GAYNOR SWAMP ENVIRONMENTAL WATER MANAGEMENT PLAN 2012

GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY

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MANAGEMENT

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EXECUTIVE SUMMARY

This plan outlines the water regimes required to protect and enhance the water dependent environmental values for Gaynor 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.

Gaynor Swamp is a 303 ha deep freshwater marsh and is located 7 km south-east of Corop Township in northern Victoria. The wetland provides important breeding habitat for Brolga within the Goulburn Broken Catchment and Victoria. The wetland part of the Corop Lakes system and is managed by Parks Victoria and is valued for its rarity, species diversity and waterbird habitat.

In the plan the following five 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;
- reinstate populations of Spiny Lignum and Salt Paperbark;
- maintain or increase the diversity and abundance of frog species supported by the wetland;
- provide opportunities for waterbird breeding especially Brolga.

To achieve these ecological objectives minimum, optimum and maximum watering regimes are recommended. These are summarised in the table below and more detail can be found in section 6.2.2- Hydrological objectives. The ecological objectives and watering regimes were developed by a Scientific Technical Committee.

Watering Regime for Gaynor Swamp

Minimum – *Provide one to three 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 Spiny Lignum and Salt Paperbark.

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ACKNOWLEDGEMENTS

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Members of the Scientific Technical Group which comprised 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 Consultant) for their input and development into the watering plans.

ABBREVIATIONS

ARI	Arthur Rylah Institute
CAMBA	China Australia Migratory Bird Agreement
CEWH	Commonwealth Environmental Water Holder
CMA	Catchment Management Authorities
DSE	Department of Sustainability and Environment
EC	Electrical Conductivity
EPBC	*Environment Protection Biodiversity Conservation Act 1999*
EVC	Ecological vegetation community
EWA	Environmental Water Allocation
EWMP	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
ML	Megalitre (one million litres)
NVIRP	Northern Victoria Irrigation Renewal Project
ROKAMBA	Republic of Korea Australia Migratory Bird Agreement
SKM	Sinclair Knight Mertz
VEWH	Victorian Environmental Water Holder

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 dependant environmental, social and economic values of the site;
- the sites 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 Gaynor 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 Victorias 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.

Gaynor Swamp is a 303 hectare seasonal deep freshwater marsh within a 395 hectare Natural Features Reserve within the Goulburn Broken Catchment (Figure 1). The swamp is situated within the localised 354km^2 Cornella Creek catchment which is part of the larger Corop Lakes drainage area, south-east of Lake Cooper (Figure 2, section 2.1 Catchment History). Gaynor Swamp is managed publically and is classified as a Natural Features Reserve – Wildlife Area. It is classified as part of the Wallenjoe Wetlands (VIC060) listed on *A Directory of Important Wetlands* (EA, 2001).

The Corop and Wallenjoe wetlands lie on a geological setting of Quaternary lacustrine and paludal sediments of Quaternary alluvium (EA, 2001). These wetlands formed when leaching and subsidence of calcareous material from the topsoil occurred (Corrick and Cowling, 1978). Prior to European settlement, Gaynor Swamp was a seasonal shallow freshwater marsh primarily fed by inflows from the Cornella Creek once Lake Cooper partially filled and backed up into the lower reach of the Cornella Creek (Figure 3). A smaller depression situated in the south-east corner of Gaynor Swamp also entered Gaynor Swamp during large flood events (DPI, 2010, DCE, 1993). Europeans settled in the Corop area in the 1840s – 1870s. Gaynor Swamp was named after John Gaynor, who owned land at the southern end of the Swamp (Anon, 1927). Gaynor Swamp hydrology was majorly changed when irrigation was introduced to the area between the 1940s and 1950s. This resulted in prolonged inundation causing the swamp to become a semi-permanent deep freshwater marsh and resulted in the death of southern cane-grass (*Eragrostis infecunda*) and river red gums (*Eucalyptus camaldulensis*) at the site (DPI, 2010, DCE, 1993).

Gaynor Swamp was freehold land until 1976-77 when it was purchased for wildlife preservation; in 1978 parts of the swamp were reserved under the *Crown Lands (Reserves) Act* (1978). In 1986 all parcels of land in the Gaynor Swamp reserve were transferred to Crown land and reserved for management (DPI, 2010). During 1995-1996 a regulating structure was constructed on the south-western side of Gaynor Swamp where backflow from Lake Cooper enters the swamp. This was constructed to prevent saline water from Lake Cooper entering Gaynor Swamp. A Victorian Environmental Assessment Council (VEAC) in 2009 deemed Gaynor Swamp a Natural Features Reserve – Wildlife Area (VEAC, 2008).

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

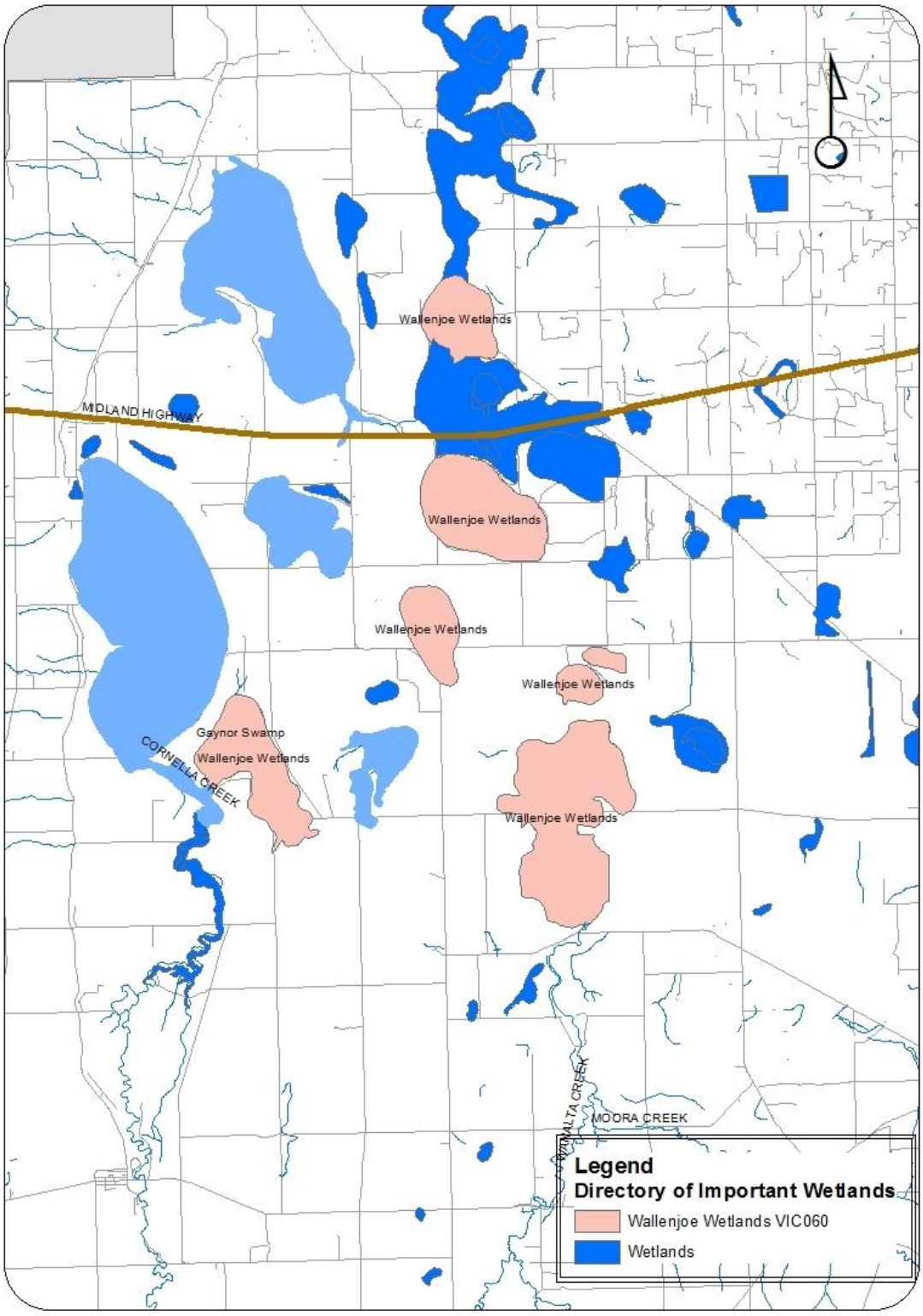

Figure 2: Gaynor Swamp listed as part of the Wallenjoe Wetlands on A Directory of Important Wetlands (VIC060).

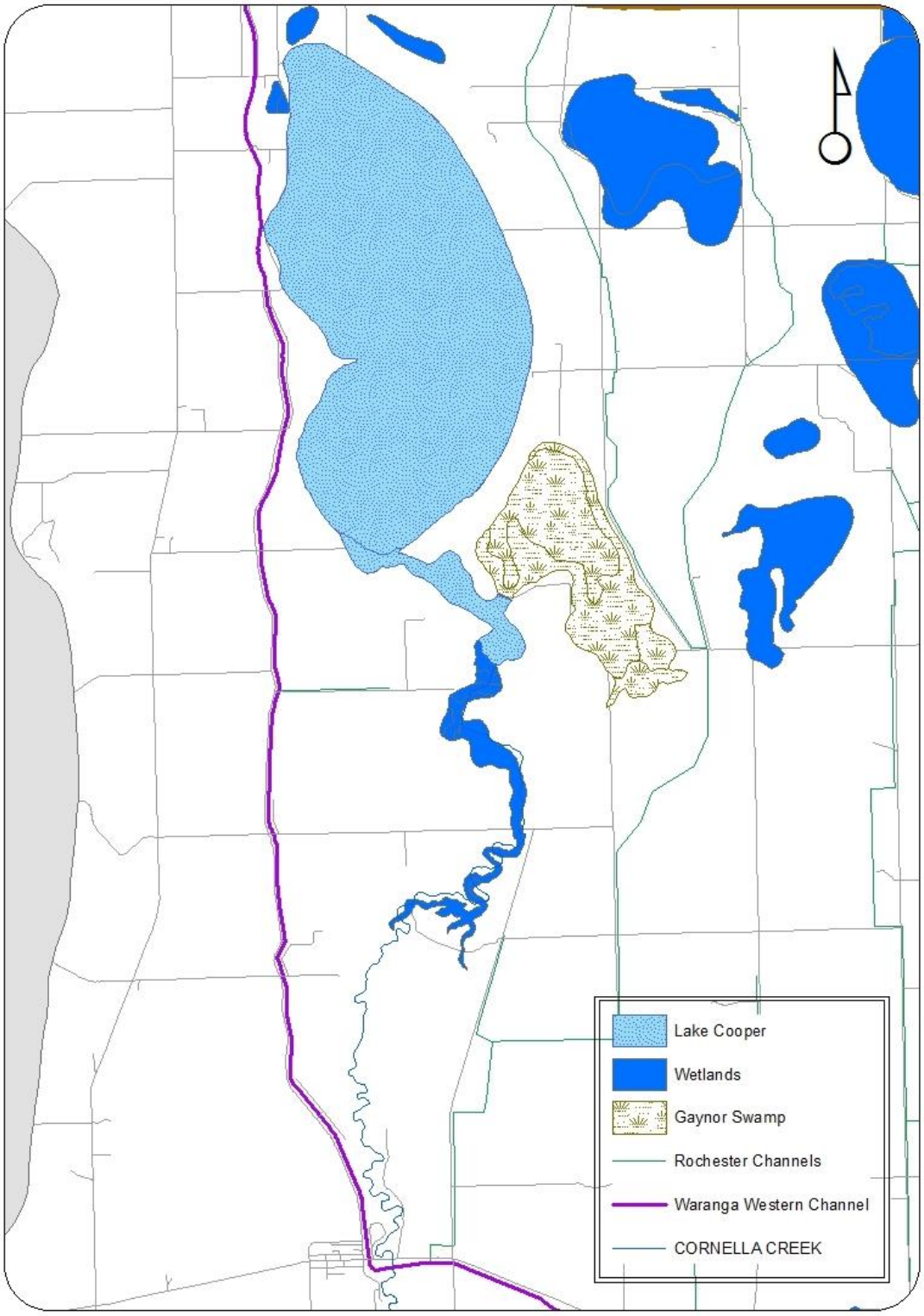

Figure 3: Gaynor Swamp in relation to Lake Cooper and Cornella Creek.

1.4 CONSULTATION

This plan was prepared by the Goulburn Broken Catchment Management Authority with input from a Scientific Technical Committee. The Scientific Technical Committee developed ecological and hydrological goals for Gaynor Swamp 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 Sam Green (Goulburn-Murray Water), Damien Cook (Australian Ecosystems), Doug Frood (Pathways Bushland and Environment), Keith Ward, Timothy Barlow, Jo Wood and Simon Casanelia (Goulburn Broken CMA). Draft plans of this report were submitted to members of the Goulburn Broken Wetland Management Group (community and industry representatives) for review.

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).
- Gaynor Swamp Environmental Management Plan DRAFT 1.4 (DPI, 2010).
- Scoping Infrastructure Works for Priority Wetlands in the Shepparton Irrigation Region. Gaynor Swamp (Paynter, 2010).
- Environmental Management Requirements for the Corop Lakes Drainage Area: Timmering and Woolwash Depression (DCE, 1993).

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 Gaynor Swamp.

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

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

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 Gaynor 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

The Cornella Creek catchment area is situated in the Victorian Riverina Bioregion which 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. Gaynor Swamp is located to the south-east of Lake Cooper at the end of the Cornella Creek within the Cornella Creek Catchment (354km^2) and is classified as nationally significant in *A Directory of Important Wetlands* – VIC 0606 Wallenjoe Wetlands (EA, 2001).

Over 60 per cent of the Goulburn Broken Catchment has been cleared for agriculture purposes (Miles et al., 2010). The Goulburn Broken catchment includes irrigated and dry land agriculture. Gaynor Swamp is situated in 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. Therefore, the remnant vegetation and wetlands within the Rochester catchment form an important corridor in the catchment and is a stronghold for native flora and fauna, especially Brolga (*Grus rubicunda*).

2.2 LAND STATUS AND MANAGEMENT

Gaynor Swamp is managed by Parks Victoria. A range of management agencies are also responsible for ensuring that management of the study area complies with a broad range of legislative requirements. Lead management agencies and their key responsibilities are summarised in Table 1. The broader community including adjacent landholders, Indigenous Peoples (section 3.4.1 - Cultural heritage), Landcare, Trust for Nature and recreational users such as Field and Game Australia also have an interest and/or role in the management of the planning area. The successful management of the study area therefore relies on effective cooperation and partnership between the government agencies and the broader community.

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

Agency	Responsibility
Aboriginal Affairs Victoria	Promote knowledge and understanding within the wider community of the study area's Aboriginal people and their history. Administer legislation protecting Aboriginal heritage sites within the study area (*State Aboriginal Heritage Act 2006* and Part IIA of the Commonwealth *Aboriginal Torres Strait Islander Heritage Protection Act 1984*).
Department of Primary Industries	Provide technical and extension support for the sustainable management of fisheries, agriculture, minerals and petroleum.
Department of Sustainability and Environment	Provide financial, policy and strategic support for the management of public and private land. Management of flora and fauna, State Forest and public Land Water Frontage. Management of hunting and domestic stock licensing on public land.
Environmental Protection 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	Manage surrounding irrigation system.
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	Land Managers of Gaynor Swamp.
Victorian Environmental Water Holder	Management of environmental water entitlements on behalf of the Minister for Environment as of July 2011.

2.3 WETLAND CHARACTERISTICS

Wetlands in Victoria are currently classified using a system developed by Corrick and Norman (1980, Appendix 2) which includes information 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).

Gaynor Swamp is classified as a deep freshwater marsh in the Department of Sustainability and Environment wetlands 1994 layer. Gaynor Swamp has a mean depth of 0.95m and has a calculated capacity of approximately 2878.5 ML[1]. The wetland is located within the Victorian Riverina bioregion within the Cornella Creek Catchment (Table 2 and Figure 3).

Gaynor Swamp is surrounded by irrigated and dryland agriculture. Environmental water has not been delivered to Gaynor Swamp due to lack of suitable infrastructure (section 8 – Environmental Water Infrastructure). Cornella Creek is the primary source of water for Gaynor Swamp and water enters the swamp when water backs up from Lake Cooper when the lake is partially filled (Paynter, 2010).

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

Table 2: Summary of site characteristics

Characteristics	Description
Name	Gaynor Swamp
Mapping Id	7824054566
Area (ha)	303
Bioregion	Victorian Riverina
Conservation Status	Nationally Significant^
Land Status	Public
Land Manager	Parks Victoria
Surrounding Land Use	Irrigated and Dryland Agriculture
Water Supply	Cornella Creek
1788 Wetland Category	Deep Freshwater Marsh
1994 Wetland Category	Deep Marsh
Wetland Capacity (ML)	2878.5
Mean wetland depth at Capacity (m)	0.95m*

^National Significance is listed in *A Directory of Important Wetlands*. Gaynor Swamp is listed within the Wallenjoe Wetlands of Directory of Important Wetlands (VIC 060).*Note: Filling Gaynor Swamp to 0.95m will not occur during every environmental watering event. Filling the wetland to variable depths will promote an increased plant species community and drawing down the wetland slowly will allow the habitat to change in its natural state, resulting in different vegetation communities establishing within the wetland body.

2.4 ENVIRONMENTAL WATER SOURCES

The Environmental Water Reserve 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 Gaynor 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 Gaynor Swamp include water savings from the Northern Victoria Irrigation Renewal Project (NVIRP) 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 Gaynor Swamp. 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.
- *Environmental Protection Biodiversity Conservation Act* 1999 (EPBC Act).
- *Water Act* 2007.
- A Framework for Determining Commonwealth Environmental Watering Actions 2009.

Victorian legislation:

- *Crowns Land 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).
- Goulburn Broken Regional River Health Strategy (GBCMA, 2005).
- Our Water Our Future (DSE, 2004).
- Northern Region Sustainable Water Strategy (DSE, 2009b).
- Biodiversity Strategy for the Goulburn Broken Catchment, Victoria 2010-2015 (Miles et al., 2010).

2.6 RELATED PLANS AND ACTIVITIES

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

1. Gaynor Swamp Environmental Management Plan. DRAFT 1.4 (DPI, 2010). 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.

2. Conservation Plan for the Timmering Landscape Zone. Biodiversity Action Planning in the Shepparton Irrigation Region (DPI, 2007a).

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

1. Revegetation of a section of the southern end of the swamp.
2. Pest plant and animal control.
3. Construction of the regulating structure to prevent saline water from Lake Cooper entering Gaynor Swamp (DPI, 2010).
4. Undertake Index of wetland condition assessment at Gaynor Swamp (DPI, 2007a).
5. Ecological monitoring of Gaynor Swamp 2012 (Cook, 2012b).
6. Fencing around the swamp boundary to control stock and vehicle access.

These plans do not limit or impinge on the development of this environmental water management plan.

3. WATER DEPENDENT VALUES

3.1 ENVIRONMENTAL - FAUNA

3.1.1 FAUNA LISTINGS AND SIGNIFICANCE

Gaynor Swamp provides habitat for a wide variety of water dependent and terrestrial fauna species. To date 110 species have been recorded at the swamp (Appendix 5). These include 91 bird species, 1 fish, four frogs, eight mammals, six reptiles and eleven exotic species. Of these 55 are wetland dependent species and, six are listed under the *Convention on the Conservation of Migratory Species* (*Bonn*), eleven are listed under the *Flora and Fauna Guarantee Act* (FFG 1988), one is listed under the *Environmental Protection Biodiversity Conservation Act* (EPBC 1999), 17 are considered endangered, vulnerable or near threatened on the *DSE Advisory list of threatened vertebrate fauna in Victoria* (2007) (Table 3 for wetland species and Appendix 5 for all species). Five birds are listed under the Japan Australia Migratory Bird Agreement (JAMBA), seven birds are listed under China Australia Migratory Bird Agreement (CAMBA) (Figure 8) and one bird is listed under Republic of Korea Australia Migratory Bird Agreement (ROKAMBA).

Many water birds such as herons, pelicans (Figure 4), spoonbills, cormorants, darters, ibis and ducks utilise the swamp as a breeding and feeding ground. Little Pied Cormorants (*Microcarbo melanoleuos*), Eurasian Coot (*Fulica atra*), Black Swan (*Cygnus atratus*), Pacific Black Duck (*Anas superciliosa*), and Grey Teal (*Anas gibberifrons*) are common species that have been known to breed and feed in the wetland (DPI, 2010). The vulnerable Royal Spoonbill (*Platalea regia*), Eastern Great Egret (*Ardea modesta*), White-faced Herons (*Egretta novaehollanidia*), White-necked Herons (*Ardea pacifica*) and Brolga (*Grus rubicunda*) utilise the swamp as a breeding site also (section 3.1.2 - Significant Fauna). In 2012, monitoring by Australian Ecosystems (Cook, 2012b), counted approximately 1,660 shorebirds – particularly Black-winged Stilts (*Himantopus himantopus*) and Red-necked Avocet (*Recurvirostra novahollandiae*) were seen utilising the Swamp (Figure 5) and 7064 individuals of Ducks and Grebes (of which 7000 were Grey Teal). Cook (2012) also observed the functional feeding groups of these species and found that Piscivores or fish feeders (six species) were the most strongly represented species, followed by Ducks and Grebes (five species), Large Wading Birds (four species), Shorebirds (three species) and Herbivores (one species).

Murray Cod (*Maccullochella peelii peelii*) were recorded at Gaynor Swamp and Lake Cooper in 1895 (Weber, 2011). Fish data from Gaynor Swamp has not since been collected and is a knowledge gap that should be investigated (section 9 – Knowledge Gaps). Fish surveys of the Cornella Creek undertaken by the Arthur Rylah Institute (ARI) have shown six native species of fish to be present in the Creek including Flat-headed gudgeon (*Philypnodon grandiceps*), Australian Smelt (*Retropinna semoni*), Carp gudgeon (*Hypseleotris spp*), Murray-Darling Rainbowfish (*Melanotaenia fluvialis*), Southern pygmy perch (*Nannoperca australis*) and Flat-headed galaxid (*Galaxias rostratus).* These species may or may not move into Gaynor Swamp in times of high flows.

Only four amphibian species have been recorded at Gaynor Swamp and may be due to the water quality becoming saline as the wetland draws down. Aquatic invertebrates have not been monitored at Gaynor Swamp. Future monitoring projects could include this component of the food chain to determine what is utilising the wetland and give a more complete picture of Gaynor Swamp food web.

Figure 4: Pelicans flying above Gaynor Swamp July 2011

Photo: J. Wood, GB CMA 2011.

Figure 5: Red-necked avocets observed at Gaynor Swamp January 2012.

Photo: D.Cook, Australian Ecosystems 2012.

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

Common Name	Scientific Name	Type	International agreements	EPBC	FFG	DSE Status
Australasian Bittern	*Botaurus poiciloptilus*	B		EN	L	End
Australasian Shoveler	*Anas rhynchotus*	B				Vul
Australian Little Bittern	*Ixobrychus dubius*	B			L	End
Australian Reed Warbler	*Acrocephalus stentoreus*	B	B (A2H)			
Blue-billed Duck	*Oxyura australis*	B			L	End
Brolga	*Grus rubicundas*	B			L	Vul
Caspian Tern	*Hydroprogne caspia*	B	C,J		L	NT
Cattle Egret	*Ardea ibis*	B	J, C, B		L	
Eastern Great Egret	*Ardea modesta*	B	J,C,B		L	Vul
Freckled Duck	*Stictonetta naevosa*	B			L	End
Glossy Ibis	*Plegadis falcinellus*	B	C, B (A2S)			NT
Hardhead	*Aythya australis*	B				Vul
Intermediate Egret	*Ardea intermedia*	B			L	Cr
Latham's Snipe	*Gallinago hardwickii*	B	J, C, R, B (A2H)			NT
Little Egret	*Egretta garzetta nigripes*	B			L	End
Musk Duck	*Bizura lobata*	B				Vul
Royal Spoonbill	*Platalea regia*	B				Vul
Sharp-tailed Sandpiper	*Calidris acuminate*	B	J, C, B (A2H)			
Whiskered Tern	*Chlidonias 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) A2H species is member of family listed in Bonn, A2S species listed explicitly in Bonn Appendix 2
EPBC Status: Endangered (EN)
FFG Status: Listed as threatened (L)
DSE Status: Endangered (End), Vulnerable (Vul), Near Threatened (NT), Critically Endangered (Cr)

3.1.2 SIGNIFICANT FAUNA

Gaynor Swamp provides critical breeding habitat for the vulnerable Brolga. The protection of the Southern Cane-grass (*Eragrostis infecunda*) in the swamp is required to ensure breeding habitat for the Brolga is maintained. Brolga breed in response to flooding (Rogers and Ralph, 2011). Brolga numbers in Northern Victoria have diminished rapidly over the past few decades and it is imperative that these wetlands are protected to allow Brolga breeding to occur. Brolga flock together between December and May usually in areas with deep freshwater marshes. Greens Lake north of Gaynor Swamp is usually a flocking area for Brolga. This flocking behaviour may be the beginning of initial pair bonding between Brolga (Arnol et al., 1984). Between May and August Brolga 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 fills 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), and eggs being incubated for 31 days (Rogers and Ralph, 2011). Young are reared between October and December (Figure 6) and 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 6: Juvenile Brolga sighted at One Tree Swamp, January 2011

Photo: D. Cook, Australian Ecosystems 2011

Gaynor Swamp provides breeding habitat for the vulnerable Royal Spoonbill (*Platalea regia*) and Eastern Great Egrets (*Ardea modesta*). The protection of River Red Gums (*Eucalyptus camaldulensis*) and the Lignum (*Muehlenbeckia florulenta*) in the swamp is required to ensure breeding habitat for the colonial Royal Spoonbills (Figure 7) and Eastern Great Egrets is maintained. Royal Spoonbills breed between October and March and usually only have one brood od 3-4 eggs per season. Lag time and breeding duration have not been fully investigated but it has been estimated that a lag time of 1-2 months, breeding duration of 2-3 months and a flood duration of 4-5 months is required (Rogers and Ralph, 2011). Eastern Great Egrets breed between November and May and usually have 2-6 eggs with a breeding duration of 3-4 months and a flood duration of 6-7 months being required (Rogers and Ralph, 2011).

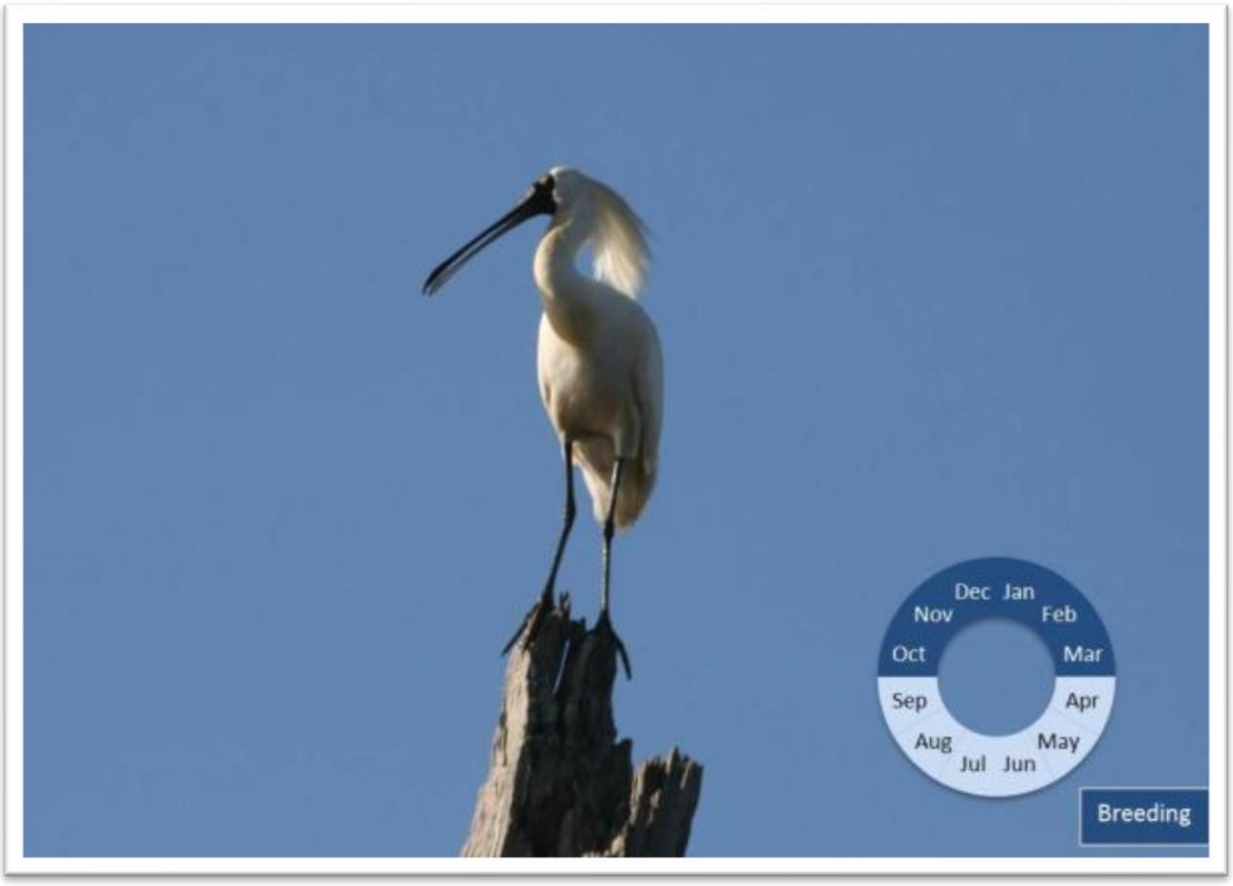

Figure 7: Royal Spoonbill with breeding plumage

Photo: Paul O'Connor DSE 2008

At an international level, the Corop wetlands including Gaynor Swamp also play an important role in providing habitat for international migratory species such as Latham's Snipe (*Gallinga hardwickii*) seen in Figure 8. Snipe have been observed around the margins of the swamp during several flood events. Other species such as Caspian Terns (*Hydropronge caspia*) and Sharp-tailed Sandpipers (*Calidris acuminate*) have also been recorded at the swamp.

Figure 8: Lathams Snipe

Photo: Jo Wood, GBCMA 2006

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.

The vegetation of Gaynor Swamp has been profoundly influenced by human-induced changes to its hydrological regime (Cook, 2012b). Prior to changes to the hydrology of the Swamp the most dominant EVC was likely to be Red Gum Swamp (ECV #292).

The deepest section of Gaynor Swamp is now dominated by Aquatic Herb land (EVC #653) and is approximately 30% of the wetland area. Shallower sections of the Swamp have developed the characteristics of a Cane-grass Wetland (EVC #292) and cover 15% of the wetland area. These EVCs were assessed and found to be in poor condition using Frood's Vegetation Condition Categories (Cook, 2012b, Frood, 2007). Cook (2012) suggests that these EVCs not be used for Index of Wetland Condition assessment or to guide restoration efforts as they are not the pre-European EVCs.

A southern section of the Swamp to the south of Bell Road supports a canopy of River Red Gums with an understory of Tangled Lignum and Southern Cane-grass. This area is classified as a complex of Red Gum Swamp (EVC #292) and Freshwater Lignum – Cane-grass Swamp (EVC #954) and should be used as a guide to restoration of vegetation at the Swamp. This area was assessed and found to be in good to moderate condition. This EVC covers approximately 55% of the Swamp.

The objective of this plan is to consider the aquatic dependent vegetation the swamp has historically supported and the likely aquatic dependent values it could support in the future considering climate change.

Table 4 shows the conservation status of the EVCs present at Gaynor Swamp within the Victorian Riverine Bioregion.

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

EVC Number	EVC Name	Bioregional Conservation Status
291	Cane-grass Swamp	Vu
292	Red Gum Swamp	Vu
653	Aquatic Herb land	De
954	Freshwater Lignum-Cane-grass Swamp Complex	–

Legend (Wierzbowski et al., 2002)

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

De = Depleted. Meaning the EVC is likely to become threatened if clearing or threatening processes continue and that 50-70% of this EVC has already been cleared since European settlement (1750) – this is only for the Murray Fans Bioregion – no data is available for the Victorian Riverina Bioregion.

3.2.1 FLORA – SPECIES LISTING AND SIGNIFICANCE

A total of 91 native flora species have been recorded at Gaynor Swamp including 60 water dependent species (Appendix 7). Of these species one is listed under the *Flora and Fauna Guarantee Act* (1999) and three are considered rare, poorly known or vulnerable in Victoria (Table 5).

Table 5: Listed water-dependent flora species recorded at Gaynor Swamp

Common Name	Scientific Name	FFG Status	DSE Status
Bluish Raspwort	*Haloragis glauca*		k
Salt Paperbark*	*Melaleuca halmaturorum subsp. halmaturorum*	L	r
Spiny Lignum*	*Muehlenbeckia horrida subsp. horrida*		v

Legend: FFG Status: Listed as threatened (L)**:** DSE Status: Poorly Known (k), Vulnerable (v), Rare (r) *Historical records

Southern cane-grass is considered a dominant species at the swamp. However, this alone should not be the target vegetation species at the swamp. Revegetation of the Red Gum Swamp (EVC #292) and the Freshwater Lignum – Cane Grass Swamp (EVC #954) should be undertaken.

3.2.2 FLORA - SIGNIFICANCE

Historical records of Gaynor Swamp show Spiny Lignum (*Muehlenbeckia horrida subsp.horrida*; Figure 9) and Salt Paperbark (*Melaleuca halmaturorum subsp.halmaturorum*) present within the swamp. Re-introduction of these species into the Swamp should be considered. Gaynor Swamp is considered to be a south-eastern outlier of Salt Paperbarks distribution (Cook, 2012a).

Figure 9: Spiny Lignum found at One Tree Swamp east of Gaynor Swamp.

Knowledge of the biology of these species is limited and should be identified as a knowledge gap (section 9).

Preservation of Southern Cane-grass is also important to ensure there is suitable habitat for Brolga to breed at the site. Southern cane-grass grows rapidly in response to rainfall or flooding. It flowers between September and May in response to rainfall. It tolerates a flooding duration of 1-6 months at an approximate depth between 10-50cm and a flooding frequency of 2-3 years.

3.3 WETLAND DEPLETION AND RARITY

Victoria's wetlands are currently mapped and are contained in a state wetland database, using an accepted state-wide 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 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).

Gaynor Swamp is currently classified as a deep freshwater marsh. Over 70 per cent of deep freshwater marsh area has been lost since settlement (EA, 2001). Within the Goulburn Broken Catchment deep freshwater marshes have declined by 60 per cent in area since settlement (GBCMA, 2006).

The conservation and protection of these areas is imperative for the flora and fauna that rely on them as breeding, feeding and roosting sites.

3.3.1 ECOSYSTEM FUNCTIONS

Wetlands are known to provide a number of ecosystem functions in the broader landscape. Key amongst these are:

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

The water regimes recommended in this plan will enhance the role of Gaynor Swamp in the Cornella Creek system, particularly in providing a breeding ground for waterbirds, particularly Brolga.

Gaynor 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).

The drainage area comprises three-sub catchments including the Cornella Creek system, Wanalta Creek and tributaries, and Woolwash Depression (DPI, 2007b). The Cornella Creek system is the main water source for Gaynor Swamp and has a catchment area of 354km$^{2.}$

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

3.4 SOCIAL VALUES

3.4.1 CULTURAL HERITAGE

Due to the absence of any known defined traditional owner group, responsibility for Caring for our Country at Gaynor Swamp is shared between current Registered Aboriginal Parties (Figure 10) ; Yorta Yorta Nation Aboriginal Corporation to the north, Taungurung Clans Aboriginal Corporation to the south and Dja Dja Wurrung Clans to the west (Sutherland, 2012). Gaynor 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 harvested. The site is also close to a known Aboriginal quarry on the Camel Ranges where greenstone was obtained for use in the manufacture of stone axes (Sutherland, 2011). Evidence of past occupation includes Aboriginal Mounds and Artefact scatters and an Aboriginal Scar tree along the Cornella Creek and at Lake Cooper. Gaynor Swamp and the surrounding wetland and creek areas are considered areas of cultural sensitivity (Figure 11).

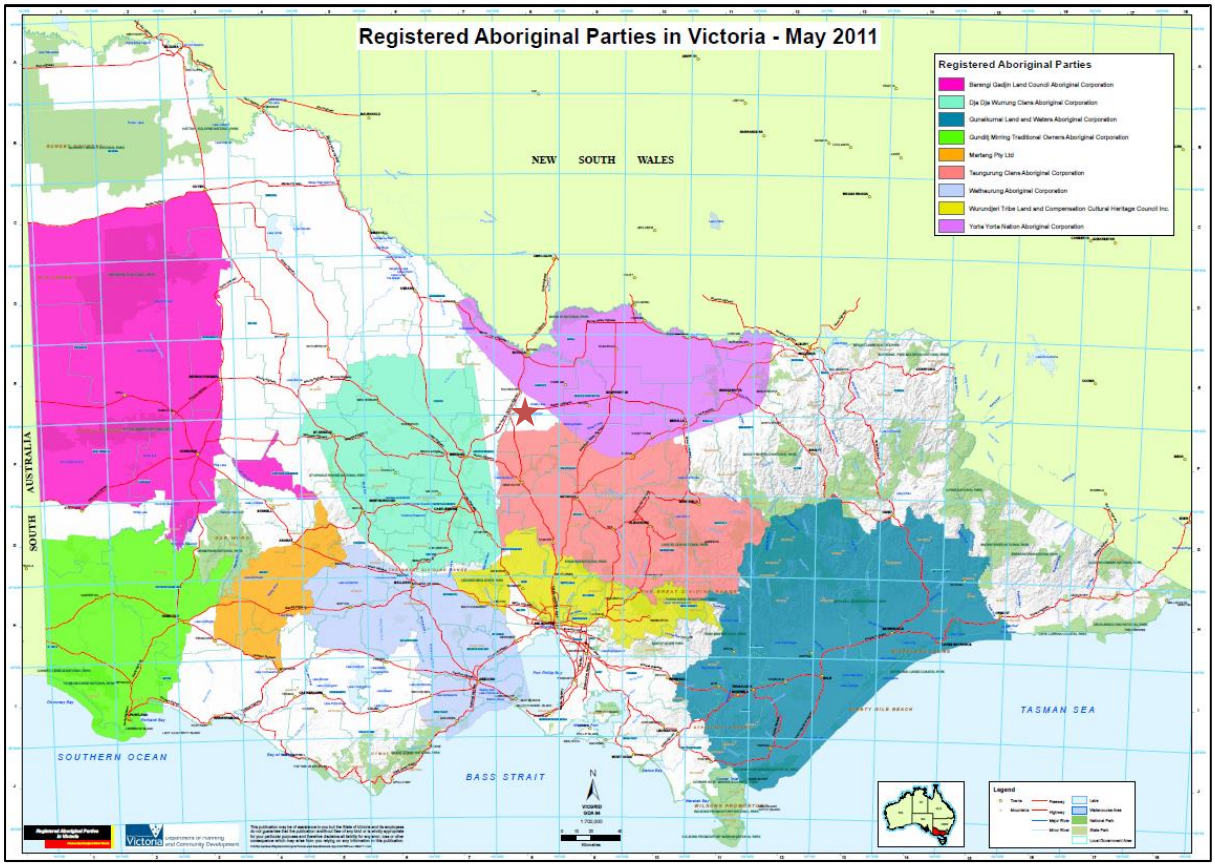

Figure 10: Registered Aboriginal Parties in Victoria (note: location of Gaynor Swamp identified by Red Star).

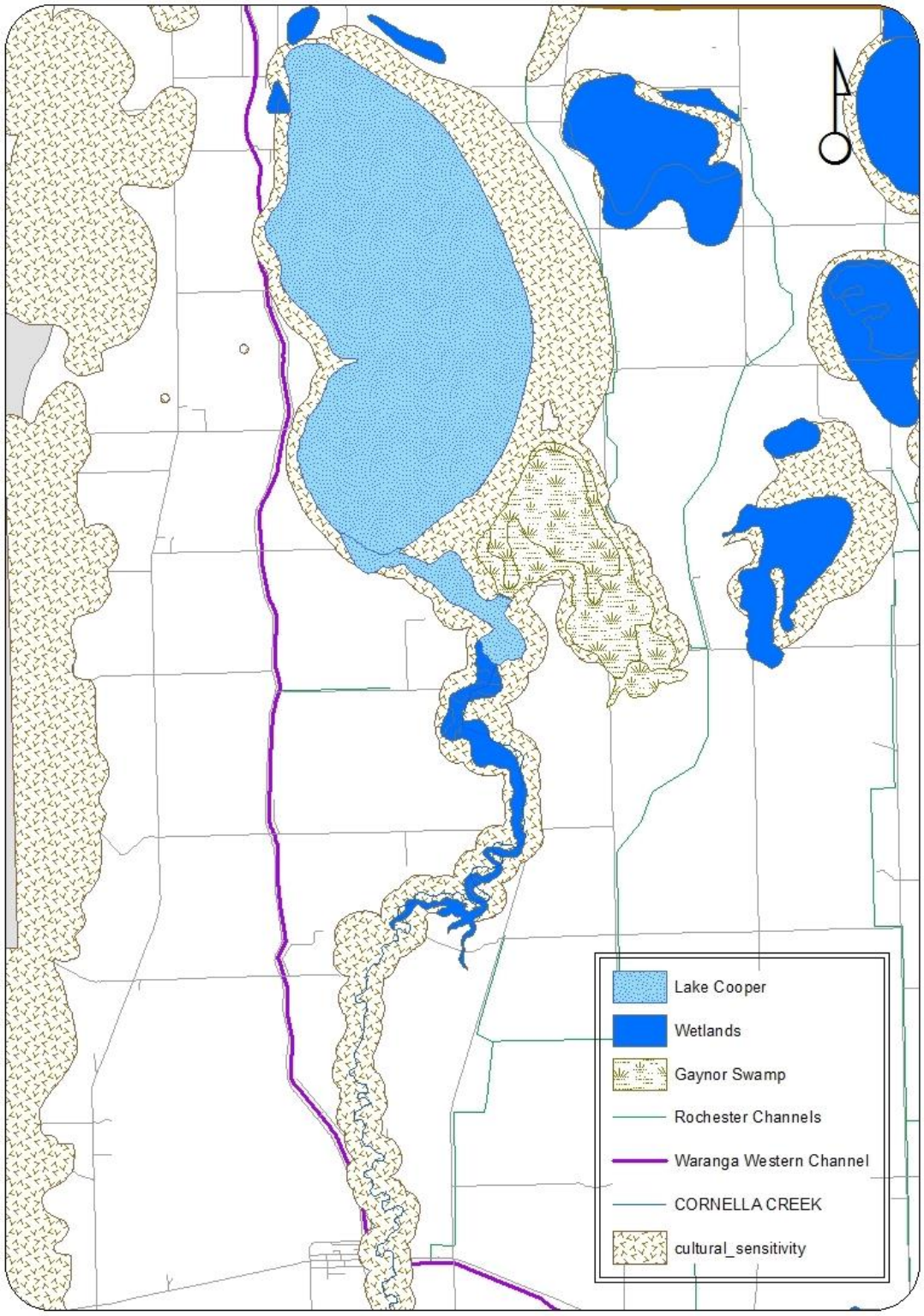

Figure 11: Culturally sensitive areas surrounding Gaynor Swamp.

3.4.2 RECREATION

Activities enjoyed by visitors to Gaynor 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. Hunting in season is permitted at the site as it is classified as Natural Features Reserve – Wildlife Area.

3.5 ECONOMIC VALUES

Wetlands provide both direct and indirect economic values to the Goulburn Broken Catchment (Cork et al., 2001) . The direct economic values that Gaynor Swamp provides include non-consumptive uses such as tourism and recreation. Indirect economic values that Gaynor 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, Gaynor Swamp was a shallow freshwater marsh fed by inflows from the Cornella Creek. Once Lake Cooper approached capacity, water backed up the lower reach of the Cornella Creek and equilibrated with the water level within Gaynor Swamp, making it one waterbody. A smaller depression situated in the south-east corner of Gaynor Swamp also entered Gaynor Swamp during large flood events (DPI, 2010, DCE, 1993).

In the 100 years between 1860 and 1961 the Lake Cooper- Gaynor Swamp system was recorded to have filled to overflowing eleven times and on several occasions between 1961 and 1978 (Corrick and Cowling, 1978). This indicates Gaynor Swamp fills to capacity (simultaneously with Lake Cooper under natural conditions) and overflows approximately 1 in 10 years (once Gaynor Swamp reaches capacity, water flows north via a natural depression to Horseshoe Lake) and with partial watering every 1 in 3 years. Flows into the wetland would have occurred during autumn and spring. The swamp would have dried over the summer in most years (DPI, 2010).

4.1.2 POST-REGULATION

Europeans settled in the Corop area in the 1840s – 1870s. Gaynor Swamp was named after John Gaynor that owned land at the southern end of the Swamp (Anon, 1927). Gaynor Swamp hydrology majorly changed when irrigation was introduced to the area between the 1940s and 1950s. This resulted in prolonged inundation causing the swamp to become a semi-permanent deep freshwater marsh and resulted in the death of southern cane-grass (*Eragrostis infecunda*) and river red gums (*Eucalyptus camaldulensis*) at the site (DPI, 2010, DCE, 1993). Gaynor Swamp was freehold land until 1976-77 when it was purchased for wildlife preservation; in 1978 parts of the swamp were reserved under the *Crown Lands Act* 1978. In 1986 all parcels of land in the Gaynor Swamp reserve were transferred to Crown land and reserved for management (DPI, 2010). During 1995-1996 a regulating structure was constructed on the southern end of Gaynor Swamp where backflow from Lake Cooper enters the swamp. This was

constructed to prevent saline water from Lake Cooper entering Gaynor Swamp. A Victorian Environmental Assessment Council (VEAC) in 2009 deemed Gaynor Swamp a Natural Features Reserve – Wildlife Area (VEAC, 2008).

4.1.3 WETLAND VOLUME

Gaynor Swamp is 303 hectares in size and has an average depth of approximately 0.95m. Therefore, the volume of the swamp equates to approximately 2878.5 ML. When dry the amount of water required to inundate the swamp to the desired depth may be twice its volume due to delivery losses and the water required to saturate the soil profile of the swamp.

4.1.4 ENVIRONMENTAL WATER

Environmental water has not been delivered to Gaynor Swamp. Potential options for delivering water includes the Cornella Creek by releasing water from the Waranga Western Main channel into the Creek, however a regulator or bank on the Creek before it reaches Lake Cooper is mandatory to divert water into Gaynor Swamp (Paynter, 2010). Backbone channel 16, which runs along the eastern side of the swamp is also a possible delivery point for environmental water, however, due to capacity constraints would only be a viable option for flows used to “top up” the wetland when it already wet. Section Eight – Environmental Water Delivery Structure discusses options for Environmental water delivery to Gaynor Swamp. Potential sources of environmental water are presented in Appendix 3.

5. THREATS AND CONDITION

5.1 WATER DEPENDENT THREATS

The key threats to the values of Gaynor 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 their impacts an integrated approach is therefore required.

Altered water regime – Hydrology is the most important component of wetland ecosystems. It drives the physical and chemical properties of a wetland and the biota it supports. As described in section 4 – Hydrology, the natural hydrological regime of Gaynor Swamp has been significantly altered by the introduction of irrigated agriculture post World War II, causing changes to the hydrological regime of the Cornella Creek.

Altered physical form – Physical form means the area and bathymetry of a wetland. The area of Gaynor Swamp has been reduced by drainage and excavation beginning in the late 1940s (post World War II) and continuing up until the late 1970s before the land was purchased for wildlife purposes. Future impacts on the physical form of the swamp are unlikely to occur due to the protection provided by its current landholders.

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 Gaynor Swamp may be impacted by:

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

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

- Human visitation (walking off designated tracks into the wetland body)
- Carp disturbance in high flood events when the wetland connects with the Cornella Creek allowing Carp to move into the wetland.
- Salt discharge from groundwater.

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 59 environmental weeds have been recorded at the site comprising 13 wetland species (Cook, 2012b, DPI, 2010). Of these species, three are listed on the *Catchment Land Protection* Act (1994) and includes St Barnaby's Thistle (*Centaurium solstitialis*), Spear Thistle (*Cirsium vulgare*) and Bathurst Burr (*Xanthium spinosum*). Toowomba Canary Grass (*Phalaris aquatica*) is classified as a very high threat weed on the *DSE advisory list of Environmental Weeds* (DSE, 2009a) pose the greatest risk to the site due to its ability to outcompete aquatic native flora species. The native 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. Pest animals recorded at Gaynor Swamp include:

- Fox (*Vulpes vulpes*) predation on Brolgas. 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 (*Cyprinus carpio*), Goldfish (*Carassius auratus*), Gambusia (*Gambusia holbrooki*) and Redfin Perch (*Perca fluviatilus*) have been recorded in the Cornella Creek and will possibly move into Gaynor Swamp during high flows.

Pest management issues will need to be considered during time of environmental water delivery or during natural flooding events to ensure waterbirds increase their chances of successful breeding and fledging.

5.2 CURRENT CONDITION

The condition of Gaynor Swamp was assessed in December 2009 using a method developed by DSE called the Index of Wetland Condition (IWC; Appendix 8). 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 overall IWC score for Gaynor Swamp in December 2009 was four out of ten, which is considered to be poor (Table 6). Of note, the subindices wetland catchment and biota were considered to be in very poor and poor condition respectively. Wetland catchment was considered to be poor due to an average buffer width of >0-5m and a low percentage of the wetland having a buffer. Biota was scored very poor possibly due to a majority of vegetation structure being wild oats (*Avena barbata*). The IWC was undertaken when Gaynor Swamp had been in dry phase for approximately 13 years. Since the IWC was undertaken, the Swamp has been flooded in 2010, 2011 and 2012. This has caused major changes to the vegetation structure within the wetland and aquatic species now dominate the swamp (see section 3.2 – Flora Vegetation Communities).

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

IWC subindex	Score	Condition category
Wetland catchment	4.5/20	Poor
Physical form	16/20	Good
Hydrology	10/20	Moderate
Water properties	13.6/20	Good
Soils	9.5/20	Moderate
Biota	4/20	Very Poor
Overall IWC Score	**4/10**	**Poor**

5.3 CONDITION TRAJECTORY

Ongoing management including the delivery of environmental water and continued monitoring of Gaynor Swamp is critical to protecting the ecological values at the Swamp. If no intervention occurs, Gaynor Swamp will receive water primarily via the Cornella Creek when Lake Cooper partially fills as well as a secondary depression during high flows. With an increasingly dry climate this may occur less frequently than appropriate for 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 water management goal of Gaynor Swamp is derived from sources including information from the Draft Gaynor Swamp Environmental Wetland Management Plan (DPI, 2010), local expertise and knowledge. The goal considers the overall values the swamp supports. This includes consideration of the aquatic dependent values the swamp has historically supported and the likely aquatic dependent values it could support into the future considering climate change.

Gaynor Swamp water management goal

"To provide a more natural hydrological regime that supports Red Gum Swamp and Freshwater Lignum – Cane Grass Swamp EVCs and habitat for significant waterbird and flora species"

The goal for Gaynor Swamp is to deliver a hydrological regime that supports the desired EVCs.

6.2 ECOLOGICAL AND HYDROLOGICAL OBJECTIVES

6.2.1 ECOLOGICAL OBJECTIVES

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

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

The ecological objectives for Gaynor Swamp are based on values that the wetland provides for the larger Cornella Creek Catchment and on a local scale for 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 its ability to support frog and waterbird breeding. The ecological objectives for Gaynor Swamp are:

- Reinstate the diversity of native wetland flora species to be consistent with Red Gum Swamp and Freshwater Lignum – Cane Grass Swamp EVC benchmarks.
- Reduce the cover and diversity of exotic flora species.
- Reinstate populations of Spiny Lignum (*Muehlenbeckia horrida subsp.horrida*) and Salt Paperbark (*Melaleuca halmaturorum subsp.halmaturorum*).
- Maintain or increase the diversity and abundance of frog species supported by the wetland during flood events.
- Provide breeding habitat for significant waterbird species especially Brolga during flooding events.

Justification for these ecological requirements is given in Table 7 and Appendix 5, 9 and 10.

Table 7: Ecological requirements for Gaynor Swamp

Ecological Objective	Justification (Value based)
Reinstate the diversity of native wetland flora species to be consistent with Red Gum Swamp and Freshwater Lignum – Cane Grass Swamp EVC benchmarks*.	Increase habitat and food sources for native fauna. Increase biodiversity.
Reduce the cover and diversity of exotic and/ or highly invasive native flora species.	Exotic plant species present at Gaynor Swamp notably Toowoomba Canary-grass and the highly invasive native Water Couch, are believed to be outcompeting native wetland plants.
Reinstate populations of Spiny Lignum and Salt Paperbark #	Gaynor Swamp has the most south-eastern population recorded of these species.
Maintain or increase the diversity and abundance of frog species supported by the wetland during flood events^.	Gaynor Swamp is relatively rich in frog species as four have been recorded (Appendix 5).
Provide opportunities for waterbird breeding especially Brolga during flood events.	Gaynor Swamp has supported breeding populations of Brolga. Ensure Mudflat, shallow and deep areas support feeding requirements for significant waterbirds.

*Refer to Appendix 9. # This objective is included although watering regimes and ecological information for both species is not known well enough to include specific requirements. ^ Refer to appendix 10.

6.2.2 HYDROLOGICAL OBJECTIVES

Consistent with the management goal and the ecological objectives above, the optimum water regime for Gaynor 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 more natural hydrological regime will encourage the restoration of the original Red Gum Swamp. A watering regime of 5 in 10 years in late autumn – spring will suit Freshwater Lignum – Cane Grass Swamp EVCs, and reduce the abundance and distribution of aquatic weeds. This coincides with Brolga, Royal Spoonbill and Eastern Great Egret breeding, hence water delivery may need to be extended into summer in order to avoid birds abandoning nests and drawdown should be slow. Monitoring will be needed in order to determine how long water should be held within the swamp. Soil should be kept moist for a duration of 12-18 months if establishment of river red gum seedlings is desired (Committee, 2011). Watering the wetland every 5 in 10 to 7 in 10 years will allow submerged aquatic species to germinate, grow and reseed.

To reintroduce and promote growth of the state threatened Spiny Lignum and Salt Paperbark environmental water delivery should coincide with watering River Red Gum and Freshwater Lignum-Cane Grass Swamp EVCs. Due to the lack of research and literature on Spiny Lignum and Salt Paperbark it is difficult to determine a singular watering regime for these species. Increased research and monitoring of these species should occur to better understand their lifecycle, preferred watering regime and tolerance to flooding duration (Section 9 – Recommendations).

Table 8: Hydrological and ecological requirements for Gaynor 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]	2878.5	Variable to 950mm
Improve the diversity of native wetland flora species to be consistent with Freshwater Lignum-Cane Grass EVC benchmarks.	Wetland body and riparian zone	1-3	3-5	10	6-8	6-9	8-36	2-3	6-8	8-9	Late Autumn – Spring	2878.5	Variable to 950mm
Provide opportunities for waterbird breeding.	Wetland body	5	5	10	6	9	12	2	6	NA	Spring	2878.5[3,4]	Maximum of 950mm
Maintain or increase the diversity and abundance of frog species.	Wetland fringe and body	NA	NA	NA	NA	NA	12[5]	2	2-6	NA	Spring-Summer[6]	2878.5	Variable to 950mm

1. Red Gums have been used as the main indicator plant for this watering regime. Red Gums should not be wet for more than two consecutive summers (Barlow, 2011).
2. More growth achieved for Red Gums if flooded during spring-summer (Roberts and Marston, 2011).
3. (Rogers and Ralph, 2011, Young, 2003).
4. Water depth should be kept fairly constant if waterbirds are nesting/ breeding to avoid nests being abandoned (Young 2003).
5. This is estimation only as research on frog survival in dry wetlands for extended periods is limited.
6. (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 one to three flooding events in ten years. Fill wetland to variable depths to provide River Red Gum and Freshwater Lignum-Cane Grass EVCs with minimum water requirements to allow survival of existing vegetation.

Optimum watering regime

Provide three -seven flooding events in ten years. Fill wetland to variable depths to provide River Red Gum and Freshwater Lignum-Cane Grass 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 Freshwater Lignum-Cane Grass EVCs vegetation or encourage breeding opportunities for aquatic biota.

Filling the wetland to full supply level is not always desired. Flooding Gaynor Swamp to variable depths will promote increased plant diversity and drawing down the wetland slowly will allow the habitat to change, resulting in different vegetation communities establishing within the wetland body. This will assist in meeting the EVC benchmarks required to restore Gaynor 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 12).

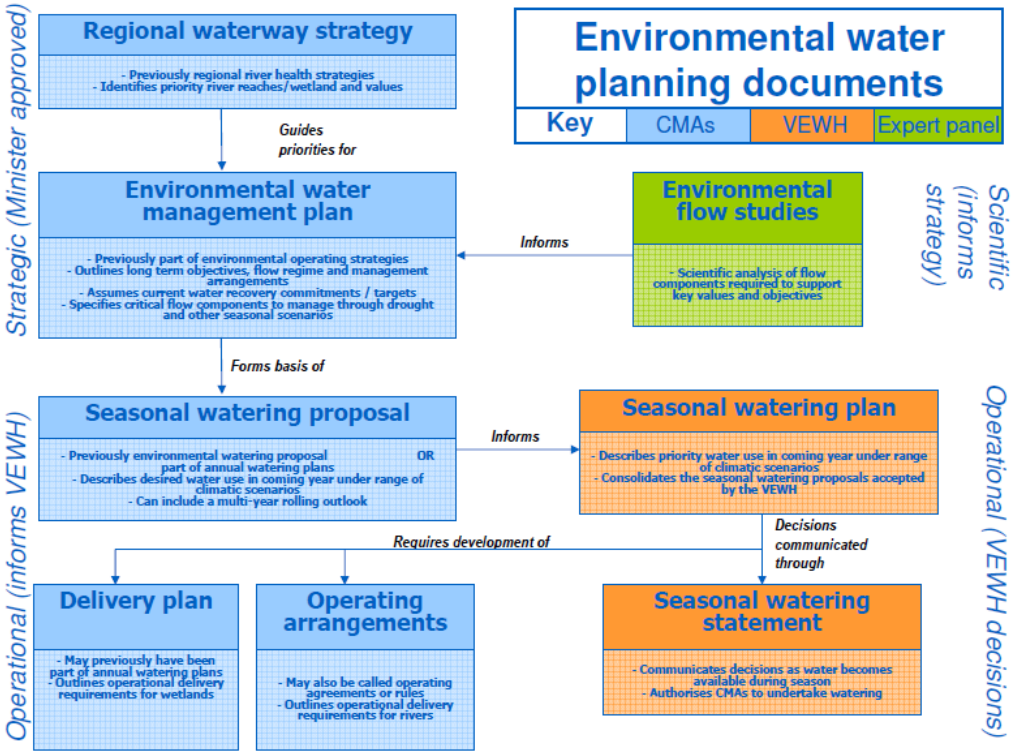

Figure 12: Flow chart for Environmental water planning

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 Gaynor 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 Gaynor 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.
- 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, which may not coincide with the desired timing.
- 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 a significant rainfall event occurs after an environmental water delivery, or water cannot be delivered within a sufficient time frame.
- Poor water quality. Water in the Cornella Creek or the channel system may have low dissolved oxygen, high turbidity, increased salinity and nutrient levels when adding environmental water to Gaynor Swamp. Flooding wetlands that have accumulated large amounts of organic material can also lead to low dissolved oxygen.
- Pest plant and animal invasion. Aquatic pest plants and pest animals can 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 Gaynor Swamp

#	Risk	Description	Potential Impacts								Mitigation
			Environmental					Social		Economic	
			Fish *Water regime does not support breeding and feeding requirements*	**Birds** *Water regime does not support breeding and feeding requirements*	**Amphibians** *Water regime does not support breeding and feeding requirements*	**Invertebrate** *Water regime does not support breeding and feeding requirements*	**Native aquatic flora** *Watering requirement does not support establishment and growth.*	Reduced public access and use	Degradation of cultural heritage sites	Flooding of adjacent land	
1	Required watering regime not met	Flood duration too long or short		✔	✔		✔				Determine environmental water requirements based on seasonal conditions and to support potential bird breeding events Monitor flood duration to inform environmental water delivery Monitor the ecological response of the wetland to flooding Add or drawdown water where appropriate or practical
		Flood timing too late or early		✓	✓		✓	✓			Liaise with Goulburn-Murray Water to seek optimum timing of water delivery Monitor flood timing to inform environmental water delivery Monitor the ecological response of the wetland to flooding
		Flooding depth too shallow or deep		✓			✓	✓	✓	✓	Determine environmental water requirements based on seasonal conditions and to support potential bird breeding events Monitor flood depth to inform environmental water delivery Liaise with adjoining landowners prior to and during the delivery of environmental water to discuss and resolve potential or current flooding issues

		Flood frequency		✓	✓	✓	✓	✓			Prioritise water requirements of wetlands in seasonal watering proposals according to their required water regimes and inundation history Monitor the condition of the wetland Monitor the ecological response of the wetland to flooding
2	Poor water quality	Low dissolved oxygen	✓	✓			✓				Monitor dissolved oxygen levels and the ecological response of the wetland to flooding Add or drawdown water where appropriate or practical
		High turbidity	✓				✓				Monitor turbidity levels and the ecological response of the wetland to flooding Add or drawdown water where appropriate or practical
		High water temperature	✓				✓				Monitor water temperature and the ecological response of the wetland to flooding Add or drawdown water where appropriate or practical
		Increased salinity levels	✓		✓	✓	✓				Monitor salinity levels and the ecological response of the wetland to flooding Add or drawdown water where appropriate or practical
		Increased nutrient levels									Monitor nutrient and Blue Green Algae levels, and the ecological response of the wetland to flooding Place public warning signs at the wetland if BGA levels are a public health risk
		Increased organic matter	✓				✓				Implement the required water regime
3	Pest aquatic plant and animal invasion	Introduction of pest fish	✓		✓	✓	✓				Monitor the ecological response of the wetland to flooding Install a carp screen Implement an appropriate drying regime

		Growth and establishment of aquatic pest plants	✓	✓	✓	✓	✓				Monitor the abundance of native and pest aquatic plants Control pest plants in connected waterways Spray or mechanically remove pest plants Implement an appropriate drying regime

8. ENVIRONMENTAL WATER DELIVERY INFRASTRUCTURE

8.1 CONSTRAINTS

Environmental water could be delivered to Gaynor Swamp via the Cornella Creek if a diversion structure was constructed on the creek before water entered Lake Cooper. This would allow water to flow into Gaynor Swamp rather than flowing into Lake Cooper (section 8.3 – Infrastructure recommendations). Constraints posed by the existing arrangements at the Swamp include:

- Flow volume – Existing channel structures such as Channel 16 do not have the capacity to deliver large amounts of water to the swamp.
- Flow duration – Timing of flows and if the system can be run high enough for time allocated to fill the swamp.
- Irrigation demands – Gaynor Swamp has a small delivery share, however large amounts of environmental water can only be delivered during the irrigation season and when there is spare capacity to carry water in the irrigation channels and the Cornella Creek.

8.2 IRRIGATION MODERNISATION

The Northern Victoria Irrigation Renewal Project (NVIRP) is a $2 billion works program to upgrade ageing irrigation infrastructure across the Goulburn-Murray Irrigation District 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 – Gaynor Swamp”(Paynter, 2010) report was developed by Goulburn-Murray Water to determine the most efficient way to deliver environmental water to the swamp using backbone channels and existing infrastructure that will not be rationalised.

8.3 INFRASTRUCTURE RECOMMENDATIONS

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

The most effective method for delivering environmental water is via the Waranga Western Main Channel off-take at Cornella Creek. This is via delivery from the Cornella Creek and makes the best of natural flows, providing benefits to both the creek and swamp. Works would include:

- Automated gates on the Waranga Western Main Channel offtake;
- Construction of a bank and regulator on the Cornella Creek;
- Modification of the isolation bank;

This would allow large volumes of water to be delivered directly to the wetland. Provision of supplementary flows to Gaynor Swamp could be conducted by utilising Channel 16 (Figure 13). This would have the benefit of allowing a partially filled swamp to be topped up or sustained by additional flow from the channel, without the losses associated with running water down the Cornella Creek (Paynter, 2010).

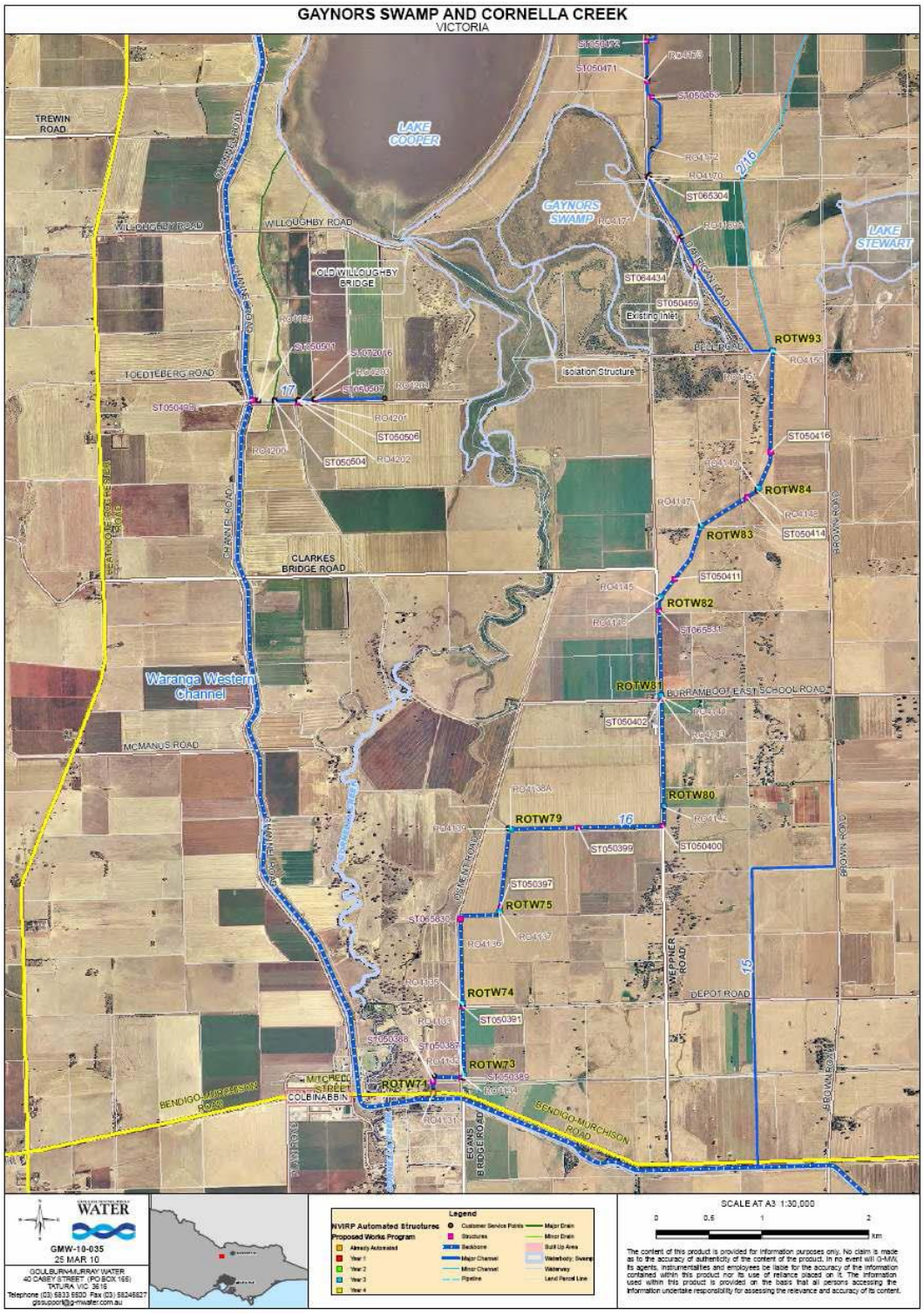

Figure 13: Environmental Water delivery options to Gaynor Swamp

Map image taken from Scoping study report (Paynter, 2010).

9. KNOWLEDGE GAPS AND RECOMMENDATIONS

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

Recommendation	Justification
Monitor sites environmental conditions and issues that may pose threats.	Monitoring of the sites environmental conditions and issues that may pose threats. This includes monitoring species such as the native water couch and exotic species such as Toowoomba Canary-grass when conditions are deemed favourable for their prolific growth. This monitoring should continue on a long-term basis ensuring control of these plants. Pest animals should be monitored and prevention/eradication should occur where possible. Investigation of management options for exotic fish species entering Gaynor Swamp should occur.
Simulate the natural hydrological regime to provide ecological benefits.	Deliver environmental water on average every 5 years in 10 if climatic conditions do not naturally fill the wetland.
Monitor water quality in Gaynor Swamp	During environmental water delivery, monitor water quality to ensure nutrient loads and salinity levels do not reach critical levels.
Undertake a risk management matrix	Undertake risk management matrix before delivery of environmental water to Gaynor Swamp
Undertake macroinvertebrate population survey at Gaynor Swamp	Macroinvertebrate populations at Gaynor Swamp are not well understood or studied.
Undertake an Index of Wetland Condition	The last index of wetland condition was undertaken during an extremely dry phase. An index of wetland condition should also be undertaken during a wet phase of the wetland to compare results.
Undertake fish population surveys at Gaynor Swamp	Fish populations at Gaynor Swamp are not well understood or studied.

The following list describes knowledge gaps that occur at Gaynor Swamp.

Knowledge Gap	Justification
Research the ecology and water requirements of Salt Paperbark and Spiny Lignum	Little is known about the biological functions of Salt Paperbark and Spiny Lignum. Research into the biology, water requirements and functions of these species will give a better understanding of how to maintain and protect these populations.

10. GLOSSARY

Alluvium
A general term for clay, silt, sand, gravel or similar unconsolidated detrital material, deposited during comparatively recent geological time by a stream or other body of running water, as a sorted or semi-sorted sediment (USGS, 2011).

Calcareous
Meaning mostly or partly composed of calcium carbonate, in other words, containing lime or being chalky. The term is used in a wide variety of scientific disciplines (Anon, 2012a).

Complex
A conceptual whole made up of complicated and related parts.

Delivery Share
An entitlement to have water delivered to land in an irrigation district and a share of the available water flow in a delivery system.

High-reliability water share
A water share against which seasonal allocations made as a first priority. High reliability shares are expected to reach 100% allocation in 95 years out of 100.

Lacustrine
Relating to a system of inland wetlands and deep-water habitats associated with freshwater lakes and reservoirs (DR, 2012).

Low-reliability water share
A water share with a relatively low reliability of supply. In Northern Victoria these shares will be at the available water once there is enough water to meet higher-reliability water shares in the current year, and, with minimum inflows, to meet higher-reliability water shares from the following year.

Paludal
Sediments that have accumulated in a marsh environment (Anon, 2012b).

Quaternary
A geological age - the 2.6 million years of the Quaternary represents the time during which recognizable humans existed (USGS, 2011).

Water Share
A legally recognised, secure share of the water available for use in a defined or declared water system. A water share is specified as a maximum volume of seasonal allocation that may be made against that share. Water shares may be high-reliability or low-reliability.

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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) is to be established in June 2011. VEWH will be responsible for holding and managing Victorian environmental water entitlements and allocations and deciding upon their best use throughout the State. The environmental entitlements held by 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 Goulburn Murray Water Connection Environmental Water Entitlements - One third of water savings from Stage 1 of the GMW Connections 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 GMW Connections 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.

***Environmental Protection Biodiversity 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)

***Crowns 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 Gaynor Swamp – taken from Victorian Fauna Database 2010, DRAFT Environmental Management Plan 2010 (DPI), and D. Cook 2012 counts.

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

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

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

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

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

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

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

re = Listed as regionally extinct on the DSE Advisory list of threatened vertebrate fauna (2007)

w Water dependant species or Waterbirds

b Observed breeding at the Swamp

Common Name	Scientific Name	EPBC	FFG	VROTS	Origin and guild
BIRDS					
Australasian Bittern	*Botaurus poiciloptilus*	E	L	en	w
Australasian Darter	*Anhinga novaehollandiae*				w
Australasian Grebe	*Tachybaptus novaehollandiae*				w
Australasian Pipit	*Anthus novaeseelandiae*				
Australasian Shoveler	*Anas rhynchotis*			vu	w
Australian Little Bittern	*Ixobrychus dubius*		L	en	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 Spotted Crake	*Porzana fluminea*				w
Australian White Ibis	*Threskiornis molucca*				w
Australian Wood Duck	*Chenonetta jubata*				w
Black Falcon	*Falco subniger*			vu	
Black Swan	*Cygnus atratus*				w
Black-chinned Honeyeater	*Melithreptus gularis*			nt	
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*				
Black-faced Wood-swallow	*Artamus cinereus*				*Not usually found in this region. Sited 2011.M. Ramsey*
Black-fronted Dotterel	*Elseyornis melanops*				w
Black-tailed Native-hen	*Gallinula ventralis*				w
Black-winged Stilt	*Himantopus himantopus*				w
Blue-billed Duck	*Oxyura australis*		L	en	w
Brolga	*Grus rubicunda*		L	vu	w
Brown Falcon	*Falco berigora*				
Brown Goshawk	*Accipiter fasciatus*				

Brown Quail	*Coturnix ypsilophora australis*			nt	
Brown Treecreeper	*Climacteris picumnus*			nt	
Bush-stone Curlew	*Burhinus grallarius*		L	en	
Caspian Tern	*Hydroprogne caspia*		L	nt	w
Cattle Egret	*Ardea ibis*				w
Chestnut Teal	*Anas castanea*				w
Crested Pigeon	*Ocyphaps lophotes*				
Crested Shrike-tit	*Falcunculus frontatus*				
Dusky Moorhen	*Gallinula tenebrosa*				w
Dusky Woodswallow	*Artamus cyanopterus*				
Eastern Great Egret	*Ardea modesta*		L	vu	w
Eastern Rosella	*Platycercus eximius*				
Eurasian Coot	*Fulica atra*				w
Freckled Duck	*Stictonetta naevosa*		L	en	w
Galah	*Eolophus roseicapilla*				
Glossy Ibis	*Plegadis falcinellus*			nt	w
Golden Whistler	*Pachycephala pectoralis*				
Golden-headed Cisticola	*Cisticola exilis*				
Great Cormorant	*Phalacrocorax carbo*				w
Great Crested Grebe	*Podiceps cristatus*				w
Grey Shrike-thrush	*Colluricincla harmonica*				
Grey Teal	*Anas gracilis*				w
Hardhead	*Aythya australis*			vu	w
Hoary-headed Grebe	*Poliocephalus poliocephalus*				w
Intermediate Egret	*Ardea intermedia*		L	cr	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*				
Masked Lapwing	*Vanellus miles*				w
Musk Duck	*Bizura lobata*			vu	w
Pacific Black Duck	*Anas superciliosa*				w
Pied Butcherbird	*Cracticus nigrogularis*				
Pink-eared Duck	*Malacorhynchus membranaceus*				w
Purple Swamphen	*Porphyrio porphyrio*				w
Red-necked Avocet	*Recurvirostra novahollandiae*				w
Red-rumped Parrot	*Psephotus haematonotus*				
Restless Flycatcher	*Myiagra inquieta*				
Royal Spoonbill	*Platalea regia*			vu	w
Sacred Kingfisher	*Todiramphus sanctus*				w
Sharp-tailed Sandpiper	*Calidris acuminate*				w

Silver Gull	*Chroicocephalus novaehollandiae*				w
Spotless Crake	*Porzana tabuensis*				w
Straw-necked Ibis	*Threskiornis spinicollis*				w
Stubble Quail	*Coturnix pectoralis*				
Superb Fairy-wren	*Malurus cyaneus*				
Sulphur-crested Cockatoo	*Cacatua galerita*				
Striated Pardalote	*Pardalotus striatus*				
Swamp Harrier	*Circus approximans*				w
Tree Martin	*Petrochelidon nigricans*				
Wedge-tailed Eagle	*Aquila audax*				
Welcome Swallow	*Hirundo neoxena*				
Western Gerygone	*Gerygone fusca*				
Whiskered Tern	*Childonias hybridus*			nt	w
Whistling Kite	*Haliastur sphenurus*				w
White-bellied Sea-Eagle	*Haliaeetus leucogaster*		L	vu	w
White-faced Heron	*Egretta novaehollandiae*				w
White-necked Heron	*Ardea pacifica*				w
White-plumed Honeyeater	*Lichenostomus penicillatus*				
Willie Wagtail	*Rhipidura leucophrys*				
Yellow-billed Spoonbill	*Platalea flavipes*				w
NATIVE FISH					
Murray Cod*	*Maccullochella peelii peelii*	Vu	L	en	w
FROGS					
Common Froglet	*Crinia signifera*				Moist depressions
Peron's Tree Frog	*Litoria peronii*				Wet and Dry areas
Plains Froglet	*Crinia parinsignifera*				Moist depressions
Spotted Marsh Frog	*Limnodynastes tasmaniensis*				Common in farm dams and wetlands
MAMMALS					
Brush-tailed Phascogale	*Phascogale tapoatafa*		L	vu	
Common Ringtail Possum	*Pseudocheirus peregrinus*				
Eastern Grey Kangaroo	*Macropus gigantus*				
Gould's Wattled Bat	*Chalinobus gouldii*				
Koala	*Phascolarcos cinereus*				
Rufous Betong*	*Aepyyprymnus rufescens*		L	re	*Historical record*
Squirrel Glider	*Petaurus norfolcensis*		L	en	
Swamp Wallaby	*Wallabia bicolor*				
REPTILES					
Bandy Bandy	*Vermicella annualta*		L	nt	
Carpet Python	*Morelia spilota variegate*		L	en	
Eastern Bearded Dragon	*Pogona barbarta*			dd	
Eastern Brown Snake	*Pseudonaja textilis*				
Lace Monitor	*Varanus varius*			vu	
Olive Legless Lizard	*Delma inorata*				

INTRODUCED SPECIES					
Black Rat	*Rattus rattus*				
Common Starling	*Sturnus vulgaris*				
English Perch	*Perca fluvitalis*				w
European Carp	*Cyprinus carpio*				w
European Greenfinch	*Carduelis chloris*				
European Goldfinch	*Carduelis caerduelis*				
Feral Cat	*Felis catus*				
House Sparrow	*Passer domesticus*				
Rabbit	*Oryctolagus cuniculus*				
Red Fox	*Vulpes vulpes*				
Spotted Dove	*Streptopelia chinensis*				

*The Murray Cod is a historical record and moved into the swamp from the Cornella Creek in 1895 (Weber, 2011).

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 Gaynor Swamp (www.dse.vic.gov.au).

Cane Grass Wetland [EVC#291]
Species-poor vegetation dominated by Southern Cane Grass occurring in association with seasonal wetlands of low rainfall plains areas, typically on extremely heavy, grey clay soils.

Red Gum Swamp [EVC#292]
Woodland of swampy depressions of lowland plains, with sedgy-herbaceous understory including aquatic species.

Aquatic Herbland [EVC#653]
Semi-permanent to seasonal wetland vegetation, treeless (or nearly so), dominated by herbaceous aquatic species (typically with at least rootstocks tolerant of dry periods).

Freshwater Lignum – Cane Grass Swamp [EVC#954]
Open shrubland to grassy shrubland of *Muehlenbeckia florulenta* and *Eragrostis infecunda* dominated wetland, usually very species poor in central deeper areas, but potentially diverse and herb-rich on the outer fringes.

APPENDIX 7: FLORA SPECIES LIST

Flora list of Gaynor Swamp – taken from Victorian Flora Database 2010, and D. Cook 2012 survey.

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 291	EVC 653	EVC 954/292	EPBC	FFG	VROTS	Origin	Indigenous Use
Hedge Wattle	*Acacia paradoxa*								
Lesser Joyweed	*Alternanthera denticulata s.l.*			✓				w	
Southern Swamp Wallaby-grass	*Amphibromus neesii*							w	
Common Swamp Wallaby-grass	*Amphibromus nervosus*							w	
Common Woodruff	*Asperula conferta*							w	
Berry Saltbush	*Atriplex semibaccata*								
Sprawling Saltbush	*Atriplex suberecta*								
Copper-awned Wallaby-grass	*Austrodanthonia fulva*								
Plump Spear-grass	*Austrostipa aristiglumis*								
Spurred Spear-grass	*Austrostipa gibbosa*						r		
Spear- grass	*Austrostipa sp.*								
Salt Club-sedge	*Bolboshoenus caldwellii*							w	
Lemon Beauty-heads	*Calocephalus citreus*								
Tall Sedge	*Carex appressa*							w	Leaves used in basket making
Common Sedge/ Knob Sedge	*Carex inversa*			✓				w	
Poong'ort / Rush Sedge	*Carex tereticaulis*			✓				w	
Drooping Cassinia	*Cassinia arcuata*								
Spiked Centaury	*Centaurium spicatum*							w	
Flat Spurge	*Chamaesyce drummondii*							#	
Clammy goosefoot	*Chenopodium pumilio*			✓				w	
Windmill Grass	*Chloris truncata*								
Pink Bindweed	*Convolvulus erubescens spp. agg.*								Tap roots made into dough
Rosinweed	*Cressa australis*								
Tall Flat-sedge	*Cyperus exaltatus*							w	
Star Fruit	*Damasonium minus*							w	
Reed Bent-grass	*Deyeuxia quadriseta*								

Climbing Saltbush	*Einadia nutans*								
Common Spike-sedge	*Eleocharis acuta*			✓				w	
Small Spike-sedge	*Eleocharis pusilla*							w	
Grey Willow-herb	*Epilobium billardierianum subsp.cinereum*			✓					
Robust Willow-herb	*Epilobium billardierianum subsp.hydrophilum*							w	
Hairy Willow-herb	*Epilobium hirtigerum*			✓				w	
Spider Grass	*Enteropogon acicularis*								
Cane-grass	*Eragostis australasica*							w	
Southern Cane-grass	*Eragrostis infecunda*	✓		✓				w	
Blue Devil	*Eryngium ovinum*							w	
River Red-gum	*Eucalyptus camaldulensis*			✓				w	
Annual Cudweed	*Euchiton sphaericus*			✓				w	
Slender Goodenia	*Goodenia gracilis*							w	
Rough Raspwort	*Haloragis aspera*								
Bluish Raspwort	*Haloragis glauca*						k	w	
Smooth Heliotrope	*Heliotropium currassavicum*								
Hollow Rush	*Juncus amabilis*							w	
Gold Rush	*Juncus flavidus*			✓				w	
Giant Rush	*Juncus ingens*							w	
Billabong Rush	*Juncus usitatus*							w	
Common Blown-grass	*Lachnagrostis filiformis var.1*			✓				w	
Small-fruit Water-mat	*Lepilaena bilocularis*		✓					w	
Poison Pratia	*Lobelia concolor*			✓				w	
Tall Lobelia	*Lobelia gibbosa*							w	
Poison Lobelia	*Lobelia pratioides*							w	
Small Loosestrife	*Lythrum hyssopifolia*			✓				w	
Common Nardoo	*Marsilea drummondii*			✓				w	
Salt Paperbark	*Melaleuca halmaturorum subsp. halmaturorum*					L	v	w	
Tangled Lignum	*Muehlenbeckia florulenta*			✓				w	
Spiny Lignum	*Muehlenbeckia horrida subsp. horrida*						r	w	
Upright Water-milfoil	*Myriophyllum crispatum*			✓				w	
Clustered Water-milfoil	*Myriophyllum glomeratum*							w	
Water-milfoil	*Myriophyllum spp*							w	
Red Water-milfoil	*Myriophyllum verrucosum*	✓	✓					w	
Swamp Lily	*Ottelia ovalifolia subsp. ovalifolia*							w	
Yellow Wood-sorrel	*Oxalis corniculata s.l*								
Grassland Wood-sorrel	*Oxalis perennans*								
Wood-sorrel	*Oxalis spp*								
Warrego Summer-grass	*Paspalidium jubiflorum*							w	
Water Couch	*Paspalum distichum*							w	*Can be very invasive and some classify it is a weed.*
Water Pepper	*Persicaria hydropiper*							w	
Creeping Knotweed	*Persicaria prostrata*							w	
Common Tussock-grass	*Poa labillardierei*								
Fennel Pondweed	*Potamogeton pectinatus*							w	
Jersey Cudweed	*Pseudognaphalium luteoalbum*			✓				w	

Drumsticks	*Pycnosorus globosus*							#	
Slender Dock	*Rumex brownii*							w	
Narrow-leaf Dock	*Rumex tenax*			✓				w	
Brown-back Wallaby-grass	*Rytidosperma duttoniana*			✓				w	
Bristly Wallaby-grass	*Rytidosperma setacea*			✓				w	
Branching Groundsel	*Senecio cunninghamii var. cunninghamii*						r		
Cotton Fireweed	*Senecio quadridentalis*								
Tall Fireweed	*Senecio runcinifiolius*			✓					
Variable Sida	*Sida corrugata*								
Coast Sand-spurrey	*Spergularia media s.l*								
Rat-tailed Couch	*Sporobolus mitchellii*							w	
Grey Germander	*Teucrium racemosum s.l.*							w	
Northern Water-ribbons	*Triglochin multifructa*							w	
Water-ribbons	*Triglochin procerum*							w	
Narrow-leaf Cumbungi	*Typha domingensis*							w	
Cumbungi	*Typha orientalis*							w	
Cumbungi	*Typha spp.*							w	
Woolly New Holland Daisy	*Vittadiani gracilis*								
Tufted Bluebell	*Wahlenbergia communis s.l*								
Rigid Panic	*Walwhalleya proluta*							w	Seeds ground to flour.
Exotic Species									
Camel Thorn	*Alhagi maurorum*								
Aster-weed	*Aster subulata*							w	
Hastate Orache	*Atriplex prostrata*							w	
Bearded Oat	*Avena barbarta*								
Wild Oat	*Avena fatua*			✓					
Soft Brome	*Bromus hordeaceus subsp.hordeaceus*								
Saffron Thistle	*Carthamus lanatus*								
Common Centaury	*Centaurium erythraea*			✓					
St Barnaby's Thistle	*Centaurium solstitialis*								
Slender Centaury	*Centaurium tenuiflorum*								
Common Sneezeweed	*Centipedia cunninghamii*							w	
Spear Thistle	*Cirsium vulgare*			✓					
Flaxleaf Fleabane	*Conyza bonariensis*			✓					
Water Buttons	*Cotula coronopifolia*							w	
Paddy Melon	*Cucumis myriocarpus subsp. leptodermis*								
Couch	*Cynodon dactylon*							w	
Umbrella Sedge	*Cyperus eragrostis*			✓				w	
Big Herons-bill	*Erodium botrys*								
Musky Herons-bill	*Erodium moschatum*								
Common Heliotrope	*Heliotropum europaeum*								
Ox-tongue	*Helminthotheca echioides*								
Mediterranean Barley Grass	*Hordeum histrix*								
Barley Grass	*Hordeum murinum s.l*								
Cat's Ear	*Hypochoeris radiate*								

Spiny Rush	*Juncus acutus subsp. acutus*								
Willow-leaf Lettuce	*Lactuca saligna*								
Prickly Lettuce	*Lactuca serriola*			✓					
Hairy Hawkbit	*Leontodon taraxacoides subsp.taraxacoides*			✓					
Common Peppercress	*Lepidium africanum*								
Wimmera Rye-grass	*Lolium rigidum*			✓					
African Box-thorn	*Lycium ferocissimum*								
Small Loosestrife/ False Loosestrife	*Lythrum hyssopifolium*							w	
Nice Mallow	*Malva parviflora*								
Burr Medic	*Medicago polymorpha*			✓					
Sweet Melilote	*Melilotus indicus*								
Paspalum	*Paspalum*								
Toowoomba Canary-grass	*Phalaris aquatica*							w	
Lesser Canary-grass	*Phalaris minor*								
Paradoxical Canary-grass	*Phalaris paradoxa*							w	
Prostate Knotweed	*Polygonum aviculare*								
Annual Beard-grass	*Polypogon monspeliensis*								
Sweet Briar	*Rosa rubiginosa*								
Clustered Dock	*Rumex conglomeratus*							w	
Curled Dock	*Rumex crispus*			✓				w	
Pepper Tree	*Schinus mollee*								
Cotton Fireweed	*Senecio quadridentatus*								
Tall Fireweed	*Senecio runcinifolius*							w	
Variegated Thistle	*Silybum marianum*								
Black Nightshade	*Solanum nigrum sensu Willis (1972)*								
Rough Sow-thistle	*Sonchus asper s.l*			✓					
Common Sow-thistle	*Sonchus olercea*			✓					
Narrow-leaf Clover	*Trifolium angustifolium var. angustifolium*								
Strawberry Clover	*Trifolium fragiferum var. fragiferum*								
Cluster Clover	*Trifolium glomeratum*	✓							
White Clover	*Trifolium repens var. repens*								
Wheat	*Triticum*							w	
Squirrel-tail Fescue	*Vulpia bromoides*			✓					
Rats-tail Fescue	*Vulpia myuros*								
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 GAYNOR SWAMP

EVC Benchmarks have been determined for Gaynor Swamp by monitoring the site in 2012 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 Freshwater Lignum – Cane Grass Swamp includes: Medium Shrubs (aim to maintain + cover – substantially modified if clearly senescing or with dense regeneration); Small to medium herbs (aim to have 4 species and 5% cover); Cane grass (aim to have 10% cover); Medium tufted grasses and sedges (aim to have 3 species and 5% cover).

For more detailed descriptions of these sites go to www.dse.vic.gov.au and type in Index of wetland condition benchmarks (DSE, 2010).

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

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