One Tree and Two Tree Swamp Environmental Water Management Plan 2011

Goulburn Broken Catchment Management Authority

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EXECUTIVE SUMMARY

This plan outlines the water regimes required to protect and enhance the water dependent environmental values of One Tree and Two Tree Swamps. 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.

One Tree (631 ha) and Two Tree (82 ha) Swamps are shallow and intermittent wetlands dominated by cane grass. They are located 30 km north west of Murchison Township in northern Victoria. The wetlands provide important breeding habitat for Brolga and One Tree Swamp is the largest cane grass dominated wetland in the Goulburn Broken Catchment. The wetlands are part of a hydrologically connected wetland system also comprising Wallenjoe Swamp (359 ha) and Mansfield Swamp (500 ha). The wetlands are managed by Parks Victoria and are listed under the Directory of important Wetlands in Australia as part of the Wallenjoe Wetlands listing. They are valued for the size, rarity, species diversity and waterbird habitat.

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

- protect and improve the diversity of wetland flora specie consistent with the applicable Ecological Vegetation Class benchmarks;
- reduce the cover and diversity of exotic flora species;
- provide opportunities for waterbird breeding especially Brolga at least one in every two years; and
- provide opportunities for native frog breeding at least one in every two years.

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

Watering Regimes for One Tree and Two Tree Swamp

Minimum – *Provide three flooding events every ten years filling wetlands to variable depths up to 400mm to maintain EVCs and provide habitat for aquatic biota.*

Optimum *– Provide five flooding events every ten years filling wetlands to variable depths up to 400mm to promote the regeneration and recruitment of EVCs and encourage breeding of aquatic fauna.*

Maximum *– Provide an annual flooding event over a ten year period, filling wetlands to variable depths up to 400mm to maintain EVCs and to promote breeding opportunities for aquatic biota.*

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

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ACKNOWLEDGEMENTS

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Members of the Scientific Technical Group which comprised Keith Ward (GBCMA), Rolf Weber (DSE), Gary Deayton (Moira Shire), Sam Green (G-MW), Damien Cook (Australian Ecosystems) and Doug Frood (Pathways Bushland and Environment Consultant) for their input and development into the watering plans. Members of the Goulburn Broken Wetland Management Group for their input and comments on DRAFT copies of this report. Jane Roberts and Terry Hillman for their scientific review and valuable insights into writing and Environmental Water Management Plan.

ABBREVIATIONS

CAMBA	China Australia Migratory Bird Agreement
CEWH	Commonwealth Environmental Water Holder
CG	Central Goulburn Channel
CMA	Catchment Management Authorities
DSE	Department of Sustainability and Environment
EC	Electrical Conductivity
EG	East Goulburn Channel
EPBC	*Environment Protection Biodiversity 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
GL	Gigalitre (one billion litres)
GMID	Goulburn-Murray Irrigation District
G-MW	Goulburn-Murray Water
IWC	Index of Wetland Condition
JAMBA	Japan Australia Migratory Birds Agreement
ML	Megalitre (one million litres)
NVIRP	Northern Victoria Irrigation Renewal Project
ROKAMBA	Republic of Korea Australia Migratory Bird Agreement
SKM	Sinclair Knight Mertz
VEWH	Victorian Environmental Water Holder

1. INTRODUCTION

1.1 BACKGROUND

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

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

1.2 PURPOSE

The Victorian Catchment Management Authorities (CMAs) and Department of Sustainability and Environment (DSE) and the Victorian Environmental Water Holder (VEWH) are working together to develop new Environmental Water Management Plans for both current and future environmental watering sites throughout northern Victoria. The primary purpose of the Plans is to provide a consistent set of documents that support Seasonal Watering Proposals to be submitted by CMAs to the Victorian Environmental Water Holder annually. 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 One Tree and Two Tree Swamps in the Goulburn Broken Catchment Management region. This watering plan is not a holistic management plan for the sites, 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.

One Tree and Two Tree Swamps are nationally significant wetlands within the Goulburn Broken Catchment (Figure 1). The wetlands are now known as the One Tree Swamp and Two tree Swamp Nature Conservation Reserve (VEAC, 2008) as Two Tree Swamp has currently had its status changed from Wildlife Reserve to Nature Conservation Reserve in July 2010 in corporation with the One Tree Swamp Nature Conservation Reserve. The wetlands are managed by Parks Victoria and are classified as Shallow freshwater marshes (section 2.3 – wetland characteristics).

One Tree swamp is situated at the terminal end of the Wanalta Creek (Figure 2). The Wanalta Creek originates from the Redcastle State Forest (Figure 3) and terminates at One Tree Swamp (via Groves Weir (section 4 – Hydrology). The Wanalta Creek fills One Tree Swamp fills which overflows into Two Tree Swamp (Figure 4). These wetlands are part of the larger Corop Lakes System (Figure 4). Corop is a derivative of the word *corgarong* meaning call of the Brolga. Brolga (*Grus rubicunda*) utilise One Tree and Two Tree Swamps as breeding and feeding sites.

Prior to European settlement One Tree and Two Tree Swamps were highly utilised by the Ngurai-illam-wurrung people. The swamps were highly fertile Cane-grass (*Eragrostis infecunda*) and River Red Gum (*Eucalyptus camaldulensis*) Swamps, providing food, shelter and medicines for the indigenous people.

Post-European settlement saw Edward Curr purchase the first parcel of land (approximately 100,000 hectares) within the Corop area in 1840. Sheep and Cattle were the main livestock in the area.

In 1995, levee banks to the east of Two Tree Swamp were constructed to protect neighbouring landowners. Existing internal banks were either removed or cut to allow movement of flood waters down the natural depression line.

One Tree swamp was purchased in 2003 by Department of Sustainability and Environment as part of the national reserve system program and is classified as one of the largest Southern Cane-grass (*Eragrostis infecunda*) dominated wetlands.

Figure 1: One Tree and Two Tree Swamp location within the Goulburn Broken Catchment

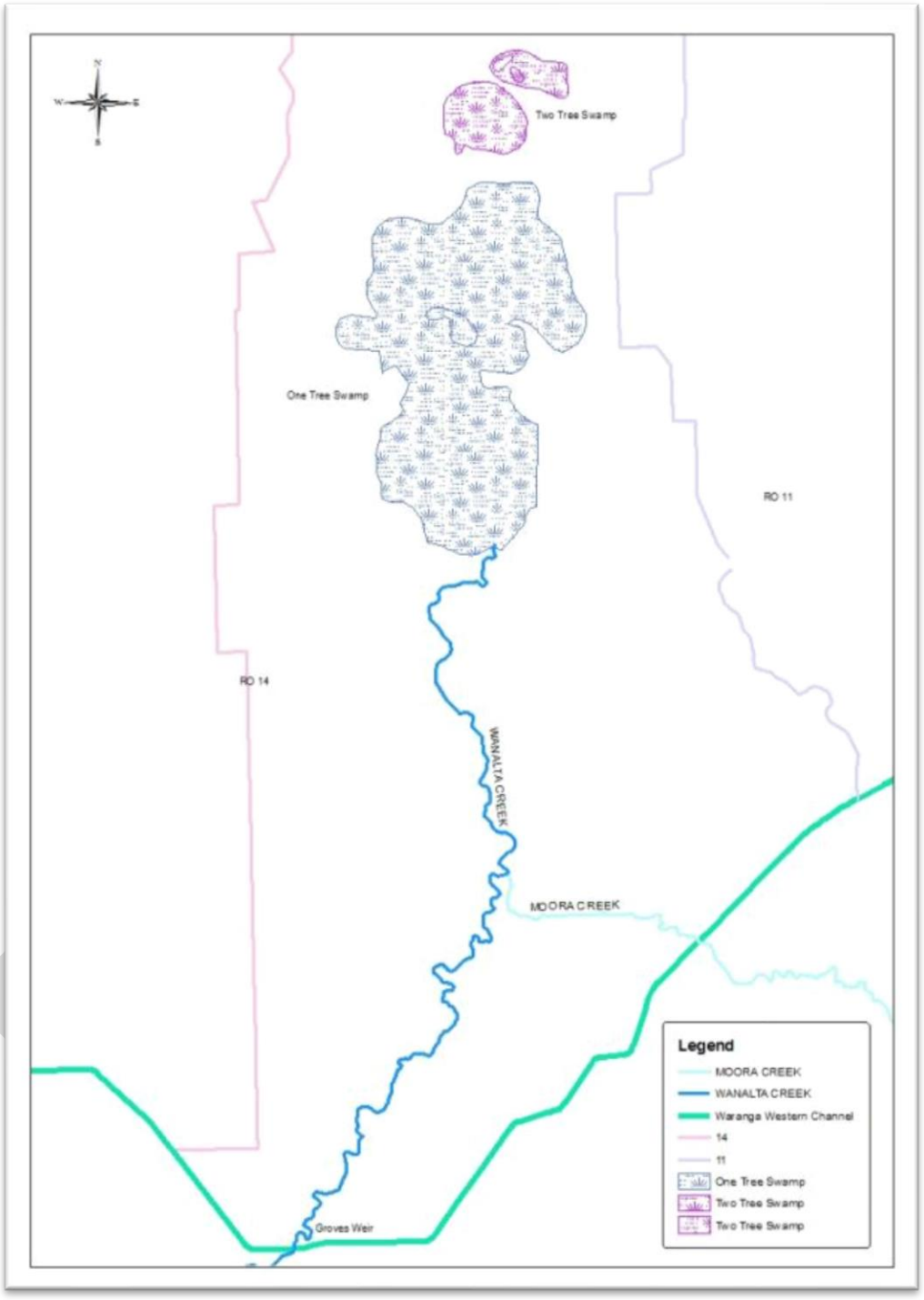

Figure 2: One Tree and Two Tree Swamp connection to Wanalta Creek

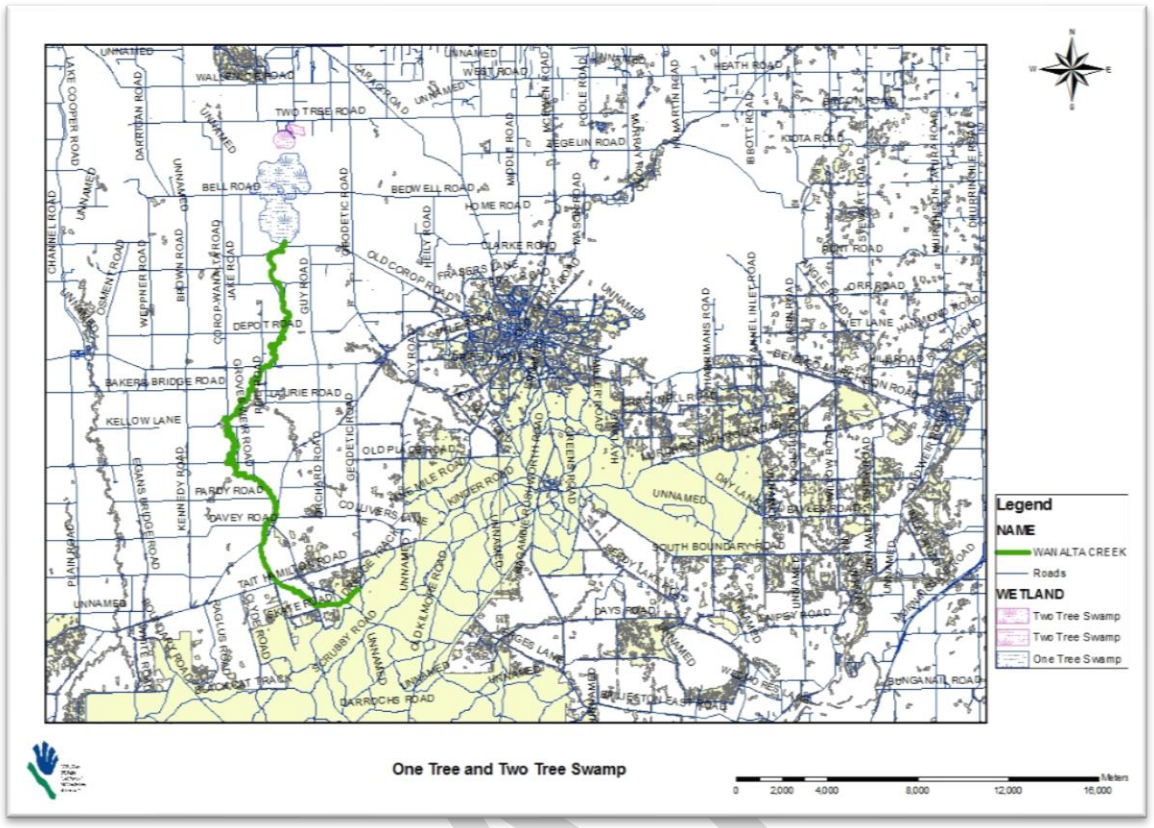

Figure 3: Origin of Wanalta Creek and flow path through the landscape.

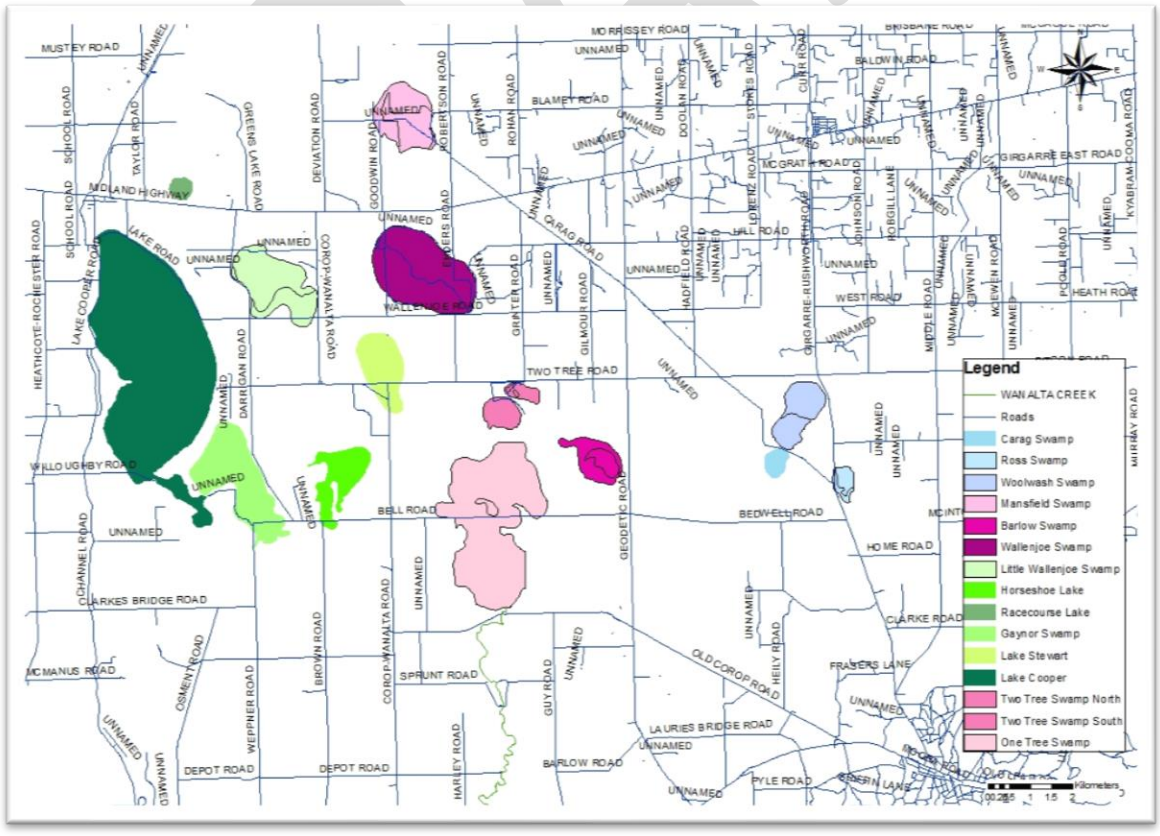

Figure 4: The Corop wetlands area.

1.4 CONSULTATION

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

1.5 INFORMATION SOURCES

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

- Those were the Days – A story of Shepparton, Victoria and (to some extent) its district (West, 1962).
- Corop Wetlands Drilling – Technical notes on results of drilling in the Corop Wetlands (Potts, 1992).
- Feasibility Study for Surface Drainage of Timmering-Woolwash Depression (Drummond, 1992).
- Corop Lakes drainage Area/ Salinity Drainage Management Strategy (Felton, 1993).
- Cornella and Wanalta Creek – Salt Load Estimates (SKM, 1999).
- Hydrogeological Assessment and Salinity Status of Wetlands in the Shepparton Irrigation Region (SKM, 2002).
- Goulburn Broken Regional River Health Strategy (GBCMA, 2005).
- Wanalta Creek Wetlands – Identification of water regime for One Tree, Two Tree and Wallenjoe Swamps (SKM, 2005).
- Mansfield Swamp Environmental Management Plan (DPI, 2007).
- Scoping Infrastructure works for Priority wetlands in the Shepparton Irrigation Region - One Tree and Two Tree Swamps (Paynter, 2010).
- Monitoring Ecological response to flooding – A study of One Tree, Two Tree, Wallenjoe and Mansfield Swamps in the Goulburn Broken Catchment (Cook and Jolly, 2011).
- Workshop booklet from the Scientific Technical Committee Technical Workshop (Committee, 2011).

This information was supplemented by discussions with people with an intimate knowledge of the Swamps, their environmental values, and the management and operation of these Swamps.

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

- Flora Information System of Victoria (DSE, 2005a);
- Atlas of Victorian Wildlife (DSE, 2007a);
- Bioregional Conservation Status of Ecological Vegetation Classes;
- Swamp environments and extent up to 1994; and
- Shire of Campaspe aerial photography (2000 layer).

1.6 LIMITATIONS

The information sources used in the development of this report have a number of limitations. These limitations include the data contained in the Flora Information System and the Atlas of Victorian Wildlife comes from a combination of incidental records and systematic surveys. The data varies in accuracy and reliability due to the distribution and intensity of survey efforts. In addition, the lack of knowledge about the distribution and characteristics of invertebrates and non-vascular plant species means the data is weighted towards the less cryptic elements of flora and fauna, i.e. vascular flora and vertebrates. The water regimes for One Tree and Two Tree Swamps 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 research documents and published literature. These sources vary in their age and hence the degree to which they reflect the current situation. However, the Plan is intended to be a live document and will be amended as new information becomes available.

2. SITE OVERVIEW

2.1 CATCHMENT HISTORY

The Corop Lakes drainage 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 Cainozic 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. One Tree and Two Tree Swamps are located at the terminal end of the Wanalta Creek and are classified as nationally significant in *A Directory of Important Wetlands* – VIC 0606 Wanalta Creek Wetlands (EA, 2001). The Wanalta Creek Catchment is approximately 284Km^2 comprising Wanalta Creek and Nine Mile Creek (Corrick and Cowling, 1978) (Figure 5).

Over 60 per cent of the Goulburn Broken Catchment has been cleared for agriculture purposes (Miles et al., 2010). One Tree and Two Tree Swamps lie within 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 are a stronghold for native flora and fauna especially Brolga.

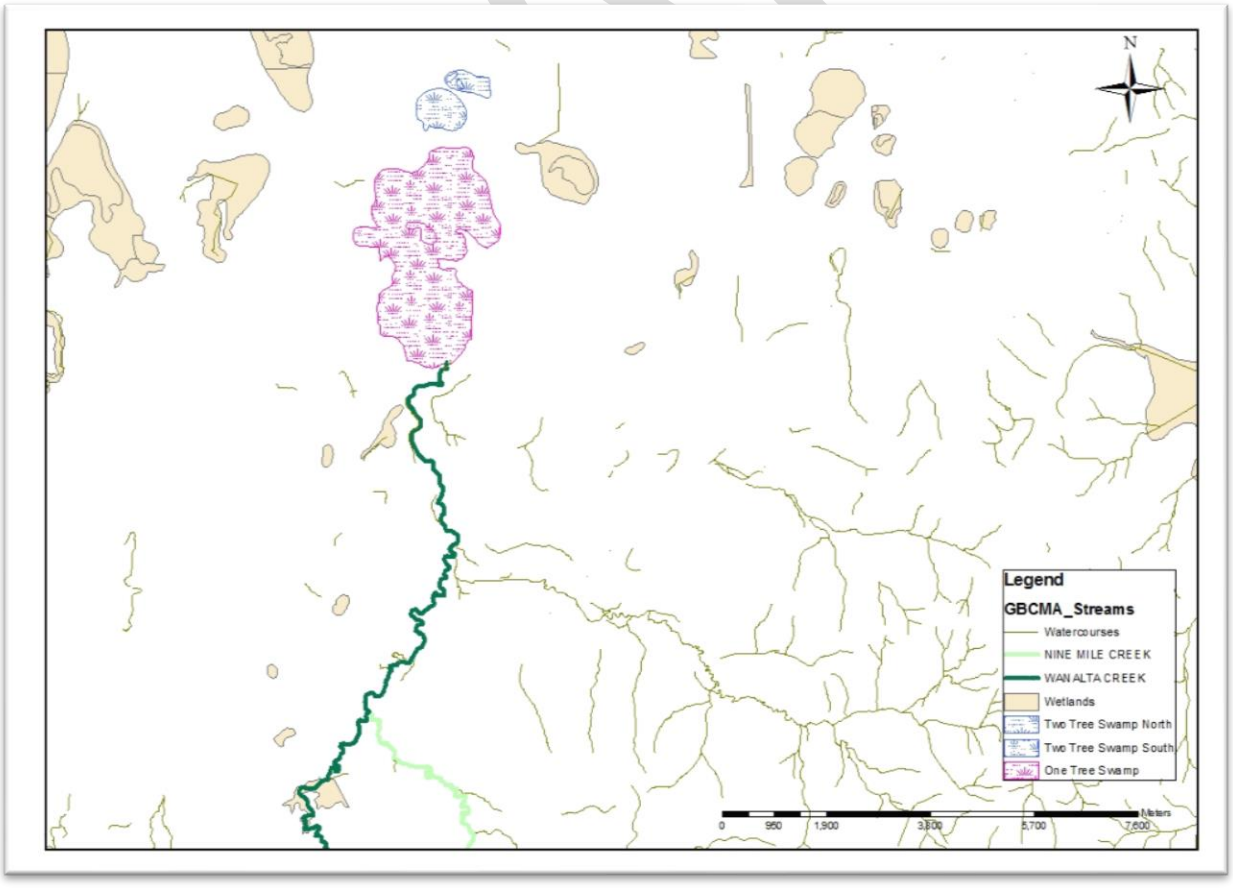

Figure 5: Nine Mile and Wanalta Creek.

2.2 LAND STATUS AND MANAGEMENT

One Tree and Two Tree Swamps are managed by Parks Victoria. However, a number of management agencies are also responsible for ensuring that management of the wetlands complies with a broad range of legislative requirements (section 2.3 – Wetland characteristics). Lead management agencies and their key responsibilities are summarised in Table 1. The broader community including adjacent landholders, Yorta Yorta Aboriginal Nation (refer to Section 3.4.1- Cultural heritage), Landcare, and recreational users also have an interest and role in the management of the planning area. The successful management of One Tree and Two Tree Swamps therefore relies on effective cooperation and partnership between the government agencies and the broader community.

Table 1: Lead government agencies and their key 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 Archaeological and Aboriginal Relics Preservation Act 1972* 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 Agency	Protect, restore and enhance air, land and water quality and control of unwanted noise.
Goulburn Broken Catchment Management Authority	Implementation of the Goulburn Broken Regional Catchment Strategy. Works on waterways, regional drainage and floodplain management, and co-ordinating Commonwealth and State natural resource management investment. Determining the environmental water requirements of wetlands and streams, developing and submitting annual water proposals to DSE for consideration, and managing the delivery of environmental water in accordance with DSEs watering plan.
Goulburn-Murray Water	Manages water related services including storage, delivery and drainage systems across Northern Victoria.
Murray-Darling Basin Authority	The Murray–Darling Basin Authority's principal aim is to manage the Basin's water resources in the national interest.
Parks Victoria	Management of One Tree Swamp and Two Tree Swamp Nature Conservation Reserve.
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 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 GIS layers (DSE, 2007b).

One Tree and Two Tree Swamps are classified as shallow freshwater marshes in the Department of Sustainability and Environment wetlands 1994 layer. This classification is considered representative of the wetlands during the time they were mapped.

One Tree and Two Tree Swamps both have a mean depth of 400mm. One Tree Swamp has an area of 631hectares and a volume of approximately 2524ML[1]. Two Tree Swamp has an area of 82 hectares and a volume of approximately 328ML[2]. The swamps were classified as a Nature Conservation Reserve in the *Victorian Environmental Assessment Council River Red Gum Investigations* (VEAC, 2008) and are managed by Parks Victoria (Table 2).

Environmental water has not been delivered to One Tree or Two Tree swamp. However, potential sources for delivering water include a release from the Waranga Western Main Channel to Wanalta Creek at Groves Weir, Rochester Channel 14 or Rochester Channel 11 (section 8 – Environmental Water Delivery Infrastructure).

[1 and 2] When delivering an environmental water allocation to the wetlands it should be noted that the wetlands be filled at varying levels (if using channels as carriers) as full supply level is not always desired. Flooding the wetlands to variable depths will promote an increased plants species community.

Table 2: Summary of One Tree and Two Tree Swamp Characteristics

Characteristics	Description	Description
Name	One Tree Swamp	Two Tree Swamp
Mapping Id	7824114555	7824121583
Area (ha)	631	82
Bioregion	Victorian Riverina	Victorian Riverina
Conservation Status	Nationally Significant	Nationally Significant
Land Status	Nature Conservation Reserve	Nature Conservation Reserve
Land Manager	Parks Victoria	Parks Victoria
Surrounding Land Use	Dryland Agriculture	Irrigated and Dryland Agriculture
Water Supply	Local catchment run-off Wanalta Creek flooding	Local catchment run-off Wanalta Creek flooding
1788 Wetland Category	Shallow Freshwater Marsh	Shallow Freshwater Marsh
1994 Wetland Category	Shallow Marsh Subcategory: Cane-grass	Shallow Marsh Subcategory: Cane-grass and Herbland
Wetland Capacity (ML)	2524	328
Mean wetland depth at Capacity (m)	0.4m^	0.4m^

*Note: National Significance is listed in the Directory of Important Wetlands. One Tree and Two Tree Swamp are listed within the Wallenjoe Wetlands REF VIC 060 - A Directory of Important Wetlands.

^ Note: Filling wetlands to 0.4m will not occur during every environmental watering event if using channels as a water carrier. Filling the wetland to variable depths will promote an increased plant species community and drawing down the wetland slowly will allow the habitat to change in its natural state, resulting in different vegetation communities establishing within the wetland body.

2.4 ENVIRONMENTAL WATER SOURCES

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

Environmental Water for One Tree and Two Tree Swamps could possibly be sourced from the water entitlements and their agencies listed in Table 3 (Appendix 3).

Table 3: Responsible Agencies for Environmental Water Allocations

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

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

Water from winter flows may enter the Wanalta Creek and into the wetlands every second year when Groves Weir is open to allow flows down the Wanalta Creek rather than directly into the Waranga Western Main Channel. Water can also be diverted from the Waranga Western Main Channel in times of extremely high flows for flood mitigation.

2.5 LEGISLATIVE AND POLICY FRAMEWORK

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

International treaties, conventions and initiatives:

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

Commonwealth legislation and policy:

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

Victorian legislation:

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

Victorian policy, codes of practice, charters and strategies:

- Goulburn Broken Catchment Regional Catchment Strategy (GBCMA, 1997).
- Our Water Our Future (DSE, 2004).
- Goulburn Broken Regional River Health Strategy (GBCMA, 2005)
- Shepparton Irrigation Region Regional Catchment Strategy (GBCMA, 2006b)
- Land and Water Biodiversity Paper. Securing our Natural Future (DSE, 2009b)
- Northern Region Sustainable Water Strategy (DSE, 2009c).
- Biodiversity Strategy for the Goulburn Broken Catchment, Victoria 2010-2015 (Miles et al., 2010).

2.6 RELATED PLANS AND ACTIVITIES

A number of key management documents have been written that directly or indirectly assist with management at One Tree and Two Tree Swamps include:

1. Corop wetlands drilling – Technical notes of drilling in the Corop Wetlands (Potts, 1992).
2. Feasibility study for Surface Drainage to Timmering and Woolwash Depressions (Drummond, 1992).
3. The ecological effects of salinity in the Shepparton Irrigation Region – Wetlands (Kelly, 1993).
4. Cornella and Wanalta Creek – Salt load estimates (SKM, 1999).
5. Hydrogeological Assessment and Salinity Status of Wetlands in the Shepparton Irrigation Region (SKM, 2002).
6. Wanalta Creek Wetlands. Identification of water regime requirements for One Tree, Two Tree and Wallenjoe Swamps (SKM, 2005).
7. Scoping infrastructure works for priority wetlands in the Shepparton Irrigation Region – One Tree and Two Tree Swamps (Paynter, 2010)
8. Monitoring Ecological Response to Flooding. A study of One Tree, Two Tree, Wallenjoe and Mansfield Swamps in the Goulburn Broken Catchment (Cook and Jolly, 2011).

These documents make a number of recommendations some of which have been implemented and have assisted with the protection and enhancement of the natural values supported by One Tree and Two Tree Swamps including:

1. Purchase of One Tree Swamp by the Department of Sustainability and Environment.
2. Replacement of boundary fences at One Tree and Two Tree Swamps to control stock and vehicle access.
3. Construction of an earthen embankment and drain at Two Tree Swamp.
4. Pest animal control such as Fox (*Vulpes vulpes*) eradication.
5. Condition assessment of One Tree and Two Tree Swamp using the Index of Wetland Condition methodology (section 5.2 – Threats and Condition).

3. WATER DEPENDENT VALUES

3.1 ENVIRONMENTAL - FAUNA

3.1.1 FAUNA LISTINGS AND SIGNIFICANCE

One Tree and Two Tree Swamps provide habitat for a variety of wetland and terrestrial fauna species. To date 92 native fauna species and six exotic species have been recorded at the wetlands (Table 4; Appendix 5). These include 70 bird species (41 wetland species and 29 terrestrial species), six frogs, one mammal, one reptile and six introduced species. Of these, nine species are listed under the *Flora and Fauna Guarantee Act* (1988) (Figure 6), two species are listed under the Bonn convention, 16 are listed under the *Advisory list of threatened vertebrate fauna in Victoria* (DSE, 2007a) and four are listed under the Japan Australia Migratory Bird Agreement (JAMBA), five under the China Australia Migratory Bird Agreement (CAMBA) and three under Republic of Korea Australia Migratory Bird Agreement (ROKAMBA). One Tree and Two Tree Swamps are important Brolga breeding sites in which breeding occurred in the 2010/11 flooding periods (Figure 6). 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 (section 3.1.2. –Significant fauna).

Many waterbirds such as herons, bitterns, egrets, crakes, ducks and spoonbills utilise these Swamps and feeding and breeding grounds. Brolga, Black Swans, Black Winged Stilts and Australasian Shoveler all bred in 2010/2011.

Amphibians thrive in the swamps when they hold water due to the aquatic habitat

Macroinvertebrate and fish species populations have not been monitored at One Tree and Two Tree Swamp in the past. Future monitoring projects could include these two components of the food chain to determine what is utilising these wetlands and give a more complete picture of the swamps food web.

Pest animals that pose a major threat to One Tree and Two Tree Swamp include the fox as they prey on nesting birds with Brolga chicks being especially vulnerable. Exotic fish species such as Carp (*Cyprinus carpio*) and Goldfish (*Carassius auratus*) have not been monitored at the site but could possibly enter the swamps via the Wanalta Creek. Carp and Goldfish could pose a major threat to One Tree and Two Tree Swamps as they compete for food, decrease water quality by foraging on the bottom of the wetland causing water to become turbid, can reproduce in large numbers and feed on native fish (refer to section 5.1 – Water dependant threats).

Table 4: Significant fauna species recorded at One Tree and Two Tree Swamp

Common Name	Scientific Name	Type	International Agreements	FFG	DSE status
Australasian Bittern	*Botaurus poiciloptilus*	B		L	End
Australian Reed Warbler*	*Acrocephalus stentoreus*	B	B		
Australasian Shoveller	*Anas novaeseelandiae*	B			Vul
Ballion's Crake	*Porzana pusilla*	B		L	Vul
Brolga	*Grus rubicunda*	B		L	Vul
Caspian tern	*Sterna caspia*	B	J,C		
Eastern Great Egret	*Ardea modesta*	B	J,C,B	L	Vul
Hardhead	*Aytha australis*	B			Vul
Intermediate Egret	*Ardea intermedia*	B		L	CEn
Latham's Snipe	*Gallinago hardwickii*	B	J,C,R,B		NT
Little Egret	*Egretta garzetta nigripes*	B		L	End
Magpie Goose	*Anseranas semipalmata*	B		L	NT
Nankeen Night Heron	*Nycticorax caledonicus*	B			NT
Royal Spoonbill	*Platalea regia*	B			Vul
Whiskered Tern	*Childonias hybridus javanicus*	B			NT
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	B	C	L	Vul

Legend
Type: Bird
International: Camba (C), Jamba (J), Rokamba (R), Bonn (B)
FFG Status: Listed as threatened (L)
DSE Status: Critically Endangered (CEn), Endangered (End), Vulnerable (Vul), Near Threatened (NT)
*Species is a member of family listed in Bonn Appendix 2 which is referred to: by the name of the species or subspecies; or as being all of the migratory species included in a higher taxon or designated part thereof.

3.1.2 SIGNIFICANT FAUNA

One Tree and Two Tree Swamps provide critical breeding habitat for the vulnerable Brolga. The protection of the Southern Cane-grass (*Eragrostis infecunda*) in the swamps 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 One Tree and Two Tree 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 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).

In 1980, over 100 Brolga were counted utilising One Tree and Two Tree Swamp, by 2010 only eleven birds were counted (Emmitt, 2011). One pair mated and raised two chicks in the summer of 2010/2011 (Cook and Jolly, 2011)(Figure 6).

Figure 6: Juvenile Brolga sighted at One Tree Swamp, January 2011

Photo: D. Cook, Australian Ecosystems 2011

3.2 FLORA – VEGETATION COMMUNITIES

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

One Tree and Two Tree Swamps are located in the Victorian Riverine Bioregion. EVCs recorded and monitored at One Tree Swamp included Cane Grass Wetland (EVC #291) and Cane Grass Wetland/Plains Grassy Wetland Complex which was originally classified as Plains Grassy Wetland EVC #125 (Frood, 2011, Cook and Jolly, 2011) and EVC #647 -Plains Sedgy Wetland (Appendix 6). Cook (2011) also wrote the following observations regarding EVCs at One Tree Swamp "*Out in the center at its deepest point the vegetation is a complex of Spike-sedge Wetland (EVC #819) and Aquatic Herbland (EVC #653). Surrounding this is Cane Grass Wetland/Aquatic Herbland Complex (EVC #602). The next shallowest zone is true Cane Grass Wetland (EVC # 291), which takes up a large proportion of the swamp. Plains Grassy Wetland/ Cane Grass Wetland Complex is mostly along the eastern side. Plains Sedgy Wetland occupies the southern quarter of the wetland, where there is also a small area of Red Gum Swamp (EVC #292).*" Monitoring of the condition of One Tree Swamp's vegetation using the Index of wetland Condition method in May 2011 indicated that vegetation was in excellent condition (section 5.2 – Condition).

EVCs recorded at Two Tree Swamp are Lignum Swamp (EVC #104), Cane Grass Wetland (EVC #291) and Plains Grassy Wetland (EVC #125). One Tree and Two Tree Swamps are located in the Victorian Riverina bioregion. Cane Grass Wetland EVC is classified as Vulnerable, Plains Grassy Wetland EVC is classified as Endangered and Lignum Swamp is classified as Vulnerable within the Victorian Riverina Bioregion (Table 5, Appendix 7). Monitoring of the condition of Two Tree Swamp vegetation using the Index of Wetland Condition method in May 2011 indicated that vegetation was in good condition (section 5.2 –Threats and Condition). Vegetation may have degraded at Two Tree Swamp slightly due to lack of inflows from One Tree Swamp impacting upon the wetland vegetation.

Plains Grassy Wetland EVC is currently being nominated to be listed on the *EPBC Act* (1999). This EVC is one of the most dominant (along with Cane-grass) within both One Tree and Two Tree Swamp vegetation.

Table 5: Conservation status of Ecological Vegetation classes recorded at One Tree and Two Tree Swamp

EVC number	EVC Name	Victorian Riverina Bioregion	Swamp
125	Plains Grassy Wetland	En	Two Tree
291	Cane-grass Wetland	Vu	One Tree Two Tree
647	Plains Sedgy Wetland	En	One Tree
TBA	Cane-grass Wetland/ Plains Grassy Wetland Complex	TBA	One Tree
104	Lignum Swamp	Vu	Two Tree
819	Spike-sedge Wetland	Vu	One Tree
653	Aquatic herbland	De	One Tree
602	Cane-grass Wetland/Aquatic herbland Complex	NA	One Tree
292	Red Gum Swamp	Vu	One Tree

Legend (Wierzbowski et al., 2002)

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

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

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

3.2.1 FLORA – SPECIES LISTINGS AND SIGNIFICANCE

A total of 89 native species have been recorded at One Tree and Two Tree Swamps, comprising 62 wetland species (Appendix 7). Of these species, nine are listed under the *Advisory list of rare or threatened plants in Victoria* (DSE, 2005a) species list and one is listed under the *Environmental Protection Biodiversity Conservation Act* (1999) and two *Flora and Fauna Guarantee Act* (1988) (Table 6, Appendix 7, and Figure 7).

Table 6: Conservation Status of Flora species recorded at One Tree and Two Tree Swamp

Common Name	Scientific Name	EPBC Status	FFG Status	DSE Status
Winged Water-starwort	*Callitriche umbonata*			r
Riverina Bitter-cress	*Cardamine moirensis*			r
Grey Spike-sedge	*Eleocharis macbaronii*			k
Long Eryngium	*Eryngium paludosum*			v
Spiny Lignum	*Muehlenbeckia horrida subsp. horrida*			r
Stiff Groundsel	*Senecio behrianus*	En	L	en
Slender Water-ribbons	*Triglochin dubia*			r
Swamp Early Nancy	*Wurmbea dioica subsp. Lacunaria*			k

Legend
EPBC Status: Endangered (EN)
FFG Status: Listed as threatened (L)
DSE Status: Endangered (en), Vulnerable (v), Rare (r), Poorly Known (k)

Common species of plant found within One Tree and Two Tree Swamp include southern cane-grass, brown-back Wallaby-grass (*Austrodanthonia duttoniana*) and common spike-sedge (*Eleocharis acuta*).

One Tree Swamp Plains Sedgy Wetland EVC is dominated by Poong'ort (*Carex tereticaulis*), tall sedge (*Carex appressa*) and common swamp Wallaby-grass (*Amphibromus nervosus*). The Cane-grass EVC is dominated by cane-grass, common spike-sedge (*Eleocharis acuta*), slender water-ribbons (*Triglochin dubia*) and swamp billy-buttons (*Craspedia paludicola*) which are not usually associated with the EVC (Cook and Jolly, 2011). Plains Grassy Wetland/ Cane-grass complex is dominated by southern cane-grass, brown-back Wallaby-grass, common swamp Wallaby-grass and many semi aquatic herbs (Appendix 7).

Two Tree Swamp Cane-grass wetland EVC is dominated by southern cane-grass and common spike-sedge. The Lignum Swamp EVC is dominated by tangled lignum (*Muehlenbeckia florulenta*), brown-backed Wallaby-grass, southern cane-grass and common nardoo (*Marsilea drummondii*) (Cook and Jolly, 2011). Plains Grassy Wetland EVC is dominated by common nardoo and brown-backed Wallaby-grass. Prior to prolonged inundation Plains Grassy Wetland EVC at Two tree Swamp had approximately 80% cover of annual weeds (Cook and Jolly, 2011). A planted specimen of EPBC (1999) listed stiff groundsel (*Senecio behrianus*) was recorded at Two Tree Swamp outside the EVCs sampled (Figure 7). This population should be managed to encourage growth and population density within the area as there is only four wild and two planted populations known to exist (Alexander, 1999, Nevill and Camilleri, 2010).

The native Water Couch (*Paspalum distichum*) poses the greatest threat to One Tree Swamp wetland body as it can out-compete other native flora. A total of 27 exotic flora species have been recorded at One Tree

and Two Tree Swamps comprising nine wetland species (Appendix 7). Curled Dock (*Rumex crispus*) poses the greatest threat to Two Tree Swamp wetland body. Threats to One Tree and Two Tree Swamp wetland fringe includes Spear thistle (*Cirsium vulgare*) which is classified as regionally restricted under the *Catchment and Land Protection Act* (1994) (Appendix 7).

3.2.2 FLORA - SIGNIFICANCE

One Tree Swamp was purchased by the Department of Sustainability and Environment under the national reserve system program as it contains one of the largest populations of Southern Cane-grass in Victoria. Brolga rely on the growth of the southern cane-grass for nesting at both One Tree and Two Tree Swamps and the protection of these Cane-grass areas is imperative. One Tree and Two Tree Swamps also contain the Plains Grassy Wetland EVC which has been nominated to be listed under the EPBC Act (1999).

Southern cane-grass grows rapidly in response to rainfall or flooding (Figure 8). It flowers between September and May in response to rainfall (Roberts and Marston, 2011). It tolerates a flooding duration of 1-6 months at an approximate depth between 10-50cm and a flooding frequency of 2-3 years (Roberts and Marston, 2011).

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

Figure 7: Stiff Groundsel (*Scenecio beharianus*) found at Two Tree Swamp, January 2011

Photo: D. Cook, Australian Ecosystems 2011

Figure 8: Southern Cane-grass growing in Two Tree Swamp.

Photo: D. Cook, Australian Ecosystems 2011

3.3 WETLAND DEPLETION AND RARITY

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

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

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

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

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

One Tree and Two Tree Swamp are classified as shallow freshwater marshes. Shallow freshwater marshes within the Goulburn Broken Catchment have declined by 40% (GBCMA, 2006a). Shallow Freshwater marshes within the Goulburn Broken Catchment tend to be smaller and less permanent than some other wetland types and are therefore more susceptible to changes in condition as a result of threats impacting on them including drainage and water regulation (GBCMA, 2006a, Lyon et al., 2002).

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

3.3.1 ECOSYSTEM FUNCTIONS

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

One Tree and Two Tree Swamps (Figure 9) are 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, 2007).The Wanalta Creek system has a catchment area of 28,400 hectares and terminates at One Tree Swamp, which flows into a larger wetland complex of Two Tree, Wallenjoe and Mansfield Swamps and forms part of the larger Timmering Depression (SKM, 2005).

These wetlands perform important functions including:

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

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

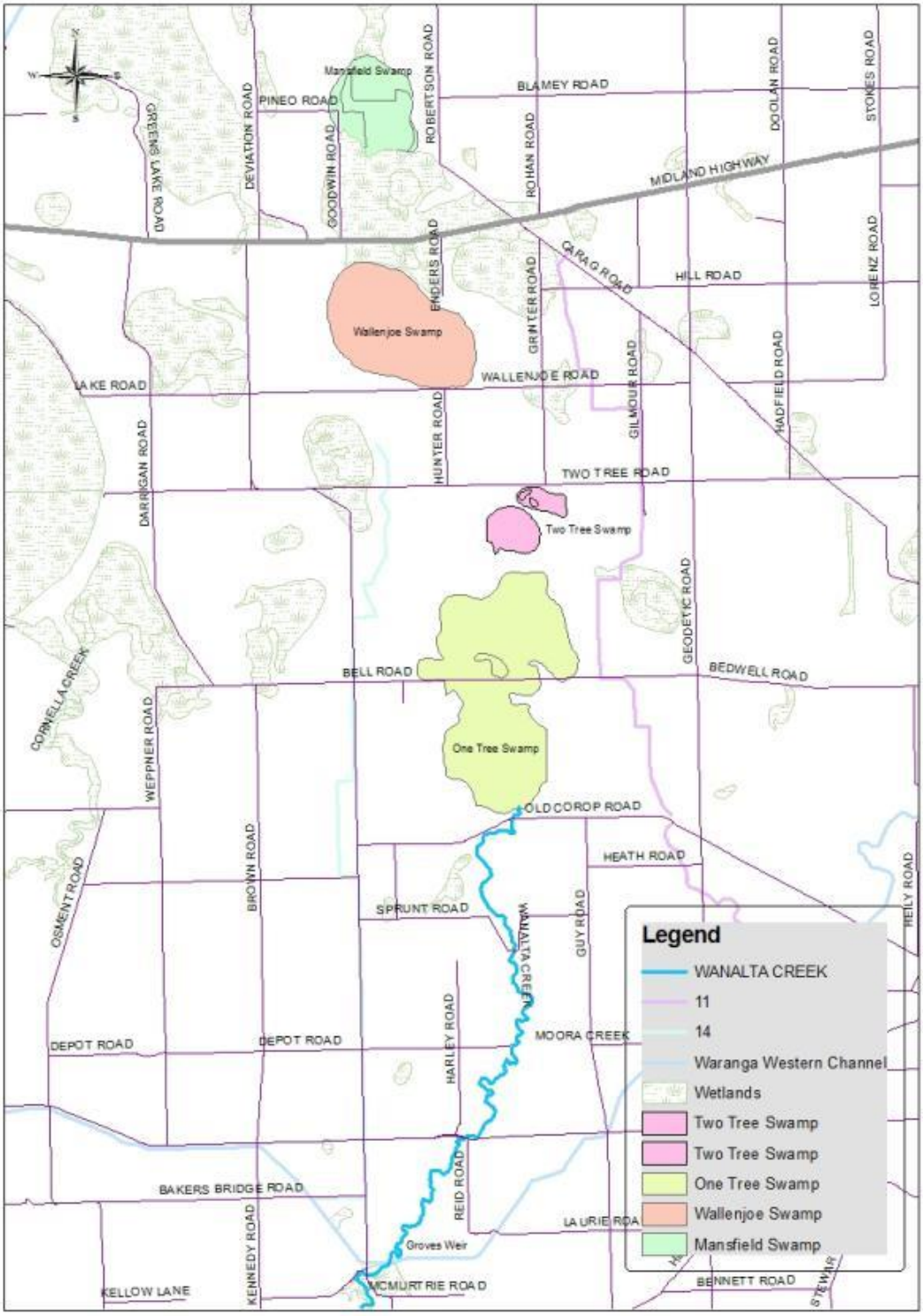

Figure 9: Wanalta Creek Catchment

3.4 SOCIAL

3.4.1 CULTURAL HERITAGE

One Tree and Two Tree Swamps have been identified as culturally sensitive areas (Figure 10) and the surrounding catchment has a long history of Indigenous occupation and is an important part of their cultural and spiritual heritage. Culturally sensitive areas are classified under the *Aboriginal Heritage Act 2006* (Vic) as waterways or land within 200m of a waterway.

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

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

All aboriginal sites, places and objects are protected under the *Aboriginal Heritage Act 2006* (Vic.) and the *Aboriginal and Torres Strait Islander heritage Protection Act 1984* (Cwlth).

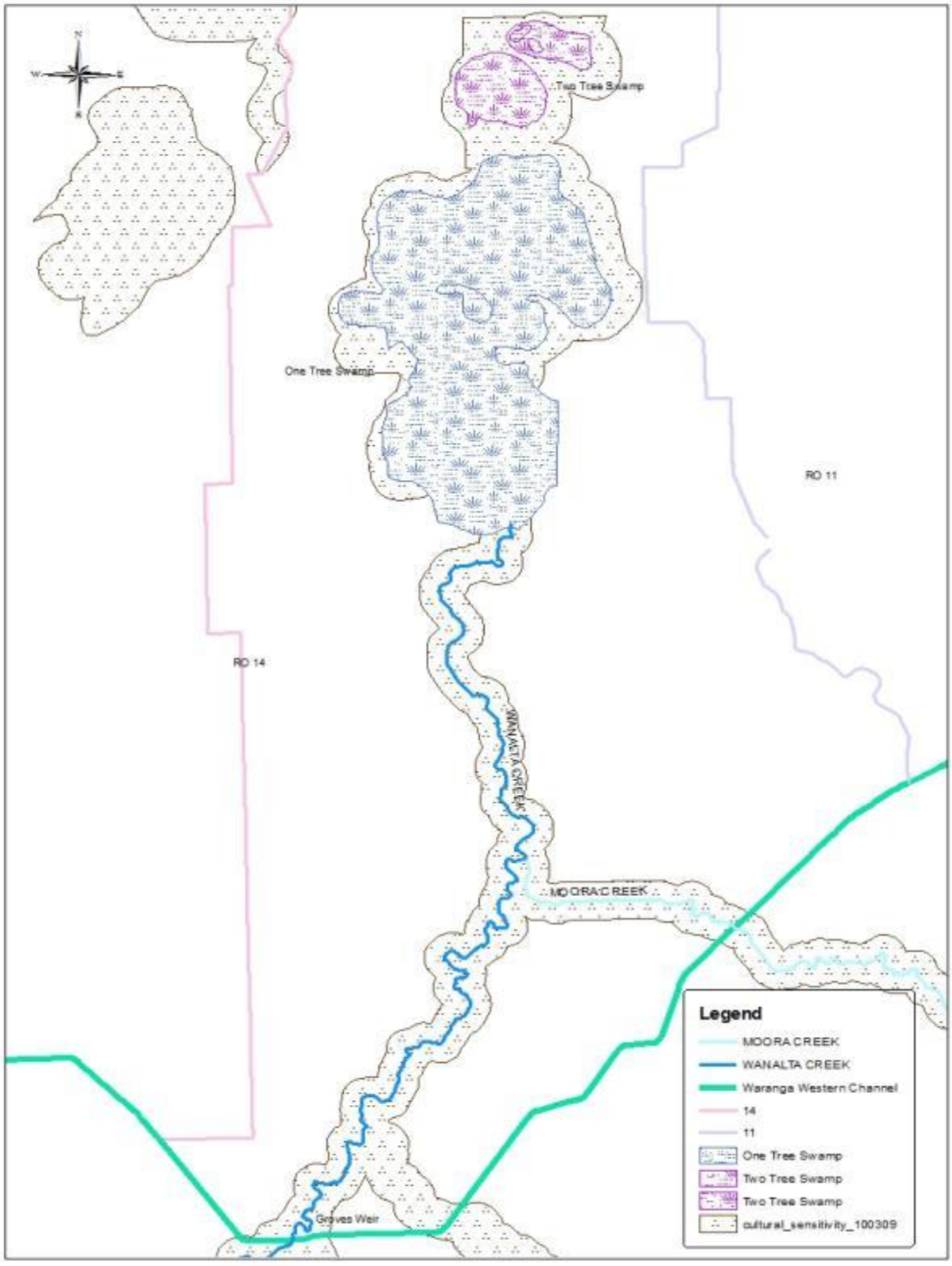

Figure 10: Cultural sensitive areas within and around One Tree and Two Tree Swamp

3.4.2 RECREATION

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

3.5 ECONOMIC

Wetlands provide both direct and indirect economic values to the Goulburn Broken Catchment (Cork et al., 2001). The direct economic values that One Tree and Two Tree Swamps provide to the Goulburn Broken Catchment include non-consumptive uses such as tourism and recreation to the area. Indirect economic values these swamps provide to the Goulburn Broken Catchment include a wide range of ecosystem services such as water filtration, flood retardation, water storage, groundwater recharge, nutrient discharge and carbon storage and habitat for threatened flora and fauna species.

4. HYDROLOGY AND SYSTEM OPERATIONS

Wetland hydrology is the most important determinant in the establishment and maintenance of wetland types and processes. It affects the chemical and physical aspects of the wetland which in turn affects the type of flora and fauna that the wetland supports (DSE, 2005b). A wetlands hydrology is determined by surface and groundwater inflows and outflows in addition to precipitation and evapotranspiration (Mitsch & Gosselink 2000 cited in DSE, 2005b). Duration, frequency, seasonality (timing) and depth are the main components of the hydrological regime for wetlands and rivers.

4.1 WATER MANAGEMENT AND DELIVERY

4.1.1 PRE-REGULATION

Under natural conditions, One Tree Swamp would have received water from flows of the Wanalta Creek. Wanalta Creek terminates at One Tree Swamp and would have run most years during late winter and spring, inundating the wetland. One Tree Swamp would have filled and spilled into Two Tree Swamp and subsequently to Wallenjoe Swamp and Mansfield Swamps with the wetlands filling most years. Given the shallow depth of One Tree and Two Tree Swamp they would have dried out most years over the summer period (SKM, 2005).

4.1.2 POST-REGULATION

Settlement in the Corop Catchment occurred around the 1840's. Land was cleared for grazing and cropping. The natural wetting and drying cycle of the wetlands in this region has been significantly altered since regulation of the Wanalta Creek in 1909 when the Waranga Western Main Channel (WWMC) was constructed (VEAC, 2008). The creek is still the major water source for the whole wetland complex, however flows are now captured at Groves Weir and diverted to the Waranga Western Main Channel as the flows from Wanalta Creek are included as part of Goulburn-Murray Water's bulk water entitlement. The two basic modes of operation of Groves Weir is when Waranga Western Main Channel is and is not in use (Figure 11). When Waranga Western Main Channel is not in use the regulator on the channel is closed and the regulator on the Wanalta Creek is opened to allow flows to pass down the creek. This occurs every second winter between the 15th of May and 15th of August when the irrigation system is closed for winter works. When the Waranga Western Main Channel is in operation the regulator on the Wanalta Creek is closed and the regulator opened to allow flows to be diverted down the channel for irrigation purposes. However, there is some leakage at the structure on Groves Weir allowing small volumes of water to flow into the Wanalta Creek.

The Wanalta Creek can be used to divert water during high rainfall events if water cannot be diverted down the Waranga Western Main Channel. This water would eventually pass into One Tree and Two Tree Swamps utilising them for flood mitigation.

Drought conditions over the past decade have seen episodic and irregular flows in the Wanalta Creek causing minimal flows entering One Tree and Two Tree Swamps.

Figure 11: Groves Weir regulator and Wanalta Creek

4.1.3 WETLAND VOLUME

Based on field measurements One Tree Swamp is 631 hectares in size and has an average depth of approximately 0.4m. Therefore, the volume of the swamp equates to approximately 2524ML.

Two Tree Swamp is 82 hectares in size and has an average depth of 0.4m. Therefore, the volume of the wetland equates to approximately 328ML. It is estimated, however that approximately 50 per cent more of these volumes would be required to compensate against loss to the soil profile in the event that environmental water was to be released to fill these wetlands from a dry state.

4.1.4 ENVIRONMENTAL WATER

Environmental water has not been delivered to One Tree or Two Tree Swamp. Potential sources for delivering water to One Tree and Two Tree Swamps include: releases from the Western Waranga Main Channel via Wanalta Creek at Groves Weir, Rochester Channel 14 or Rochester Channel 11 (section 8 – Environmental water delivery infrastructure). One Tree and Two Tree Swamps can currently only receive water from the Wanalta Creek during high rainfall events or flood mitigation events released from the Waranga Western Main Channel.

5. THREATS AND CONDITION

5.1 WATER DEPENDENT THREATS

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

Altered water regime – Hydrology is the most important component of wetland ecosystems. It drives the physical and chemical properties of a wetland, and the biota it supports. As described in Section 4.1.2 - Post Regulation, the natural hydrological regime of One Tree and Two Tree Swamps has been significantly altered by the construction of the Waranga Western Main Channel and Groves Weir cutting the natural flow of the Wanalta creek off from One Tree Swamp. This has impacted upon flows needed for the habitat for waterbirds to breed especially Brolga. The constriction of natural flows down the Wanalta Creek has seen small to medium flows being passed down the creek. These flows may be diverted by licenced diverters down the Wanalta Creek or may be lost to evaporation before reaching One Tree Swamp.

Altered physical form – Physical form relates to the area and bathymetry of a wetland. The area of One Tree and Two Tree Swamp have been physically altered by past drainage and excavation activities and the construction of a levee at Two Tree Swamp on its north eastern margin. In addition, the construction of a road between Wanalta Creek and One Tree Swamp and at the northern end of Two Tree Swamp has reduced the area of the broader wetland complex. No impacts on the bathymetry of the wetland have been identified. Future impacts on the physical form of the wetlands are unlikely to significantly vary over the foreseeable decades occur due to the protection provided by their current land status as Natural Feature Reserves. Sediment deposition rates are unknown entering One Tree Swamp from Wanalta Creek and Two Tree Swamp from One Tree Swamp and the surrounding catchment.

Poor Water Quality – Poor water quality including high nutrient loads and sediments may reduce habitat available for native aquatic biota, reducing its diversity and abundance. Water quality in One Tree and Two Tree Swamps may be impacted by:

- Run-off containing high nutrient loads and sediment from Wanalta Creek into One Tree swamp.
- Pollutants entering Wanalta Creek from irrigation and dryland agriculture drainage.
- High saline groundwater – A groundwater survey conducted in 2004 discovered groundwater levels around One Tree and Two Tree Swamps vary between 1-5 meters (SKM, 2002) with salinity levels of 26,775 – 45,450µs/cm. Such high saline groundwater can have a significant impact on the structure and composition of aquatic plants and invertebrates. This in turn will affect bird populations which depend upon flora and fauna for food and habitat. To date no impact has been detected and recent dry conditions have caused groundwater levels to recede.

Degraded habitats (Soil disturbance) – Wetland soils provide the physical substrate which aquatic vegetation requires to establish, and provides habitat for benthic invertebrates and microorganisms (DSE, 2009a). Potential threatening processes that can lead to poor wetland soils within One Tree and Two Tree Swamps include:

- Human visitation (wading within or walking around the fringe of the wetland).
- Driving vehicles illegally within the wetland drying both dry and wet phases; and
- Possible illegal excavation within the wetland bodies or fringes.

Exotic Flora and Fauna – The invasion of native vegetation by pest plants is listed as 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 indigenous communities. Modifications to the composition and structure of indigenous vegetation as a result of pest plant invasion can modify the abundance of indigenous fauna, geomorphological process, hydrological cycles, the nutrient content of soil and disturbance regimes including fire, grazing and insect activity (PV, 2003).

The native plant, water couch poses the greatest threat and has been recorded at One Tree Swamp. As discussed in section 3.1.4 – Flora Species, a total of 27 exotic species have been recorded at the wetlands.

Terrestrial weeds found within the surrounding area of One Tree and Two Tree Swamp include Spear thistle, listed under the *Catchment and Land Protection Act* (1994).

Pest animals threaten the ecological values of wetlands by predating native species, transmitting diseases, and competing for food and habitat. Pest animals recorded at One Tree and Two Tree Swamp include:

- Fox 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).
- European Rabbit (*Oryctolagus cuniculus*) and Hare (*Lepus capensis*).

Fish population surveys have not been conducted at One Tree or Two Tree Swamp. Therefore, introduction of exotic fish species into the wetlands is unknown and a significant knowledge gap.

5.2 CURRENT CONDITION

The condition of One Tree and Two Tree Swamps was assessed in May 2011 using a method developed by DSE called the Index of Wetland Condition (IWC). The IWC defines wetland condition as the state of the biological, physical, and chemical components of the wetland ecosystem and their interactions (DSE, 2005b).

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

The overall IWC score for One Tree Swamp in May 2011 was 7 out of 10, which is considered to be Good (Table 7). Of note the wetland catchment subindices was considered to be in poor condition, due to dryland agriculture dominating the catchment. Biota and Physical form subindices were considered to be in excellent condition. This may be due to the prolonged flooding conditions causing exotic species to die out and allowing native wetland species to thrive.

The overall IWC score for Two Tree Swamp in May 2011 was 5 out of 10, which is considered to be in moderate condition (Table 7). As mentioned above for One Tree Swamp, wetland catchment was considered poor. Biota and Physical form subindices at Two Tree Swamp were considered to be in good condition. This may be due to the altered hydrology and flow rates in the Wanalta Creek affected by the construction of Grove Weir and thus constricting large natural flows down the Wanalta Creek and into One Tree and Two Tree Swamps. The construction of a levee bank along the north-eastern margin of Two Tree Swamp may also have caused part of the swamp to become drier and allowed more terrestrial species to encroach into what was once wetland area.

Table 7: One Tree and Two Tree Swamp IWC subindex score, overall score and associated condition categories.

IWC subindex	One Tree Score	One Tree Condition category	Two Tree Score	Two Tree Condition category
Wetland catchment	4/20	Poor	6/20	Poor
Physical form	20/20	Excellent	15.6/20	Good
Hydrology	10/20	Moderate	10/20	Moderate
Water properties	15/20	Good	15/20	Good
Soils	20/20	Excellent	20/20	Excellent
Biota	18.6/20	Excellent	16.8	Good
Overall IWC Score	**7/10**	**Good**	**5/10**	**Moderate**

5.3 CONDITION TRAJECTORY

Ongoing management including possible delivery of environmental water is critical to assist the recovery and protection of One Tree and Two Tree Swamps. If no intervention occurs One Tree and Two Tree Swamps will only receive water via large flooding events which, with an increasing drying climate, may occur less frequently than suits the wetland habitat. This may cause accelerated loss of species diversity and terrestrialisation of vegetation within the wetland area.

6. MANAGEMENT OBJECTIVES AND ADAPTIVE APPROACHES

6.1 MANAGEMENT GOAL

The Management goal of One Tree and Two Tree Swamps is derived from a variety of sources including historic management goals, information sources (section 1.5 – information sources), local expertise and knowledge and by a scientific technical advisory committee (section 1.4 – Consultation). The goals consider the values the wetlands support and the potential risk factors that need to be managed. This includes the consideration of the values the wetlands could support into the future considering climate change.

One Tree Swamp Management Goal

"To provide a watering regime that supports a Cane-grass/Plains Grassy Wetland Complex and provides breeding opportunities for a diverse range of native wetland biota in particular Brolga"

Two Tree Swamp Management Goal

"To provide a watering regime that supports Cane-grass and Lignum Swamp EVCs provides breeding opportunities for a diverse range of native wetland biota"

The goals for One Tree and Two Tree Swamp is to deliver a hydrological regime that its closer to natural than they have been.

6.2 ECOLOGICAL AND HYDROLOGICAL OBJECTIVES

6.2.1 ECOLOGICAL OBJECTIVES

Ecological objectives represent the desired ecological outcomes of the sites. In line with Victoria's asset-based river health investment, the ecological objectives are based on the key values of the site (outlined in section 3 – Water Dependent Values). The ecological objectives are expressed as the target condition of functionality for each key value. These objectives are expressed as establishing one of the following trajectories of each key value, which is related to the present condition or functionality of the value.

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

The ecological objectives for One Tree and Two Tree Swamp are based on the values that the wetland provides for the larger Corop Catchment and on a local scale for their waterbird carrying capacity, ability to support species listed under the Environmental Protection Biodiversity and Conservation Act (1999) and the Flora and Fauna Guarantee Act (1988) and their ability to support native frogs and waterbird breeding. The ecological objectives for One Tree Swamp are:

- Protect and improve the diversity of native wetland flora species consistent with Cane-grass and Cane-grass/Plains Grassy Wetland Complex EVC benchmarks for One Tree Swamp.
- Reduce the cover and diversity of native flora such as water couch that can compete against other native flora or exotic flora species at One Tree and Two Tree Swamps.
- Provide opportunities for waterbird breeding especially Brolga at least one in two years.
- Provide opportunities for native frog breeding at least one in two years .

The ecological objectives for Two Tree Swamp are:

- Protect and improve the diversity of native wetland flora species in particular stiff groundsel and consistent with Cane-grass and Lignum Swamp EVC benchmarks for Two Tree Swamp.
- Reduce the cover and diversity of native flora such as water couch that can compete against other native flora or exotic flora species at One Tree and Two Tree Swamps.
- Provide opportunities for waterbird breeding especially Brolga at least one in two years.
- Provide opportunities for native frog breeding at least one in two years.

Justification for the ecological objectives are discussed in Table 8 and Appendix 5, 7,9 and 10.

Table 8: Ecological Objectives for One Tree and Two Tree Swamp

Ecological Objective	Justification (Value based)
Protect and improve the diversity of native wetland flora species consistent with Cane-grass and Cane-grass/ Plains Grassy Wetland Complex benchmarks for One Tree Swamp. Protect and improve the diversity of native wetland flora species consistent with Cane-grass and Lignum Swamp Ecological Vegetation Communities benchmarks for Two Tree Swamp.	Increase habitat and food sources for native fauna. Increase biodiversity.
Reduce the cover and diversity of native flora that can compete against other native flora or exotic flora species at One Tree and Two Tree Swamps.	The native water couch poses as threat at One Tree Swamp due to its vigorous growth and ability to outcompete other native species. Exotic plant species present at One Tree and Two Tree Swamp notably Curled Dock and Spear thistle.
Provide opportunities for waterbird breeding especially Brolga at least one in every two years.	One Tree and Two Tree Swamps are breeding grounds for Brolga.
Provide opportunities for native frog breeding at least one in every two years.	One Tree and Two Tree Swamps are relatively rich in frog species as five species have been recorded (Appendix 5).

6.2.2 HYDROLOGICAL OBJECTIVES

Consistent with the implementation of the water management goal and the ecological objectives above, the following water regimes area proposed for One Tree and Two Tree Swamp. One Tree and Two Tree Swamps are to experience a three to five years in a ten year period (Table 9). This is based on the ideal wetland habitat required for reproduction/ regeneration of vegetation to occur to One Tree and Two Tree Swamps.

Table 9: Summary table of Hydrological and Ecological Objectives for One Tree and Two Tree Swamp

Ecological Objectives	Water management area	Hydrological Objectives											
		Mean frequency of events (in 10 years)			Tolerable interval between events once wetland is dry (months)			Median duration of ponding (months)			Preferred timing of inflows	Volume to fill to target supply level (ML)	Depth (mm)
		Min	Opt	Max	Min	Opt	Max	Min	Opt	Max			
Maintain Cane-grass EVC of One Tree Swamp and Two Tree Swamp	Wetland body	3	5	10	6	6-9	36	3	6[1]	9	Autumn – Spring	2524ML One Tree 328 ML Two Tree[4]	Variable to 400mm[6]
Maintain Plains Grassy Wetland EVC at One Tree and Two Tree Swamps	Wetland fringe	3	3	10	6	6-9	9	3	4-5	6	Autumn - Spring	2524ML One Tree 328 ML Two Tree	Variable to 300mm
Maintain Lignum Swamp EVC at Two Tree Swamp	Wetland fringe	1	1	1	8	8	8	2	2-8	8[2]	Spring - Summer	328 ML	Variable to 400mm
Provide opportunities for waterbird breeding	Wetland body	5	5	10	6	9	12	2	6	NA	Spring [2]	2524ML or 328ML	Variable to 400mm[5]
Provide key opportunities for frog breeding	Wetland fringe	NA	NA	NA	NA	NA	NA	1	2-6	NA	Spring – Autumn[3]	2524ML or 328ML	Variable to 400mm

1. Six months for deepest area of Swamp
2. Rogers and Ralph 2011; (Young, 2003).
3. ARC, 2010, Appendix 10.
4. Based on area x depth calculations
5. Water depth should be kept fairly consistent if waterbirds are nesting/ breeding to avoid nests being abandoned (Young, 2003).
6. Under the current watering regime One Tree Swamp will have to be filled and spill into Two Tree Swamp for Two Tree Swamp to obtain water. Variable depths will only occur at One Tree Swamp if water can be directly delivered to Two Tree Swamp.

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. The optimum regime involves five fillings in ten years on average; however the duration of watering may vary between these hydrological regimes. Due to inter-annual variability of these estimates (particularly the climatic conditions), determination of the predicted volume requirements in any given year will need to be undertaken by the environmental water manager when watering is planned.

Minimum watering requirements

Provide three flooding events every ten years. Fill wetlands to variable depths up to 400mm to maintain EVCs and provide habitat for aquatic biota.

Optimum watering requirement

Provide five flooding events every ten years. Fill wetlands to variable depths up to 400mm to promote the regeneration and recruitment of EVCs and encourage breeding opportunities for aquatic biota.

Maximum watering requirement

Provide an annual flood event over a ten year period. Fill wetlands to variable depths up to 400mm to maintain EVCs to promote breeding opportunities for aquatic biota.

Filling the wetlands to full supply level in not always desired. Flooding One Tree and Two Tree Swamps to variable depths and drawing down of the wetlands slowly will promote greater wetland plant diversity. This will assist in obtaining the EVC benchmarks required to improve One Tree and Two Tree Swamps. Wherever possible, this managed hydrological regime should be aligned with local and climatic conditions.

6.3 IMPLEMENTATION: SEASONALLY ADAPTIVE APPROACH

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

The seasonally adaptive approach identifies the priorities for environmental watering, works and complementary measures, depending on the amount of water available in a given year or prevailing climatic conditions. It is a flexible way to deal with short-term climatic variability and helps guide annual priorities and manage drought. This approach is outlined in Table 10.

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

The proposals are prepared in consultation with key stakeholders and partners and are approved by CMA boards. The proposals are submitted to the Victorian Environmental Water Holder (VEWH) for consideration. The VEWH then prepares **seasonal watering plans** based on the CMAs seasonal watering proposals. The plans describe the desired environmental water use for rivers and wetlands across Victoria in the coming year. To help facilitate the desired environmental water use outlined in these plans, the VEWH negotiates access to environmental water managed by the Commonwealth Environmental Water Holder (CEWH) and the Murray Darling Basin Authority (MDBA). The VEWH then prepares **seasonal watering statements** that authorise CMAs to undertake the agreed watering activities, including the use of CEWH and MDBA water. As more environmental water becomes available during the season the VEWH may prepare additional seasonal watering statements. Where possible, the VEWH, CEWH and the MDBA seek to coordinate the delivery and management of environmental water to maximise ecological benefits (Figure 12).

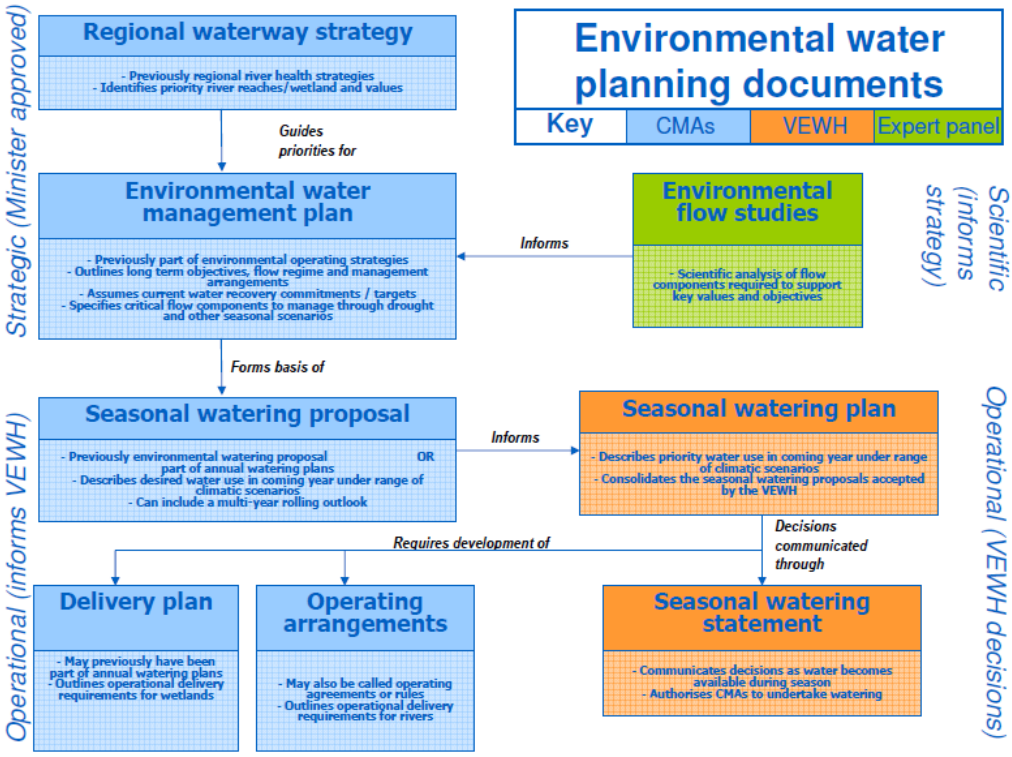

Figure 12: Flow chart for Environmental water planning

Table 10: The seasonally adaptive approach to river and wetland management

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

7. POTENTIAL RISKS AND MITIGATION MEASURES

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

Potential risk of environmental water delivery to One Tree and Two Tree Swamps include:

- Flood duration is too long or too short. If duration is too short birds breeding may abandon nests and aquatic flora may not set-seed.
- Flood timing is too late or early. Environmental water can only be delivered during the irrigation season when there is sufficient space capacity in the Waranga Western Main Channel and Wanalta Creek which may not coincide with the desired timing. Licenced diverters downstream of Groves Weir will need to be considered.
- Flooding depth is too shallow or deep. This may occur if environmental water allocations cannot be achieved due to delivery constraints, or a high rainfall event occurs after delivery, causing deeper flooding than required.
- Flood frequency is too long or short. This may occur if a significant rainfall event occurs after an environmental water delivery, prolonging flooding of the wetland, or water cannot be delivered within a sufficient period.
- Poor water quality. Flows to the Wanalta Creek have been restricted by the construction of Groves Weir. Lack of flows into the Wanalta Creek can lead to stagnant water with high nutrient and salinity levels and have low dissolved oxygen, which can enter One Tree and Two Tree Swamps when delivering environmental water.
- Pest plant and animal invasion. Pest plants and animals such as Carp (*C. carpio*) can be introduced via environmental water delivery. Flooding can also stimulate the growth of pest plants and animals if it at the wrong time or duration.
- Impacts to social and economic values such as reduced public access or degradation of cultural heritage sites if flooding is too high.

Table 11: Potential risks associated with environmental water delivery

#	Risk	Description	Potential Impacts								Mitigation
			Environmental					Social		Economic	
			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 Add or

											drawdown water where appropriate or practical
		Flood frequency too long or short	✓	✓	✓	✓	✓	✓			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 Add or drawdown water where appropriate or practical

		Increased organic matter	✓				✓				Implement the required water regime
3	Pest aquatic plant and animal invasion	Introduction of pest fish	✓		✓	✓	✓				Monitor the ecological response of the wetland to flooding Install a carp screen Implement an appropriate drying regime
		Growth and establishment of aquatic pest plants	✓	✓	✓	✓	✓				Monitor the abundance of native and pest aquatic plants Control pest plants in connected waterways Spray or mechanically remove pest plants Implement an appropriate drying regime

8. ENVIRONMENTAL WATER DELIVERY INFRASTRUCTURE

8.1 CONSTRAINTS

Environmental water can be delivered to One Tree and Two Tree Swamps via the Wanalta Creek or possibly by Channel 11 or 14. Delivery of an environmental water supply can be constrained by the following:

- Timing of flows –water may not be able to be delivered at appropriate time for ecological benefit.
- Possibility of flooding neighbouring properties.
- Irrigation demands – One Tree and Two Tree Swamps do not have a delivery share, therefore environmental water can only be delivered when there is spare capacity to carry water in the Waranga Western Main Channel.

8.2 IRRIGATION MODERNISATION

The Northern Victorian Renewal Project (NVIRP) is a $2 billion works program to upgrade ageing irrigation infrastructure in the Goulburn-Murray Irrigation District to save water lost through leakage, evaporation and system inefficiencies.

NVIRP will rationalise and re-configure the existing channel system within the Rochester irrigation region in which One Tree and Two Tree Swamps are located. Channel systems that could have possibly delivered water are proposed to be decommissioned.

8.3 INFRASTRUCTURE RECOMMENDATIONS

An investigation into the delivery of environmental water to One Tree and Two Tree Swamps has been undertaken by Goulburn-Murray Water (Paynter, 2010) . The report identified different options to deliver environmental water to One Tree and Two Tree Swamps via the Wanalta Creek and existing channel infrastructure. Observations from the scoping study include that the filling of One Tree Swamp and maintenance of its levels to replace evaporation and seepage and to outfall into Two Tree Swamp and the continuing wetland complex is most feasible by Wanalta Creek from the Waranga Western Main Channel at Groves Weir. Water currently delivered via Wanalta Creek is viable however; upgrades of the system would assist with a more efficient flow regime to the wetlands. Works recommended to deliver both natural flows and environmental water to One Tree and Two Tree Swamp includes:

- Modification of the Groves Weir off-take.
- Stabilisation of a derelict weir on Wanalta Creek.
- Improving the capacity of Wanalta Creek.
- Construction of an outlet regulator on One Tree Swamp; and
- Construction of an outlet regulator on Two Tree Swamp.

9. KNOWLEDGE GAPS AND RECOMMENDATIONS

There are currently a number of knowledge gaps in relation to environmental water management at One Tree and Two Tree Swamps. A majority of these do not impact upon the ability to provide water to One Tree and Two Tree Swamps and generate ecological benefit; the addressing of these knowledge gaps would significantly improve the accuracy of environmental water bids, and provide long-term ecological understanding of the sites.

The following list describes how environmental water would be delivered to One Tree and Two Tree Swamps and knowledge gaps that may occur within these areas.

1. Monitoring of the water dependant environmental values of the Swamp such as aquatic flora and fauna.
    a. Investigate the appropriate flooding regimes and requirements for Southern Cane-grass.
    b. Investigate monitoring options for increasing Brolga population numbers that utilise the Wanalta wetlands.
    c. Investigate monitoring options for macroinvertebrate and fish species that may utilise One Tree and Two Tree Swamps when inundated.
2. Monitoring the sites environmental conditions and issues that may pose threats such as:
    a. Water Couch at One Tree Swamp and Curled Dock at Two Tree Swamp and ensure that a natural drawdown/ drying period in the summer months to assist with control.
    b. Spear Thistle at One Tree and Two Tree Swamp ensuring controls are put in place to prevent further spread.
    c. Sediment deposition rates entering One Tree and Two Tree Swamps from the Wanalta Creek and the surrounding catchment.
    d. Water quality, especially salinity levels within One Tree and Two Tree Swamps when inundated.
    e. Pest animals enforcing prevention or eradication techniques where possible.
3. Utilising the seasonally adaptive approach by modelling the effects of differing climate change scenarios on One Tree and Two Tree Swamps.
4. Simulating the natural hydrological regime to provide ecological benefits by delivering environmental water 3-5 years out of 10 year period if conditions prevail.
5. Undertaking a risk management matrix before delivering environmental water to One Tree and Two Tree Swamps.

10. GLOSSARY

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

Cainozoic – The division of geological time which succeeds the Mesozoic and ends at the Quaternary. The duration is approximately 63 m.y. from 65 m.y to 2 m.y. It is commonly used as a synonym for Tertiary.

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

Depression - A sunken or depressed geological formation within the landscape.

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

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

11. REFERENCES

ALEXANDER, J. K. 1999. Stiff Groundsel (Senecio behrianus) Recovery Plan 1999-2001. Melbourne: Department of Sustainalbility and Environment.

ARNOL, J. D., WHITE, D. M. & HASTINGS, I. 1984. Management of the Brolga (*Grus rubicundus*) in Victoria. Victoria: Department of Conservation, Forests and Lands.

BROCK, M., NIELSEN, D. L., SHEIL, R., GREEN, J. & LANGLEY, J. 2003. Drought and aquatic community reslience: the role of eggs and seeds in sediments of temporary wetlands. *Freshwater Biology,* 48**,** 1207-1218.

COA 2002. National Land and Water Resource Audit. Australian Terrestrial Biodiversity Assessment. Canberra: Land and Water.

COMMITTEE, S. T. 2011. *RE: Environmental Water Workshop.* Type to WOOD, J.

COOK, D. & JOLLY, K. 2011. Monitoring Ecological Response to Flooding. A study of One Tree, Two Tree, Wallenjoe and Mansfield Swamps in the Goulburn Broken Catchment. FINAL Report. Patterson Lakes: Australian Ecosystems Pty Ltd.

CORK, S., CUNNINGHAM, S., ALEXANDRA, J., HOWDEN, M., COLLOFF, M., HAIBLEN, J., FREUDENBERGER, D., BARNETT, G., HAIRSINE, P., WILLIAMS, J., JONES, G., VERTESSY, R., STAUFFACHER, M., SNOW, V. & SMITH, C. 2001. Natural Assets: An Inventory fo Ecosystem Goods and Services in the Goulburn Broken Catchment. CSIRO.

CORRICK, A. & COWLING, S. 1978. A survey of wetlands in the Lake Cooper Area, Victoria. East Melbourne: Ministry for Conservation Fisheries and Wildlife Division.

CORRICK, A. & NORMAN, F. 1980. Wetlands of Victoria I. Wetlands and waterbirds of the Snowy River and Gippsland Lakes Catchment. . *Proceedings of the Royal Society of Victoria,* 91**,** 1-15.

DNRE 1997. *Victoria's Biodiversity* - Directions in Management. Melbourne: Department of Natural Resources and Environment.

DNRE 2002. Wetlands Technical Paper. Melbourne: Department of Natural Resources and Environment.

DPI 2007. Mansfield Swamp Environmental Management Plan. Tatura: Department of Primary Industries.

DRUMMOND, I. 1992. Feasibility Study for Surface Drainage of timmering-Woolwash Depression. Wangaratta: Murray Basin Consulting Group.

DSE 2004. Securing our water future together. Our Water Our Future. Melbourne: Department of Sustainability and Environment.

DSE 2005a. Advisory list of Rare or Threatened Plants in Victoria. East Melbourne: Department of Sustainability and Environment.

DSE 2005b. Index of Wetland Condition Assessment of wetland vegetation: DRAFT FOR COMMENT. Melbourne: Department of Sustainability and Environment.

DSE 2005c. Stiff Groundsel *Senecio behrianus*. A nationally threatened species of the grassy wetland community. *In:* ENVIRONMENT, D. O. S. A. (ed.). Melbourne.

DSE 2007a. Advisory list of Threatened Vertebrate Fauna in Victoria. East Melbourne: Department of Sustainability and Environment.

DSE 2007b. Index of Wetland Condition: Review of wetland assessment methods. Melbourne: Department of Sustainability and Environment.

DSE 2009a. Aquatic Value Identification and Risk Assessment (AVIRA: Environmental, Social and Economic values and threats). Report prepared for Department of Sustainability and Environment by Riverness Protection and Restoration Services, Victoria.

DSE 2009b. Land and Biodiversity White Paper. Securing our natural future. Melbourne: Department of Sustainabiility and Environment.

DSE 2009c. Northern Region Sustainable Water Strategy. Our Water Our Future. Melbourne: Department of Sustainability and Environment.

DSE. 2011. *Ecological Vegetation Class (EVC) Benchmakrs for Bioregion* [Online]. Melbourne: Department of Sustainability and Environment.

EA 2001. *A Directory of Important Wetlands,* Canberra, Environment Australia.

EMMITT, B. 2011. Will the Brolga survive? *Feathers and Fur***,** 56-58.

FELTON, R. 1993. Corops Lakes drainage Area Salinity/ Drainage Management Strategy. Individual wetland strategy Mansfield Swamp (Timmering Depression Subcatchment). Shepparton: Department of Natural Resources and Environment.

FROOD, D. 2011. *RE: Environmental Water Management Workshop Discussions.* Type to WOOD, J. & CASANELIA, S.

GBCMA 1997. Goulburn Broken Catchment Management Authority. Shepparton: Goulburn Broken Catchment Management Authority.

GBCMA 2005. Goulburn Broken Regional River Health Strategy 2005-2015. Shepparton: Goulburn Broken Catchment Management Authority.

GBCMA 2006a. Priority wetlands within the Goulburn Broken Catchment. Shepparton: Goulburn Broken Catchment Management Authority.

GBCMA 2006b. Shepparton Irrigation Region Regional Catchment Strategy. Shepparton: Goulburn Broken Catchment Management Authority.

KELLY, M. 1993. The Ecological Effects of Salinity in the Shepparton Irrigation Region - Wetlands. Benalla: Department of Conservation and Natural Resources.

LYON, J., SCHREIBER, E. & BUTCHER, R. 2002. Prioritising Wetlands for management of biodiversity conservation for the Goulburn Broken Catchment Management Authority. Heidelberg: Authur Rylah Institute for Environmental Research.

MILES, C., MC LENNAN, R., KEOGH, V. & STOTHERS, K. 2010. Biodiversity Strategy for the Goulburn Broken Catchment, Victoria. 2010-2015. Shepparton: Goulburn Broken Catchment Management Authority.

NEVILL, G. & CAMILLERI, M. 2010. National Recovery Plan for the Stiff Groundsel Senecio behrianus. Melbourne: Department of Sustainability and Environment.

PAYNTER, N. 2010. Scoping Infrastructure Works for Priority Wetlands in the Shepparton Irrigation Region - One Tree and Two Tree Swamps. Tatura: Goulburn-Murray Water.

POTTS, I. 1992. Corop Wetlands Drilling - Technical notes on results of Drilling in the Corop Wetlands. *In:* COMMISSION, R. W. (ed.). Bendigo: Department of Conservation and Environment.

PV 2003. Murray River Reserve: DRAFT Environmental Action Plan. Bendigo: Parks Victoria.

ROBERTS, J. & MARSTON, F. 2011. *Water regime for wetlands and floodplain plants. A source book for the Murray-Darling Basin,* Canberra, National Water Commision.

ROGERS, K. & RALPH, T. 2011. *Floodplain wetland biota in the Murray-Darling Basin. Water and habitat requirements,* Collingwood, CSIRO Publishing.

SKM 1999. Cornella and Wanalta Creek - Salt Load Estimates.

SKM 2002. Hydrogeological Assessment and Salinity Status of Wetlands in the Shepparton Irrigation Region. Tatura: Goulburn-Murray Water.

SKM 2005. Wanalta Creek Wetlands - Identification of water regime for One Tree, Two Tree and Wallenjoe Swamp. Armadale.

SUTHERLAND, G. 2011. *RE: One Tree and Two Tree Swamp.* Type to WOOD, J.

VEAC 2008. River Red Gum Investigations. Melbourne: Victorian Environmental Assessment Council.

WEST, R. 1962. *Those Were The Days - A story of Shepparton, Victoria and (to some extent) its district,* Shepparton, Waterwheel Press, PTTY LTD.

WIERZBOWSKI, P., LOWE, K. W., HANDLEY, K., BERWICK, S., ROBINSON, D. & AHERN, L. D. 2002. Biodiveristy Action Planning. Stratgic overview for the Victorian Riverina Bioregion. Melbourne: Department of Natural Resources and Environment.

YOUNG, W. S. 2003. *Murray Flow Assessment Tool* [Online]. Available: http://www2.mdbc.gov.au/livingmurray/mfat/downloads.htm.

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 CATEGORIES

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

Freshwater meadow

These include shallow (up to 0.3m) and temporary (less than 4 months duration) surface water, although soils are generally waterlogged throughout winter.

Shallow freshwater marsh

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

Deep freshwater marsh

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

Permanent open freshwater

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

Semi-permanent saline

These wetlands may be inundated to a depth of 2m for as long as eight months each year. Saline wetlands are those in which salinity exceeds 3,00mg/L throughout the whole year.

Permanent saline

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

APPENDIX 3: ENVIRONMENTAL WATER SOURCES

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

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

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

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

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

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

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

The environment's share of water savings will be over and above The Living Murray and Snowy commitments and will primarily target the use of environmental water for priority Victorian wetlands and tributaries. This will also have flow on benefits when the water enters the River Murray, which can then be reused to meet the needs of the Murray and its floodplains and wetlands, including Kerang Lakes, Barmah Forest, Gunbower Forest, Hattah Lakes, Lindsay-Wallpolla Island and various other sites along the River Murray. Stage 2 is expected to deliver a further 200 billion litres of water savings a year, which will be shared equally between irrigators and the environment.

Commonwealth Environmental Water Holder (CEWH) – The *Water Act* (2007) established the Commonwealth Environmental Water Holder to manage the water entitlements that the Commonwealth acquires. These water entitlements will be used to protect or restore environmental assets such as wetlands and streams.

APPENDIX 4: LEGISLATIVE FRAMEWORK

Acts, Agreements and Conventions

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

Bilateral Migratory Bird Agreements

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

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.

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

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

ACTS (NATIONAL)

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

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

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

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

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

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

ACTS (VICTORIA)

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 - 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.

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.

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.

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

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

Policy and Frameworks

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

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

Policy and Frameworks (Victoria)

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

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

Reports Applicable to the Environmental Watering Plan

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

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

The 110 actions aim to:

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

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

APPENDIX 5: FAUNA SPECIES LIST

Fauna list of One Tree and Two Tree Swamps – taken from Victorian Fauna Database 2007 and D. Cook 2010-11 counts.

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

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

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

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

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

w = wetland species

b = observed breeding in 2010/11 flood

Common Name	Scientific Name	FFG	VROTS	Origin and guild
BIRDS				
Australasian Bittern	*Botaurus poiciloptilus*	L	en	w
Australasian Pipit	*Anthus novaeseelandiae*			
Australasian Shoveller	*Anas rhynchotis*		vu	w
Australian Magpie	*Gymnorhina tibicen*			
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
Baillon's Crake	*Porzana pusilla*	L	vu	w
Black Swan	*Cygnus atratus*			w,b
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*			
Black-tailed Native-hen	*Gallinula ventralis*			w
Black-winged Stilt	*Himantopus himantopus*			w
Brolga	*Grus rubicunda*	L	vu	w,b
Brown Falcon	*Falco berigora*			
Brown Goshawk	*Accipiter fasciatus*			
Brown Songlark	*Cincloramphyus cruralis*			
Brown Quail	*Coturnix ypsilophora*		nt	w
Buff-banded Rail	*Gallirallus phillippensis*			w
Caspian Tern	*Hydroprogne caspia*	L	nt	w
Chestnut Teal	*Anas castanea*			w
Crested Pigeon	*Ocyphaps lophotes*			
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
Eurasian Skylark	*Alauda arvensis*			
Galah	*Eolophus roseicapilla*			
Golden-headed Cisticola	*Cisticola exilis*			
Great Cormorant	*Phalacrocorax carbo*			w
Grey Fantail	*Rhipidura albiscarpa*			
Grey Teal	*Anas gracilis*			w
Hardhead	*Aythya australis*		vu	w
Hoary-headed Grebe	*Poliocephalus poliocephalus*			w
Horsfield's Bronze-cuckoo	*Chalcites basalis*			
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 Eagle	*Hieraaetus morphnoides*			
Little Egret	*Egretta garzetta nigripes*	L	en	w
Little Grassbird	*Megalurus gramineus*			w
Little Pied Cormorant	*Microcarbo melanoleucos*			w
Little Raven	*Corvus mellori*			
Magpie Goose	*Anseranas semipalmata*	L	nt	w
Magpie-lark	*Grallina cyanoleuca*			
Masked Lapwing	*Vanellus miles*			w
Nankeen Kestrel	*Falco cenchroides*			
Nankeen Night Heron	*Nycticorax caledonicus*		nt	w
Noisy Friarbird	*Philemon corniculatus*			
Noisy Miner	*Manorina melanocephala*			
Olive-backed Oriole	*Oriolus sagittatus*			
Pacific Black Duck	*Anas superciliosa*			w
Pallid Cuckoo	*Cuculus pallidus*			
Pink-eared Duck	*Malacorhynchus membranaius*			w
Purple Swamphen	*Porphyrio porphyrio*			w
Red Wattlebird	*Anthochaera carunculata*			
Red-rumped Parrot	*Psephotus haematonotus*			
Restless Flycatcher	*Myiagra inquieta*			
Royal Spoonbill	*Platalea regia*		vu	w
Rufous songlark	*Cindoramphus mathewsi*			
Silver Gull	*Chroicocephalus novaehollandiae*			w
Singing Busklark	*Mirafra javanica*			
Spotless Crake	*Porzana tabuensis*			w
Straw-necked Ibis	*Threskiornis spinicollis*			w
Stubble Quail	*Coturnix pectoralis*			
Superb Fairy-wren	*Malurus cyaneus*			
Swamp Harrier	*Circus approximans*			w
Tree Martin	*Hirundo nigricans*			
Welcome Swallow	*Hirundo neoxena*			w
Western Gerygone	*Gerygone fusca*			
Whiskered Tern	*Chlidonias hybridus javanicus*		nt	w
Whistling Kite	*Haliaster 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
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*			
Zebra Finch	*Taeniopygia guttata*			
FROGS				
Barking Frog	*Limnodynastes fletcheri*			
Common Froglet	*Crinia signifera*			
Peron's Tree Frog	*Litoria peronii*			
Plains Froglet	*Crinia parinsignifera*			
Pobblebonk	*Limnodynastes dumerilii*			
Spotted Marsh Frog	*Limnodynastes tasmaniensis*			
MAMMALS				
Eastern Grey Kangaroo	*Macropus giganteus*			
REPTILES				
Brown Snake	*Pseudonaja textilis*			
INTRODUCED SPECIES				

Common Blackbird	*Turdus merula*			
Common Starling	*Sturnus vulgaris*			
Brown Hare	*Lepus capensis*			
House Sparrow	*Passer domesticus*			
Rabbit	*Oryctolagus cuniculus*			
Red Fox	*Vulpes vulpes*			

APPENDIX 6: ECOLOGICAL VEGETATION CLASSES

The following information has been cited 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 (i.e. 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 One Tree and Two Tree Swamp (www.dse.gov.au).

Plains Grassy Wetland [EVC #125]

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

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.

Lignum Swamp [EVC#104]

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

APPENDIX 7: FLORA SPECIES LIST

Flora list of One Tree and Two Tree Swamp – taken from Cook *et al* 2010-11 survey and FIS Database 2010.

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

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

en = Listed as endangered on the DSE Advisory list of rare or threatened plants in Victoria (2005)

r = Listed as rare on the DSE Advisory list of rare or threatened plants in Victoria (2005)

k = Listed as poorly known on the DSE Advisory list of rare or threatened plants in Victoria (2005)

w = wetland species

= Native to Victoria but grows outside its natural range

Common Name	Scientific Name	One tree Swamp			Two tree Swamp			EPBC	FFG	VROT	Origin	Indigenous use
		EVC 647	EVC 291	EVC 125	EVC 104	EVC 291	EVC 125					
Lesser Joyweed	*Alternanthera denticulate s.l*	✓									w	
Plains Joyweed	*Alternanthera spp* (Plains)									k		
Long-nosed Swamp Wallaby-grass	*Amphibromus macrorhinus*			✓								
Common Swamp Wallaby-grass	*Amphibromus nervosus*	✓	✓	✓	✓	✓					w	
Swamp Wallaby-grass	*Amphibromus spp*					✓					w	
Small Vanilla-Lily	*Arthropodium minus*											Tubers eaten
Chocolate Lily	*Arthropodium strictum*											
Common Woodruff	*Asperula conferta*				✓						w	
Berry Saltbush	*Atriplex semibaccata*											
Common Wallaby-grass	*Austrodanthonia caespitosa*											
Brown-back Wallaby-grass	*Austrodanthonia duttoniana*		✓	✓	✓		✓				w	
Bristly Wallaby-grass	*Austrodanthonia setacea*											
Plump Spear-grass	*Austrostipa aristiglumis*											
Woodland Swamp-daisy	*Brachyscome basaltica var.gracilis*		✓	✓							w	
Tah-vine	*Boerhavia dominii*										#	
Winged Water Starwort	*Callitrichie umbonata*		✓	✓						r	w	
Lemon Beauty-heads	*Calocephalus citreus*											
Tufted Burr-daisy	*Calotis scapigera*										w	
Bitter-cress	*Cardamine spp*										w	
Riverina Bitter-cress	*Cardamine moirensis*			✓						r	w	
Tall Sedge	*Carex appressa*	✓									w	
Poong'ort	*Carex tereticaulis*	✓			✓	✓					w	Used to make string and fibre.
Chara	*Chara sp*		✓								w	
Windmill Grass	*Chloris truncata*											
Pink Bindweed	*Convolvulus erubenscens spp.agg.*											Tap roots made into dough
Swamp Billy-buttons	*Craspedia paludicola*		✓	✓	✓						w	
Spreading Crassula	*Crassula decumbens var.decumbens*			✓								
Purple Crassula	*Crassula peduncularis*			✓								

Waterwort	*Elatine gratioloides*			✓							w	
Common Spike-sedge	*Eleocharis acuta*	✓	✓	✓	✓	✓					w	
Grey Spike-sedge	*Eleocharis macbaronii*		✓	✓						k	w	
Small Spike-sedge	*Eleocharis pusilla*	✓	✓	✓	✓						w	
Grey Willow-herb	*Epilobium billardierianum subsp. cinereum*	✓									w	
Robust Willow-herb	*Epilobium billardierianum subsp. hydrophilum*	✓									w	
Southern Cane-grass	*Eragrostis infecunda*		✓	✓	✓	✓					w	
Long Eryginum	*Eryngium paludosum*		✓	✓	✓					v	w	
River Red Gum	*Eucalyptus camaldulensis*										w	Used to make canoe, shields, shelter and water vessels
Australian Sweet-grass	*Glyceria australis*										w	
Slender Goodenia	*Goodenia gracilis*		✓	✓							w	
Spreading Goodenia	*Goodenia heteromera*			✓								
Plain Quillwort	*Isoetes drummondii*		✓	✓							w	
Broad-fruit Club-sedge	*Isolepis cernua var. playcarpa*	✓	✓								w	
Grassy Club-sedge	*Isolepsis hookeriana*	✓									w	
Club Sedge	*Isolepis spp.*			✓							w	
Toad Rush	*Juncus bufonius*	✓	✓	✓	✓						w	
Gold Rush	*Juncus flavidus*		✓	✓	✓	✓	✓				w	
Joint-leaf Rush	*Juncus holoschoenus*	✓		✓							w	
Rush	*Juncus spp*			✓								
Common Blown-grass	*Lachangrostis filiformis*	✓									w	
Australian Lilaeopsis	*Lilaeopsis polyantha*			✓							w	
Austral Mudwort	*Limosella australis*			✓							w	
Poison Pratia	*Lobelia concolor*				✓	✓					w	
Poison Lobelia	*Lobelia pratioides*		✓	✓							w	
Small Loosestrife	*Lythrum hyssopifolia*	✓	✓	✓	✓						w	
Narrow-leaf Nardoo	*Marsilea costulifera*	✓	✓	✓							w	
Common Nardoo	*Marsilea drummondii*	✓		✓	✓		✓				w	Sporocarp eaten
Nardoo	*Marsilea sp.*		✓								w	
Tangled Lignum	*Muehlenbeckia florulenta*				✓							Fruits ground into flour
Spiny Lignum	*Muehlenbeckia horrida subsp. horrida*									r	w	
Upright Water-milfoil	*Myriophyllum crispatum*	✓				✓					w	
Amphibious Water-milfoil	*Myriophyllum simulans*			✓							w	
Water-milfoil	*Myriophyllum spp.*		✓	✓							w	
Stonewort	*Nitella spp*			✓							w	
Austral Adder's-tongue	*Ophioglossum lusitanicum*											
Swamp Lily	*Ottelia ovalifolia subsp. ovalifolia*						✓				w	
Grassland Wood-sorrel	*Oxalis perennans*											
Slender Knotweed	*Persicaria decipiens*	✓									w	
Austral Pillwort	*Pilularia novae-hollandiae*			✓							w	
Clay Plantain	*Plantago cunninghamii*			✓								
Red Pondweed	*Potamogeton chessmanii*	✓									w	
Drumsticks	*Pycnosorus globosus*										#w	
Ferny Small-flower Buttercup	*Ranunculus pumilio*	✓	✓	✓							w	
Floating Crystalwort	*Riccia duplex*		✓	✓							w	
Slender Dock	*Rumex brownii*											
Wiry Dock	*Rumex dumosus*											
Narrow-leaf Dock	*Rumex tenax*				✓						w	

Stiff Groundsel	*Scenecio behrianus*							En	L	en	w	
Variable Sida	*Sida corrugata*											
Broughton Pea	*Swainsona procumbens*										w	
Silky Swainson-pea	*Swainsona sericea*									v	w	
Water-ribbons	*Triglochin dubia*		✓	✓	✓	✓				r	w	
Northern Water-ribbons	*Triglochin multifructa*			✓							#w	
Trithuria	*Trithuria submersa*			✓							w	
Purple Bladderwort	*Utricularia beaugleholei*			✓							w	
River Bluebell	*Wahlenbergia fluminalis*			✓								
Bluebell	*Wahlenbergia spp.*		✓	✓								
Rigid Panic	*Walwhalleya proluta*		✓	✓	✓		✓				w	Seeds ground to make flour
Tiny Duckweed	*Wolffia australiana*										w	
Swamp Early Nancy	*Wurmbea dioica subsp. lacunaria*									k		
EXOTIC SPECIES												
Wild Oat	*Avena barbata*						✓					
Oat	*Avena spp*				✓							
Thread Water-starwort	*Callitriche hamulata*	✓		✓							w	
Common Water-starwort	*Callitriche stagnalis*	✓									w	
Slender Cicendia	*Cicendia filiformis*			✓								
Spear Thistle	*Cirsium vulgare*	✓	✓		✓	✓	✓					
Drain Flat-sedge	*Cyperus eragrostis*	✓									w	
Manna Grass	*Glyceria declinata*	✓									w	
Ox-tongue	*Helminthotheca echioides*	✓		✓			✓					
Yorkshire Fog	*Holcus lanatus*	✓										
Barley Grass	*Hordeum spp*		✓									
Awned Club-sedge	*Isolepis hystrix*	✓		✓							w	
Tiny Flat-sedge	*Isolepis levynsiana*	✓		✓							w	
Willow-leaf Lettuce	*Lactuca saligna*	✓										
Prickly Lettuce	*Lactuca serriola*				✓							
Hairy Hawkbit	*Leontodon taraxacoides subsp. taraxacoides*	✓	✓	✓								
Wimmera Rye-grass	*Lolium rigidum*	✓	✓	✓	✓							
Burr Medic	*Medicago polymorpha*	✓										
Paspalum	*Paspalum dilatatum*	✓										
Water Couch	*Paspalum distichum*	✓									w	
Toowoomba Canary-grass	*Phalaris aquatica*	✓										
Paradoxical Canary-grass	*Phalaris paradoxa*			✓								
Onion Grass	*Romulea rosea*	✓		✓								
Curled Dock	*Rumex crispus*	✓			✓		✓				w	
Rough Sow-thistle	*Sonchus asper*	✓		✓								
Common Sow-thistle	*Sonchus oleraceus*			✓	✓							
Wandering Speedwell	*Veronica peregrina*			✓							w	

APPENDIX 8: INDEX OF WETLAND CONDITION METHOD

Table 12 below shows what is measured for each of the six subindices and how they are scored.

Table 12: IWC subindices and measures

IWC subindex	What is measured	How it is scored
Wetland catchment	1. The intensity of the land use within 250 metres of the wetland	• The more intensive the landuse the lower the score
	2. The width of the native vegetation surrounding the wetland 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 wetland 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 wetland bed which has been excavated or filled	• The greater the percentage of wetland bed modified, the lower the score
Hydrology	5. Whether the wetland's water regime (i.e. the timing, frequency of filling and duration of flooding) has been changed by human activities	• 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 wetland are present	• The more activities present, the lower the score
	7. Whether the wetland has become more saline or in the case of a naturally salty wetland, whether it has become more fresh	• An increase in salinity for a fresh wetland lowers the score or a decrease in salinity of a naturally salty wetland lowers the score
Soils	8. The percentage and severity of wetland 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 wetland vegetation	• The lower the diversity and poorer health of native wetland vegetation, the lower the score • The increased degree of weediness in the native wetland 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 (Table 13). The maximum possible total score for a wetland is 38.4, which for ease of reporting, is scaled to 10 by dividing the total score by 38.4 and multiplying by 10. The score is then rounded to the nearest whole number.

Table 13: Weights of each subindex

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

Five wetland condition categories have been assigned to the subindex scores (Table 14) and total IWC scores (Table 15), to be consistent with the number of categories used in other condition indices such as the Victorian Index of Stream Condition. Biota score categories were determined by expert opinion and differ to those of the other subindices.

Table 14: Wetland condition categories assigned to subindex scores.

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

Table 15: Wetland condition categories assigned to total IWC scores

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

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

APPENDIX 9: EVC BENCHMARKS FOR ONE TREE AND TWO TREE SWAMP

EVC benchmarks have been determined for One Tree and Two Tree Swamps by monitoring the sites between 2010-2011.

EVC 104: Lignum Swamp

Description:
A relatively heterogenous group of species-poor wetlands dominated by robust and often dense lignum. Scattered in lower rainfall areas of north and west, including rain-shadow areas on basalt.

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

Scientific name	Common name
Asperula gemella	Twin-leaf Bedstraw
Austrodanthonia duttoniana	Brown-back Wallaby-grass
Eleocharis acuta	Common Spike-sedge
Eragrostis infecunda	Southern Cane-grass
Lachnagrostis filiformis var. 1	Common Blown-grass
Marsilea drummondii	Common Nardoo
Muehlenbeckia florulenta	Tangled Lignum
Scleroblitum atriplicinum	Starry Goosefoot
Senecio glossanthus	Slender Groundsel
Senecio runcinifolius	Tall Fireweed

Conditions when the EVC should not be assessed
None recognised. However, it should be noted that vegetation condition may be underscored during prolonged dry periods.

1. CRITICAL LIFEFORMS

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

General comments on assessing critical lifeform groupings
None.

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

Critical lifeform	No. spp.	% Cover	Comments
Medium (to tall) shrubs	1	10	
Medium to tall herbs	3	5	
Small to prostrate herbs	3	5	
Medium to tall graminoids	1	+	substantially modified if absent
Small non-tufted graminoids	1	+	substantially modified if absent

+ denotes presence

Ecological Vegetation Class benchmark for Index of Wetland Condition

Victoria
The Place To Be

EVC 104: Lignum Swamp

2. WEEDS

High threat weed species

Scientific name	Common name
Cirsium vulgare	Spear Thistle
Cynara cardunculus	Spanish Artichoke
Helminthotheca echioides	Ox-tongue
Lilaea scilloides	Lilaea
Lycium ferocissimum	African Box-thorn
Nassella trichotoma	Serrated Tussock
Phyla canescens	Fog-fruit

Conditions where weeds are considered to have a negligible impact

None recognised.

3. INDICATORS OF ALTERED PROCESSES

Indicator of altered process	Cover	Scale of severity
Samphire (eg. *Halosarcia pergranulata*) invasion	<1%	Minor
	1-5%	Moderate
	>5%	Severe

Circumstances where some critical lifeform groupings may not be evident

None recognised.

4. VEGETATION STRUCTURE AND HEALTH

Structural dominant	Benchmark cover
Tangled Lignum *Muehlenbeckia florulenta*	20%

Published by the Victorian Government Department of Sustainability and Environment September 2009

EVC 125: Plains Grassy Wetland

Description:

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

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

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

Herbs on the verge zones of relatively intact sites

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

Notes on indicator species

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

Conditions when the EVC should not be assessed

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

1. CRITICAL LIFEFORMS

Conditions when specific critical lifeform groupings should not be assessed

None recognised.

General comments on assessing critical lifeform groupings

None

EVC 125: Plains Grassy Wetland

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

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

+ denotes presence

2. WEEDS

High threat weed species

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

Conditions where weeds are considered to have a negligible impact

None recognised.

3. INDICATORS OF ALTERED PROCESSES

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

Circumstances where some critical lifeform groupings may not be evident

None recognised.

4. VEGETATION STRUCTURE AND HEALTH

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

Department of Sustainability and Environment

EVC Benchmark for the Index of Wetland Condition

EVC 291: Cane Grass Wetland

Description:

Species-poor vegetation dominated by Southern Cane-grass *Eragrostis infecunda* occurring in association with seasonal wetlands of low rainfall plains areas, typically on extremely heavy, grey clay soils. Scattered in drier plains areas in the west and north of the State.

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

Scientific name	Common name	Comments
Eragrostis infecunda	Southern Cane-grass	variously with e.g. *Eleocharis acuta, Potamogeton tricarinatus* s.l., *Lachnagrostis filiformis* var. 1.

Notes on indicator species

Species-poor.

Conditions when the EVC should not be assessed

None recognised, but may underscore following protracted drought conditions.

1. CRITICAL LIFEFORM GROUPINGS

Conditions when specific critical lifeform groupings should not be assessed

Representation of groups (other than Cane-grass) required on verges only.

General comments on assessing critical lifeform groupings

None.

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

Critical lifeform	No. spp.	% Cover	Comments
Cane grass	1	5	
Aquatic herbs or medium sedges	2	+	
Small (to medium) semi-aquatic herbs	5	10	on verges

+ denotes presence

3. INDICATORS OF ALTERED PROCESSES

None recognised.

4. VEGETATION STRUCTURE AND HEALTH

Structural dominant	Benchmark cover
Southern Cane-grass *Eragrostis infecunda*	10%

Ecological Vegetation Class benchmark for Index of Wetland Condition

Victoria The Place To Be

APPENDIX 10: FROG BREEDING EVENTS

Evidence of water requirements for frog species listed at One Tree and Two Tree Swamp (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