indicating vegetation is in good condition) using Frood's Wetland Vegetation Condition Assessment Categories (Cook and Jolly, 2011). The discrepancies in these scores may be due the swamp having been affected by drought in 2009.

Table 6: Mansfield Swamp IWC subindex score, overall score and associated condition categories

IWC subindex	Score	Condition category
Wetland catchment	4.5/20	Very Poor
Physical form	12/20	Moderate
Hydrology	0/20	Very poor
Water properties	15/20	Good
Soils	10.5/20	Moderate
Biota	13/20	Poor
Overall IWC Score	**5/10**	**Moderate**

5.3 CONDITION TRAJECTORY

If no intervention occurs, Mansfield Swamp will only receive water via the Wanalta Creek and across One Tree, Two Tree and Wallenjoe Swamp, which, with an increasingly dry climate, may occur less frequently than suits the swamp vegetation and dependant aquatic fauna. Shifts in climate such as an increase in summer storm events may also impact the wetland. This may increase flooding duration over summer and possibly cause loss of species diversity and terrestrialisation of vegetation within the wetland area.

6. MANAGEMENT OBJECTIVES AND ADAPTIVE APPROACHES

6.1 MANAGEMENT GOAL

The management goal of Mansfield Swamp is derived from a variety of sources including historical information, the Mansfield Swamp Environmental Wetland Management Plan (DPI, 2007), local expertise and knowledge (section 1.5 – Information Sources). The goals consider the values the wetlands support and the potential risk factors that need to be managed. This includes the consideration of the values the wetlands could support into the future considering climate change.

Mansfield Swamp management goal

"To provide a watering regime that supports Red Gum Swamp and Lignum Swamp EVCs, habitat for flora species and significant waterbirds such as Brolga"

6.2 ECOLOGICAL AND HYDROLOGICAL OBJECTIVES

6.2.1 ECOLOGICAL OBJECTIVES

Ecological objectives represent the desired ecological outcomes and are based on the key values of the site (outlined in section 3 – Water Dependent Values). The ecological objectives are expressed as the target condition of functionality for each key value. These objectives are expressed as establishing one of the following trajectories of each key value, which is related to the present condition or functionality of the value.

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

The key values for Mansfield Swamp are for the Corop Catchment and on a local scale, its waterbird carrying capacity, ability to support species listed under the *Environmental Protection Biodiversity Conservation Act* (1999) and the *Flora and Fauna Guarantee Act* (1988) and their ability to support native frogs and waterbird breeding.

The ecological objectives for Mansfield Swamp are:

- Protect and improve the diversity of native wetland flora species consistent with Red Gum Swamp and Lignum Swamp EVC benchmarks, in particular Southern Cane-grass and Stiff groundsel.
- Improve the potential to support Brolga recruitment and feeding in the region.
- Reduce the cover and diversity of exotic flora species and highly invasive native species that might otherwise dominate the species composition of favoured EVCs.
- Provide opportunities for waterbird breeding especially Brolga.
- Provide opportunities for native frog breeding.

Justification for these ecological requirements is given in Table 7.

Table 7: Ecological requirements for Mansfield Swamp

Ecological Objective	Justification (Value based)
Protect and improve the diversity of native wetland flora species consistent with Red Gum Swamp and Lignum Swamp EVC benchmarks*.	Increase habitat and food sources for native fauna. Increase biodiversity.
Reduce the cover and diversity of exotic flora species and highly invasive native species that might otherwise dominate the species composition of favoured EVCs. .	The native water couch poses as threat at Mansfield Swamp due to its vigorous growth and ability to outcompete other native species. Exotic plant species such as Thread Water-starwort also poses a threat to the Swamp especially in areas such as the Lignum-Cane Grass EVC.
Provide opportunities for waterbird breeding especially Brolga.	The Red Gum and Lignum Swamp areas of Mansfield Swamp are a breeding ground for Brolga. Brolga are the flagship species for the site.
Provide opportunities for native frog breeding^.	Mansfield Swamp is relatively rich in frog species as five species have been recorded (Appendix 5).

*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 Mansfield 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 8). In the long term, reinstating a hydrological regime that will encourage the restoration of the original Red Gum Swamp and Lignum Swamp EVC, and reduce the abundance and distribution of aquatic weeds. Red Gums grow more if flooded in spring – summer (Roberts and Marston, 2011). Monitoring will be needed in order to determine how long water should be held within the swamp. Soil should be kept moist for a duration of 12-18 months if establishment of river red gum seedlings is desired (Committee, 2011). Watering the wetland every 5 in 10 to 7 in 10 years will allow submerged aquatic species to germinate, grow and reseed.

Table 8: Hydrological and ecological requirements for Mansfield 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 to be consistent with Red Gum Swamp EVC benchmarks #.	Wetland body and riparian zone	2	5-7	10	3	6	54	2	6	18[1]	Late Autumn – Spring or spring summer for more growth[2]	2582	Variable to 500mm
Improve the diversity of native wetland flora species to be consistent with Lignum Swamp EVC benchmarks.	Wetland body and riparian zone	3	5-7	10	6	6	42	3	6	9	Late Autumn – Spring	2582	Variable to 500mm
Provide opportunities for waterbird breeding especially Brolga.	Red Gum Swamp and Lignum Swamp.	3	10	10	6	9	12	6	8	NA	Spring [3]	2582	Maximum of 500mm
Maintain or increase the diversity and abundance of frog species.	Wetland fringe and body	NA	NA	NA	NA	NA	12[4]	2	2-6[5]	NA	Spring-Summer	2582	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. Water depth should be kept fairly constant if waterbirds are nesting/ breeding to avoid nests being abandoned (Young, 2003).
4. This is estimation only as research on frog survival in dry wetlands for extended periods is limited.
5. (ARC, 2010); Appendix 9.

6.2.3 WATERING REGIME

The wetland watering regime has been derived from the ecological and hydrological objectives. To allow for adaptive and integrated management, the watering regime is framed using the seasonally adaptive approach. 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; 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 regime

Provide two flooding events in ten years. Fill wetland to variable depths to provide River Red Gum and Lignum Swamp EVCs with minimum water requirements to allow survival of existing vegetation.

Optimum watering regime

Provide five -seven flooding events in ten years. Fill wetland to variable depths to provide River Red Gum and Lignum Swamp EVCs with appropriate watering requirement, allow regeneration and recruitment of species within the wetland body and encourage breeding opportunities for aquatic biota.

Maximum watering regime

Provide ten flooding events in ten years. Fill wetland to variable depths to encourage growth of specific River Red Gum and Lignum Swamp EVCs vegetation or encourage breeding opportunities for aquatic biota.

Filling the wetland to full supply level is not always desired. Flooding Mansfield Swamp to variable depths will promote increased plant diversity and allowing natural draw down of the wetland to allow habitat to change, resulting in different vegetation communities establishing within the wetland body. This will assist in meeting the EVC benchmarks required to protect and improve the diversity of native wetland flora species within Mansfield 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 9.

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 9).

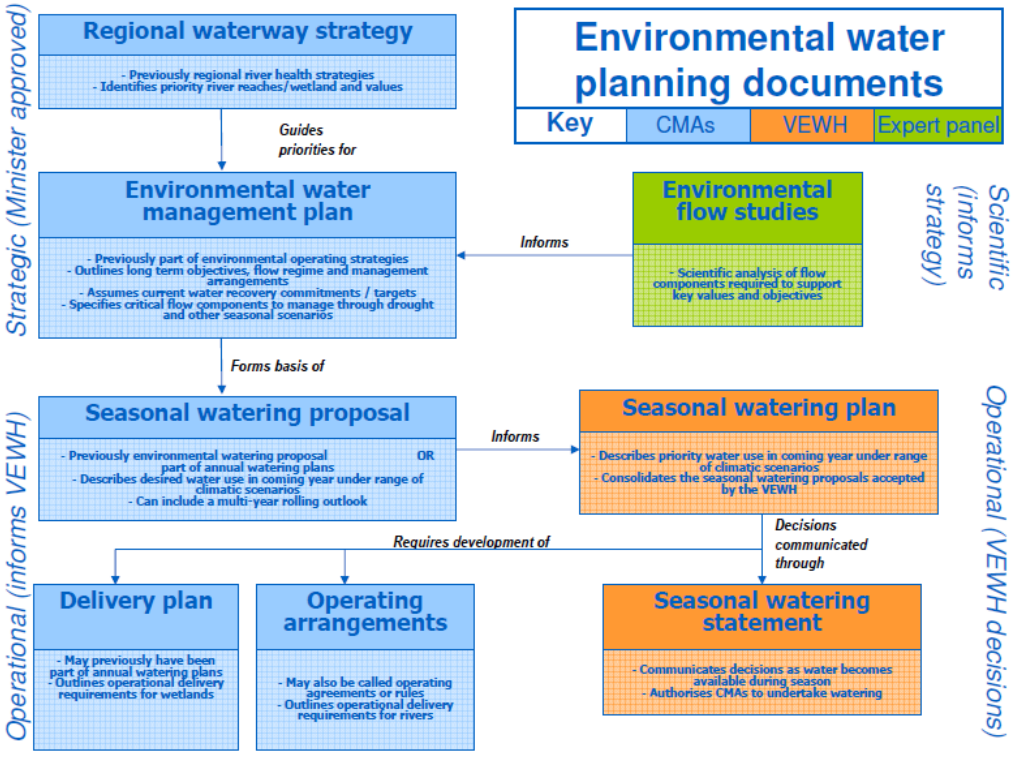

Figure 9: Flow chart for Environmental water planning

Table 9: 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 Mansfield Swamp are listed in Table 10. In addition, a detailed risk assessment process will be developed prior to delivering environmental water in any give season and will be provided in the site watering proposal. Mitigation measures will also occur during environmental water delivery and thereafter to assist with lessening any potential risks.

Potential risks of environmental water delivery to Mansfield Swamp include:

- Flood duration is too long or short. If duration is too short, waterbirds may abandon nests, frogs may not complete all stages in life-cycle and aquatic flora may not set-seed. If duration is too long, vegetation composition may be lost or become less diverse due to waterlogging. This may occur if a significant rainfall event occurs after an environmental water delivery.
- Flood timing is too late or early. Environmental water can only be delivered during the irrigation season when there is capacity in the channel system and the Wanalta Creek.
- Flood depth is too shallow or deep. Shallow flooding may occur if environmental water allocations cannot be achieved due to delivery constraints, or deep flooding may occur if a high rainfall event occurs after delivery.
- Flood frequency is too frequent or infrequent. This may occur if water cannot be delivered within a sufficient time frame.
- Poor water quality. Flooding wetlands that have accumulated large amounts of organic material can lead to low dissolved oxygen.
- Pest plant and animal invasion. Aquatic pest plants and pest animals such as Carp can possibly be introduced via environmental water delivery. Flooding can also stimulate the growth of pest plants and animals if it is the wrong time or duration.
- Impacts to social and economic values such as reduced public access if flooding is too high, or the accidental degradation of cultural heritage sites.

Table 10: Potential risks associated with environmental water delivery to Mansfield Swamp

Risk	Description	Environmental		Social		Economic	Mitigation		
		Impact on native Fauna	Impact on native Flora	Public	Cultural	Flooding	Environmental Water	Monitor	Liaise
Required watering regime not met	Flood duration too long or short	Birds and Amphibians	Yes	x	x	x	Determine requirements based on seasonal conditions and to support potential bird breeding events	Flood duration and ecological response	
	Flood timing too early or late	Birds and Amphibians	Yes	Reduced public access	x	x	x	Flood timing and ecological response	G-MW to seek optimum timing of water delivery
	Flood depth too shallow or deep	Birds	Yes	Reduced public access	Degradation of cultural sites	Flooding of adjacent land	Determine requirements based on seasonal conditions and to support potential bird breeding events	Flood depth	Adjoining landowners prior to and during delivery.
	Flood Frequency	Birds, Amphibians and Invertebrates	Yes	Reduced public access	x	x	Prioritise water requirements of wetlands in annual seasonal watering proposal.	Condition of wetland and ecological response	
Water quality	Low dissolved oxygen (DO)	Fish and birds	Yes				Add or drawdown water where appropriate	DO levels and ecological response	
	High turbidity	Fish	Yes				Add or drawdown water where appropriate	Turbidity levels and ecological response	
	High water temperature	Fish					Add or drawdown water where appropriate	Water temperature and ecological response	
	Increased salinity	Fish, amphibians and invertebrates	Yes				Add or drawdown water where appropriate	Salinity levels and ecological response	
	Increased nutrient levels	Fish						Nutrient or Blue-green algae levels and ecological response	Public signage erected if BGA levels are a public risk
	Increased organic matter	Fish	Yes				Implement required watering regime		
Pest plants and animal invasion	Introduction of pest fish	Fish, amphibians and invertebrates	Yes				Implement appropriate drying regime	Ecological response of wetland to flooding and install Carp screen if possible	
	Establishment of pest plants	Fish, birds, amphibians and invertebrates	Yes				Implement appropriate drying regime	Monitor pest plant and control by spraying or mechanically removing.	

8. ENVIRONMENTAL WATER DELIVERY INFRASTRUCTURE

8.1 CONSTRAINTS

The primary proposed method to fill Mansfield Swamp is via the chain of Wanalta Wetlands (One Tree, Two Tree and Wallenjoe Swamp before outfalling into Mansfield Swamp). This method is the most practical and can occur if infrastructure upgrades and works occur along Wanalta Creek, and at the wetlands along the creek, One Tree Swamp, Two Tree Swamp and Wallenjoe Swamp (section 8.3 – Infrastructure recommendations). Constrains posed by the existing infrastructure in getting flows to the Swamp include:

- Flows natural depression – Mansfield Swamp is at the confluence of three main depression systems (Cornella, Woolwash and Wanalta). At present the dominant inflow source is the Wanalta Creek System and is dependent from inflows Wanalta Creek and overflow passing through One Tree, Two Tree and Wallenjoe Swamps before reaching Mansfield Swamp. Smaller inflows are currently prevented from reaching Mansfield Swamp due to a drain at the north-west corner of Wallenjoe Swamp that diverts flows towards Greens Lake.
- Flows existing channel structures – Channel CG 7/9 is the only channel in the vicinity of Mansfield Swamp and services properties to the east (Paynter, 2010). The channel could be connected to the Timmering Drain along the Midland Highway to allow flows into the deep freshwater marsh section of Mansfield Swamp. The channel has a good capacity for flows but does not have the capacity to fill Mansfield Swamp and concurrently meet irrigation demands.
- Flows surface water management systems – Timmering Drain follows the east boundary of Mansfield Swamp and is equipped to divert drainage water into the swamp. The drain must fill to the overflow level of the spillway before inflow occurs.
- Flow duration – Timing of flows and if the system can be run high enough for time allocated to fill the swamp.
- Irrigation demands – Mansfield Swamp does not have a delivery share, therefore environmental water can only be delivered when there is spare capacity to carry water in the Wanalta Western Main Channel and the Wanalta Creek.

8.2 IRRIGATION MODERNISATION

The Goulburn-Murray Water Connections 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.

A "*Scoping Infrastructure Works for Priority Wetlands in the Shepparton Irrigation Region – Mansfield Swamp*" report was developed by Goulburn-Murray Water to determine the most efficient way to deliver environmental water to the swamp using the Wanalta Creek and existing infrastructure using the rationalised system[1].

8.3 INFRASTRUCTURE RECOMMENDATIONS

The following infrastructure recommendations are taken from the Goulburn-Murray Water "*Scoping Infrastructure Works for Priority Wetlands in the Shepparton Irrigation Region – Mansfield Swamp*" (Paynter, 2010).

The report recommends that the primary method of environmental water delivery to Mansfield Swamp is to provide a link to Mansfield Swamp via Wanalta Creek and One Tree, Two Tree and Wallenjoe Swamps from the Waranga Main Channel at Groves Weir. Expenditure on the Wanalta Creek flow path is more cost effective than the channel supply options, and it is recommended that investment be concentrated on this supply option (Paynter, 2010).

Paynter (2011) describes the Infrastructure recommendations and are shown in Figure 10. This includes:

1. Modification at Groves Weir for automated flow delivery and measurement.
2. Stabilisation of the derelict weir on Wanalta Creek.
3. Improvement of hydraulic capacity of Wanalta Creek by removal of localised hydraulic obstructions.
4. Construction of One Tree Swamp 2 No. bay automated outflow regulator.
5. Construction of Two Tree Swamp 6 No. bay manual outflow regulator.
6. Construction of Wallenjoe Swamp 6 No. manual outflow regulator.

If channel supply is considered necessary to deliver environmental water to Mansfield Swamp, the recommended method using the irrigation network is via CG 7/9 to the Midland Highway (Paynter, 2010). This supply will on have the ability to deliver water to the deep freshwater marsh section of the Swamp. Works would need to be conducted before environmental water delivery could occur, and include:

- Connecting the CG 7/9 channel to the Timmering Drain along the Midland Highway; and
- Upgrade of the non-backbone channel on the CG 7/9 (Figure 11).

[1] The Scoping study only refers to the 92.06 ha deep freshwater marsh section of Mansfield Swamp.

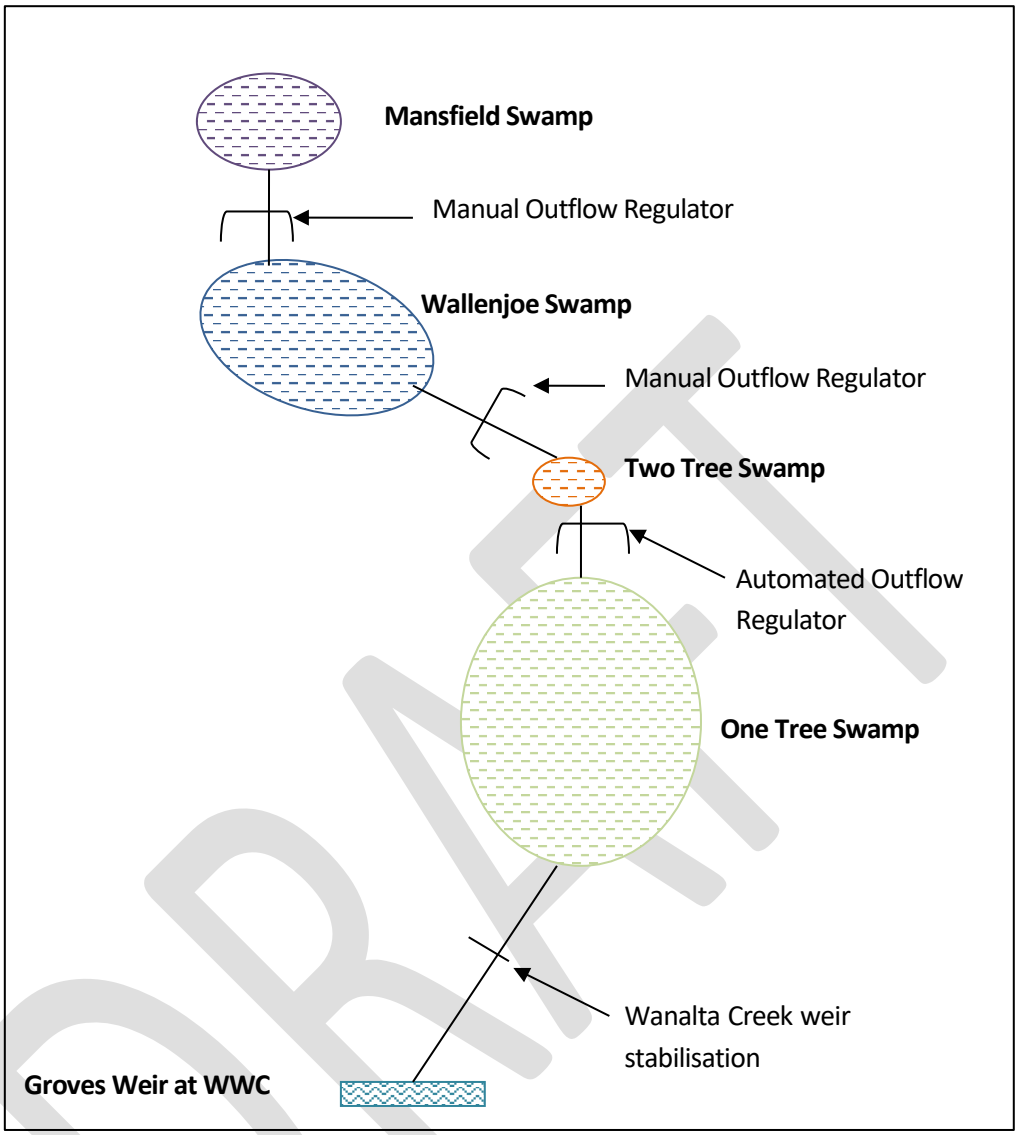

Figure 10: Schematic of proposed works to Wanalta Creek and downstream wetlands (Paynter, 2011)

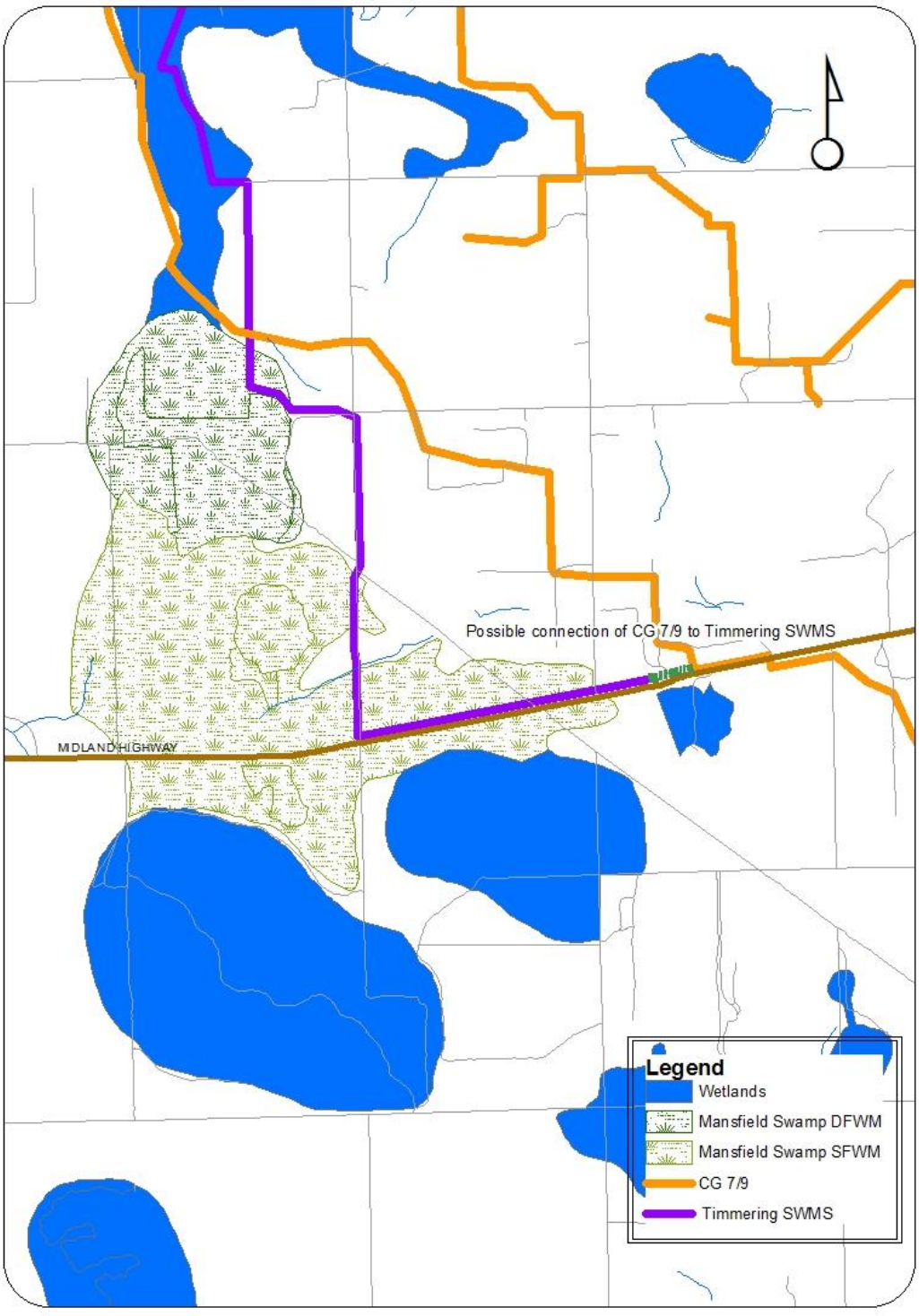

Figure 11: Possible site connection (green dash line) of CG 7/9 to Timmering Drain to allow direct environmental water delivery to Mansfield Swamp

9. KNOWLEDGE GAPS AND RECOMMENDATIONS

There are currently a number of knowledge gaps in relation to environmental water management at Mansfield 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 and/or recommendations that may assist with more efficient environmental water delivery to Mansfield Swamp.

1. Review the existing wetland capacity and survey the wetland bed (once site has dried).
2. Monitoring of the sites environmental conditions and issues that may pose threats. This includes monitoring of exotic pest plant species on a long-term basis to ensure control and possible eradication of these species.
3. Simulating the natural hydrological regime to provide ecological benefits by delivering environmental water on average five – seven years in ten if conditions prevail.
4. Undertake a risk management matrix before delivering environmental water to the Wanalta Wetlands (including Mansfield Swamp).
5. Modelling of flows within the wetland if infrastructure upgrades are proposed and continuation of monitoring of the wetland during and environmental water delivery and thereafter.
6. Construction of the Wallenjoe Swamp outflow regulator to allow more efficient delivery of water to Mansfield Swamp.
7. Research the ecological and hydrological requirements of Stiff groundsel. Monitoring of this species is imperative to preserve the population at Mansfield Swamp.

10. GLOSSARY

Alluvium

Detrital material which is transported by a river and deposited – usually temporarily – at points along the flood plain of a river. Commonly composed of sands and gravels.

Cainozoic

The division of geological time which succeeds the Mesozoic and ends at the Quaternary. Duration is approximately 63 million years from 65 million years to 2 million years.

Complex

A conceptual whole made up of complicated and related parts.

Confluence

Streams of approximately equal size which unite.

Depression

A sunken or depressed geological formation within the landscape.

Seasonal water regime

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

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12. APPENDICES

APPENDIX 1: WORKSHOP NOTES

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

APPENDIX 2: CORRICK AND NORMAN CLASSIFICATION 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 upon 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 are generally 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 as 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 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.

Victorian Environmental Water Holder (VEWH) – The Victorian Environmental Water Holder (VEWH) was be established in June 2011. VEWH is 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 VEWH that could potentially be made available to this site include:

- The Victorian River Murray Flora and Fauna Bulk Entitlement; and
- Future Northern Victorian Irrigation Renewal Project (NVIRP) 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 NVRIP Environmental Water Entitlements - One third of water savings from Stage 1 of the NVIRP project will be used for the environment, some of which will be stored in Lake Eildon. This water will be released into stressed rivers and streams when required. The NVIRP water savings are predicted to provide up to 75GL as a statutory environmental entitlement, which will be used to help improve the health of priority stressed rivers and wetlands in northern Victoria (DSE 2008). The entitlement will have priorities 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

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

Bilateral Migratory Bird Agreements

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.

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

These agreements require that 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.

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.

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.

ACTS (NATIONAL)

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

***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.

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

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

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

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

ACTS (VICTORIA)

***Crown Land (Reserves) Act* 1978** – Land reserved for a variety of public purposes are managed under this Act.

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

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

- Advisory list of Threatened Invertebrate Fauna in Victoria - 2009

Policy and Frameworks

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

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

The Goulburn Broken Regional River Health Strategy 2005 - This Strategy fits into the broader government vision for the management of water in the State to ensure that rivers are managed in accordance with relevant Victorian Government policies. This strategy provides a framework for integration of actions which will enable rivers of high quality to be protected and others to be improved in quality for current and future generations.

The Goulburn Broken Regional River Health Strategy aims to achieve four main objectives for the rivers and streams of the Goulburn Broken Catchment:

- Enhance and protect the rivers that are of highest community values (environmental, social and economic) from any decline in condition;
- Maintaining the condition of ecologically healthy rivers;
- Achieving the "overall improvement" in the environmental condition of the remainder of rivers;
- Preventing damage from inappropriate development and activities.

Biodiversity strategy for Goulburn Broken Catchment 2009 - This Strategy follows implementation of Goulburn Broken CMAs 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).

APPENDIX 5: FAUNA SPECIES LIST

Fauna list of Mansfield Swamp – taken from Victorian Fauna Database 2010 and D. Cook 20010-11 counts.

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

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

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

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

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

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

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

w Water dependant species or Waterbirds

Common Name	Scientific Name	EPBC	FFG	VROTS	Origin and guild
BIRDS					
Australasian Bittern	*Botaurus poiciloptilus*	EN	L	en	w
Australasian Darter	*Anhinga novaehollandiae*				w
Australasian Grebe	*Tachybaptus novaehollandiae*				w
Australasian Pipit	*Anthus novaeseelandiae*				
Australasian Shoveler	*Anas rhynchotis*			vu	w
Australian Magpie	*Gymnorhina tibicen*				
Australian Pelican	*Pelecanus conspicillatus*				w
Australian Raven	*Corvus coronoides*				
Australian Reed-Warbler	*Acrocephalus stentoreus*				w
Australian Shelduck	*Tadorna tadornoides*				w
Australian White Ibis	*Threskiornis molucca*				w
Australian Wood Duck	*Chenonetta jubata*				w
Ballion's Crake	*Prozana pusilla*		L	vu	w
Bar-tailed Godwit	*Limosa lapponica*				w
Black Swan	*Cygnus atratus*				w
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*				
Black-fronted Dotterel	*Elseyornis melanops*				w
Black-shouldered Kite	*Elanus axillaris*				
Black-tailed Native-hen	*Gallinula ventralis*				w
Black-winged Stilt	*Himantopus himantopus*				w
Blue-billed Duck	*Oxyura australis*			en	w
Brolga	*Grus rubicunda*			vu	w
Brown Falcon	*Falco berigora*				
Brown Treecreeper (south-eastern ssp.)	*Climacteris picumnus victoriae*			nt	
Caspian Tern	*Hydroprogne caspia*		L	nt	w
Chestnut Teal	*Anas castanea*				w
Common Crow	*Euploea core corinna*				
Curlew Sandpiper	*Calidris ferruginea*				w
Double-banded Plover	*Charadrius bicinctus*				w
Dusky Moorhen	*Gallinula tenebrosa*				w
Eastern Barn Owl	*Tyto alba*				

Eastern Great Egret	*Ardea modesta*		L	vu	w
Eastern Rosella	*Platycercus eximius*				
Eurasian Coot	*Fulica atra*				w
Freckled Duck	*Stictonetta naevosa*			en	w
Galah	*Eolophus roseicapilla*				
Glossy Ibis	*Plegadis falcinellus*			nt	w
Great Cormorant	*Phalacrocorax carbo*				w
Great Crested Grebe	*Podiceps cristatus*				w
Grey Teal	*Anas gracilis*				w
Hardhead	*Aythya australis*			vu	w
Hoary-headed Grebe	*Poliocephalus poliocephalus*				w
Intermediate Egret	*Ardea intermedia*		L	en	w
Latham's Snipe	*Gallinago hardwickii*			nt	w
Laughing Kookaburra	*Dacelo novaeguineae*				
Little Black Cormorant	*Phalacrocorax sulcirostris*				w
Little Corella	*Cacatua sanguinea*				
Little Egret	*Egretta garzetta*		L	en	w
Little Grassbird	*Megalurus gramineus*				w
Little Pied Cormorant	*Microcarbo melanoleucos*				w
Little Raven	*Corvus mellori*				
Magpie-lark	*Grallina cyanoleuca*				
Marsh Sandpiper	*Tringa stagnatilis*				w
Masked Lapwing	*Vanellus miles*				w
Musk Duck	*Biziura lobata*			vu	w
Nankeen Kestrel	*Falco cenchroides*				
Nankeen Night Heron	*Nycticorax caledonicus*			nt	w
Noisy Miner	*Manorina melanocephala*				
Pacific Black Duck	*Anas superciliosa*				w
Peaceful Dove	*Geopelia striata*				
Peregrine Falcon	*Falco peregrinus*				
Pied Butcherbird	*Cracticus nigrogularis*				
Pied Cormorant	*Phalacrocorax varius*			nt	w
Pink-eared Duck	*Malacorhynchus membranaceus*				w
Plumed Whistling-Duck	*Dendrocygna eytoni*				w
Purple Swamphen	*Porphyrio porphyrio*				w
Red-capped Robin	*Petroica goodenovii*				
Red-kneed Dotterel	*Erythrogonys cinctus*				w
Red-necked Avocet	*Recurvirostra novahollandiae*				w
Red-necked Stint	*Calidris ruficotlis*				w
Red-rumped Parrot	*Psephotus haematonotus*				
Restless Flycatcher	*Myiagra inquieta*				
Royal Spoonbill	*Platalea regia*			vu	w
Sacred Kingfisher	*Todiramphus sanctus*				
Sharp-tailed Sandpiper	*Calidris acuminata*				w
Silver Gull	*Chroicocephalus novaehollandiae*				w
Singing Bushlark/ Horsfield's Bushlark	*Mirafra javanica*				

Spotless Crake	*Porzana tabuensis*				w
Straw-necked Ibis	*Threskiornis spinicollis*				w
Striated Pardalote	*Pardalotus striatus*				
Stubble Quail	*Coturnix pectoralis*				
Superb Fairy-wren	*Malurus cyaneus*				
Swamp Harrier	*Circus approximans*				w
Tree Martin	*Hirundo nigricans*				
Wedge-tailed Eagle	*Aquila audax*				
Welcome Swallow	*Hirundo neoxena*				w
Whiskered Tern	*Childonias hybridus javanivus*			nt	w
White-bellied Sea-Eagle	*Haliaeetus leucogaster*		L	vu	w
White-browed Woodswallow	*Artamus superciliosus*				
White-faced Heron	*Egretta novaehollandiae*				w
White-fronted Chat	*Epthianura albifrons*				
White-necked Heron	*Ardea pacifica*				w
White-plumed Honeyeater	*Lichenostomus penicillatus*				
Willie Wagtail	*Rhipidura leucophrys*				
Yellow-billed Spoonbill	*Platalea flavipes*				w
FISH					
Flat-headed Galaxis	Galaxias rostratus			vu	
FROGS					
Common Froglet	*Crinia signifera*				Moist depressions
Peron's Tree Frog	*Litoria peronii*				Creek lines, woodlands and urban areas
Plains Froglet	*Crinia parinsignifera*				Moist depressions
Pobblebonk	*Limnodynastes dumerilii*				Most areas except Alpine and extreme dry
Spotted Marsh Frog	*Limnodynastes tasmaniensis*				Common in farm dams and wetlands
MAMMALS					
Common Brush-tail Possum	*Trichosurus vulpecular*				
Eastern Grey Kangaroo	*Macropus giganteus*				
Swamp Wallaby	*Wallabia bicolor*				
REPTILES					
Woodland Blind Snake	*Ramphotyphlops proximus*			nt	
Eastern Brown Snake	*Pseudonaja textilis*				
Eastern Snake-necked Turtle	*Chelodina longicollis*				w
Lace Monitor	*Varanus varius*			vu	
Tiger Snake	*Notechis scutatus*				
INTRODUCED SPECIES					
Brown Hare	*Lepus capensis*				
Common Blackbird	*Turdus merula*				
Common Starling	*Sturnus vulgaris*				
Common Myna	*Sturnus tristis*				
European Carp	*Cyprinus carpio*				w
House Sparrow	*Passer domesticus*				
Red Fox	*Vulpes vulpes*				

APPENDIX 6: ECOLOGICAL VEGETATION CLASSES

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

Below is a description of the EVCs found within and surrounding Mansfield Swamp (www.dse.gov.au).

Red Gum Swamp [EVC #292]

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

Tangled Lignum [EVC #104]

A relatively heterogeneous group of species-poor wetlands dominated by robust and often dense lignum.

EVCs SURROUNDING MANSFIELD SWAMP

Plains Grassy Woodland [EVC #55]

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

Plains Grassy Woodland/Gilgai Wetland Mosaic [EVC # 259] – No description offered

APPENDIX 7: FLORA SPECIES LIST

Flora list of Mansfield Swamp – taken from Victorian Flora Database 2010, DPI Mansfield Swamp Management Plan Flora list and D. Cook 2011 counts.

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

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

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

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

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

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

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

w = Wetland species

p = Planted

= Native to Victoria but grows outside natural range

Common Name	Scientific Name	EVC 104	EVC 292	EPBC	FFG	VROTS	Origin	Indigenous Use
Gold-dust Wattle	*Acacia acinacea s.l.*							
Golden Wattle	*Acacia pycnantha*							
Water Plantain	*Alisma plantago-aquatica*						w	
Buloke	*Allocasurina luehmannii*							
Lesser Joyweed	*Alternanthera denticulata s.l.*						w	
Plains Joyweed	*Alternanthera sp.1*							
Southern Swamp Wallaby-grass	*Amphibromus neesii*						w	
Common Swamp Wallaby-grass	*Amphibromus nervosus*		✓				w	
Small Vanilla-lily	*Arthropodium minus*						w	Tubers eaten
Common Woodruff	*Asperula conferta*						w	
Mealy Saltbush	*Atriplex pseudocampamulata*					r	#	
Saltbush	*Atriplex spp*							
Common Wallaby-grass	*Austrodanthonia caespitosa*		✓				w	
Brown-back Wallaby-grass	*Austrodanthonia duttoniana*		✓				w	
Bristly Wallaby-grass	*Austrodanthonia setacea*		✓					
Plump Spear-grass	*Austrostipa aristiglumis*							
Rough Spear-grass	*Austrostipa scabra subsp. falcata*							
Pacific Azolla	*Azolla filiculoides*						w	
Ferny Azolla	*Azolla pinnata spp.pinnata*						w	
Woodland Swamp-daisy	*Brachyscome basaltica var. gracillis*						w	
Winged Water-starwort	*Callitriche umbonata*		✓			r	w	
Tufted Burr-daisy	*Calotis scapigera*						w	
Riverina Bitter-cress	*Cardamine moirensis*		✓			r	w	
Tall Sedge	*Carex appressa*						w	Leaves used in basket making
Poong'ort / Rush Sedge	*Carex tereticaulis*						w	

Drooping Cassinia	*Cassinia arcuata*							
Common Sneezeweed	*Centipeda cunninghamii*						w	
Clammy goosefoot	*Chenopodium pumilio*							
Windmill Grass	*Chloris truncata*							
Pink Bindweed	*Convolvulus erubescens spp. agg.*							Tap roots made into dough
Water Buttons	*Cotula coronopifolia*						w	
Swamp Billy-buttons	*Craspedia paludicola*		✓				w	
Variable Flat-sedge	*Cyperus difformis*						w	
Star Fruit	*Damasonium minus*		✓				w	
Yellow Twin-heads	*Eclipta platyglossa*						# w	
Nodding Saltbush	*Einadia nutans subsp. nutans*							
Waterwort	*Elatine gratioloides*		✓				w	
Common Spike-sedge	*Eleocharis acuta*		✓				w	
Grey Spike-sedge	*Eleocharis macbarronii*					k	w	
Small Spike-sedge	*Eleocharis pusilla*		✓				w	
Hairy Willow-herb	*Epilobium hirtigerum*						w	
Cane-grass	*Eragrostis austalasica*						w	
Southern Cane-grass	*Eragrostis infecunda*	✓	✓				w	
Blue Devil	*Eryngium ovinum*						w	
Prick Foot	*Eryngium vesiculosum*						w	
River Red-gum	*Eucalyptus camaldulensis*		✓				w	
Black Box	*Eucalyptus largiflorens*							
Yellow Box	*Eucalyptus melliodora*							
Grey Box	*Eucalyptus microcarpa*							
Annual Cudweed	*Euchiton sphaericus*							
Slender Goodenia	*Goodenia gracilis*		✓				w	
Dwarf Brooklime	*Gratiola pumilo*		✓			r	w	
Rough Raspwort	*Haloragis aspera*							
Bluish Raspwort	*Haloragis glauca*					k		
Plain Quilwort	*Isoetes drummondii*		✓				w	
Grassy Club-sedge	*Isolepis hookeriana*						w	
Hollow Rush	*Juncus amabilis*						w	
Yellow Rush	*Juncus flavidus*						w	
Joint-leaf Rush	*Juncus holoschoenus*		✓				w	
Pale Rush	*Juncus pallidus*						w	
Rush	*Juncus sp*						w	
Common Blown-grass	*Lachnagrostis filiformis*		✓				w	
Common Blown-grass	*Lachnagrostis filiformis var.1*						w	
Stalked Plover-daisy	*Leiocarpa websteri*							
Thin Duckweed	*Landoltia punctate*	✓					w	
Common Duckweed	*Lemna disperma*	✓	✓				w	
Austral Water-mat	*Lepilaena australis*						w	
Austral Mud-mat	*Limosella australis*						w	
Poison Pratia	*Lobelia concolor*						w	
Poison Lobelia	*Lobelia pratioides*						w	
Clove-strip	*Ludwigia peploides subsp. montevidensis*						w	

Small Loosestrife	*Lythrum hyssopifolia*		✓				w	
Black Cotton-bush	*Maireana decalvans*							
Narrow-leaf Nardoo	*Marsilea costulifera*		✓				w	
Common Nardoo	*Marsilea drummondii*	✓	✓				w	
Creeping mint	*Mentha satureoides*							Leaves used as medicine
Tangled Lignum	*Muehlenbeckia florulenta*	✓					w	
Upright Water-milfoil	*Myriophyllum crispatum*		✓				w	
Slender Water-milfoil	*Myriophyllum gracile var. lineare*				L	e	w	
Water-milfoil	*Myriophyllum spp*							
Water Nymph	*Najas tenufolia*	✓				r	w	
Swamp Lily	*Ottelia ovalifolia subsp. ovalifolia*						w	
Grassland Wood-sorrel	*Oxalis perennans*							
Austral Pillwort	*Pilularia novaehollandiae*		✓				w	
Tussock-grass	*Poa australis spp.agg*							
Red Pondweed	*Potamogeton cheesemanii*		✓				w	
Floating Pondweed	*Potamogeton tricarinatus*						w	
Drumsticks	*Pycnosorus globosus*						#	
Buttercup	*Ranunculus spp.*						w	
Slender Dock	*Rumex brownii*						w	
Narrow-leaf Dock	*Rumex tenax*						w	
Stiff Groundsel	*Senecio behrianus*			E	L	e	*w*	
Medusa Bog-sedge	*Schoenus latelaminatus*						w	
Black Roly-poly	*Sclerolaena muricata*							
Variable Sida	*Sida corrugata*							
Slender Darling-Pea	*Swainsona murrayana*			V	L	e	w	
Broughton Pea	*Swainsona procumbens*		✓				w	
Grey Germander	*Teucrium racemosum s.l.*						w	
Slender Water-ribbons	*Triglochin dubia*					r	w	
Northern Water-ribbons	*Triglochin multifructa*						w	
Water-ribbons	*Triglochin procerum*						w	
Cumbungi	*Typha orientalis*						w	
Cumbungi	*Typha spp.*						w	
Fuzzy New Holland Daisy	*Vittadinia cuneata*							
Woolly New Holland Daisy	*Vittadinia gracilis*							
Tufted Bluebell	*Wahlenbergia communis s.l*							
River Bluebell	*Wahlenbergia fluminalis*							
Rigid Panic	*Walwhalleya proluta*		✓				w	Seeds ground to flour.
Exotic Species								
Water Plaintain	*Alisma plantago-aquatica*						w	
Cape Weed	*Arctotheca calendula*							
Aster-weed	*Aster subulata*						w	
Bearded Oat	*Avena barbata*		✓					
Wild Oat	*Avena fatua*							
Oat	*Avena sp*							
Thread Water Starwort	*Callitriche hamulata*		✓				w	
Water Starwort	*Callitriche stagnalis*						w	

Saffron Thistle	*Carthamus lanatus*							
Chicory	*Cichorium intybus*							
Spear Thistle	*Cirsium vulgare*							
Couch	*Cynadon dactylon*						w	
Umbrella Sedge	*Cyperus eragrostis*						w	
Paterson's Curse	*Echium plantagineum*							
Ox-tongue	*Helminthotheca echioides*							
Barley Grass	*Hordeum sp*							
Cat's Ear	*Hypochoeris radiate*							
Spiny Rush	*Juncus acutus subsp. acutus*						w	
Willow-leaf Lettuce	*Lactuca saligna*							
Prickly Lettuce	*Lactuca serriola*							
Common Peppercress	*Lepidium africanum*							
Wimmera Rye-grass	*Lolium rigidum*		✓					
African Boxthorn	*Lycium ferocissimum*							
Nice Mallow	*Malva parviflora*							
Hoarehound	*Marrubium vulgare*							
Lucerne	*Medicago sativa var.sativa*							
Paspalum	*Paspalum dilatatum*							
Toowoomba Canary-grass	*Phalaris aquatica*							
Paradoxical Canary-grass	*Phalaris paradoxa*							
Ribwort	*Plantago lanceolata*							
Prostate Knotweed	*Polygonum aviculare*							
Celery Buttercup	*Ranunculus sceleratus subsp.seleratus*						w	
Onion Grass	*Romulea rosea*							
Clustered Dock	*Rumex crispus*						w	
Curled Dock	*Rumex crispus*						w	
Pepper Tree	*Schinus molle*							
Variegated Thistle	*Silybum marianum*							
Black Nightshade	*Solanum nigrum*							
Rough Sow-thistle	*Sonchus asper s.l*							
Common Sow-thistle	*Sonchus olercea*							
Garden Dandelion	*Taraxacum sect.vulgaria*							
Narrow-leaf Clover	*Trifolium angustifolium var. angustifolium*							
Strawberry Clover	*Trifolium fragiferum var.fragiferum*							
White Clover	*Trifolium repens var.repens*							
Knotted Clover	*Trifolium striatum*							
Subterraneum Clover	*Trifolium subterraneum*							
Bathurst Burr	*Xanthium spinosum*							

APPENDIX 8: INDEX OF WETLAND CONDITION METHOD

Table 11 below shows what is assessed for each of the six subindices and how they are scored.

Table 11: IWC subindices and measures.

IWC subindex	What is measured	How it is scored
Swamp catchment	1. The intensity of the land use within 250 metres of the swamp	• The more intensive the landuse the lower the score
	2. The width of the native vegetation surrounding the swamp and whether it is a continuous zone or fragmented	• The wider the zone and more continuous the zone, the higher the score
Physical form	3. Whether the size of the swamp has been reduced from its estimated pre-European settlement size	• A reduction in area results in a lowering of the score
	4. The percentage of the swamp bed which has been excavated or filled	• The greater the percentage of swamp bed modified, the lower the score
Hydrology	5. Whether the swamp's water regime (i.e. the timing, frequency of filling and duration of flooding) has been changed by human activities	• The more severe the impacts on the water regime, the lower the score
Water properties	6. Whether activities and impacts such as grazing and fertilizer run-off that would lead to an input of nutrients to the swamp are present	• The more activities present, the lower the score
	7. Whether the swamp has become more saline or in the case of a naturally salty swamp, whether it has become more fresh	• An increase in salinity for a fresh swamp lowers the score or a decrease in salinity of a naturally salty swamp lowers the score
Soils	8. The percentage and severity of swamp soil disturbance from human, feral animals or stock activities	• The more soil disturbance and the more severe it is, the lower the score
Biota	9. The diversity, health and weediness of the native swamp vegetation	• The lower the diversity and poorer health of native swamp vegetation, the lower the score • The increased degree of weediness in the native swamp vegetation, the lower the score

Adapted from DSE letter 29 April 2010

Scoring method

Each subindex is given a score between 0 and 20 based on the assessment of a number of measures. Weightings are then applied to the scores as shown in Table 12. 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 12: Weights of each subindex

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

Six wetland condition categories have been assigned to the subindex scores (Table 13) and total IWC scores (Table 14), 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 13: Swamp condition categories assigned to subindex scores.

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

Table 14: Swamp condition categories assigned to total IWC scores

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

This information has been drawn from - Version 9 of the Index of 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 MANSFIELD SWAMP

EVC benchmarks have been determined for Mansfield Swamp by monitoring that was undertaken at the site in 2011 by Australian Ecosystems.

Benchmarks for Red Gum Swamp includes: Trees (aim to maintain 5-10% cover); Sedges (aim to have >2 species and >10% cover); Medium to large grasses (aim to have >3 species and >10% cover around verges); Aquatic herbs (aim to have >3 species and >10% cover).

Benchmarks for Lignum Swamp includes: Medium (to Tall) shrubs (aim to maintain 1 species and 10% cover); Medium to Tall herbs (aim to have 3 species and 5% cover); small to prostrate herbs (aim to have 3 species with 5 % cover); Medium to tall graminoids (aim to maintain 1 species) and small non-tufted gramnoids (aim to maintain 1 species).

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 *Crinia signifera*	*	*	*	C	CB	CB	C	2-4
Plains Froglet *Crinia parasignifera*	*	*	*	C	CB	CB	C	2-4
Pobblebonk *Limnodynastes dumerili*		*	*	CT	CB	CB	C	5-6
Barking Marsh Frog *Limnodynastes fletcheri*		*	*	C	CB	B		3-4
Spotted Marsh Frog *Limnodynastes tasmaniensis*	*	*	*	C	CB	B		3-4
Perons Tree Frog *Litoria peronii*	*	*	*	C	CB	B		3-4
Growling Grass Frog *Litoria raniformis*		*	*	C	CB	B		3-5

C = Calling, B=Breeding, T = Tadpoles may be present