



# Loch Garry

## Environmental Water Management Plan

August 2019

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## Loch Garry Environmental Water Management Plan

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## Executive summary

This plan is prepared to guide the use of environmental water at Loch Garry, a wetland on the Goulburn River floodplain downstream of Shepparton. Environmental water is a legally recognised amount of water, set aside to meet environmental needs for sites such as Loch Garry.

This watering plan is not a holistic management plan for the site as it is limited to issues related to the management of water dependent values and environmental water.

Loch Garry is a 680-hectare wetland on the lower Goulburn River floodplain approximately 20 kilometres north of Shepparton. The complex wetland incorporates a paleochannel of the Goulburn River and is approximately 1m deep at its deepest point. It is surrounded by shallow wetland depressions, riverine forest and sand ridges.

Loch Garry provides a number of environmental, recreational and cultural values to the lower Goulburn region. It is managed as a State Game Reserve by Parks Victoria and is popular for duck and quail hunting. It is also contains numerous values and sites important to Yorta Yorta people and is recognised key point of interest in the Yorta Yorta Whole of Country Plan (YYNAC, 2012). Goulburn Murray Water is the designated waterway manager for Loch Garry, operating the Loch Garry Flood Protection scheme to mitigate the impacts of flooding in the lower Goulburn catchment.

Loch Garry has been assessed as being in good condition, providing an example of larger (>50 ha) freshwater swamps less commonly found on the lower Goulburn floodplain. The wetland supports a diversity of native plant and animal species, many of which are of conservation significance. These values have been used to develop management objectives associated with the future use of environmental water at the site.

***Management goal:*** Provide a watering regime at Loch Garry that protects ecosystem functions and provides the vital habitat needed to support the life cycles of water dependent plants and animals over the longer term.

Supporting objectives needed to achieve this management goal were developed in collaboration with a range of agency stakeholders, the Yorta Yorta Nation Aboriginal Corporation and wetland ecologists. These include:

- Restore diversity, recruitment and regeneration of target EVCs from the 2015 - 2019 benchmark by 2025.
- Ensure the protection of threatened plant species by establishing benchmark condition by 2024 and setting an objective by 2025.
- Protect refugia to support the long-term survival and resilience of waterbirds and turtles, to allow for re-colonisation beyond the refugia following dry periods, assessed by the presence of priority species.
- Protect the diversity of frog species in 80% of years to 2025
- Protect the diversity of wetland fish species by restoring self-sustaining population and expanding the range of species known to occur in the lower Goulburn system by 2035.

The Goulburn River has been developed to capture water for consumptive use, particularly irrigation on the plains of northern Victoria. The Lake Eildon storage in the headwaters and Goulburn Weir (which supplies the Waranga Basin) in the middle of the catchment harvest flows in the river, capturing minor and moderate floods and disconnecting the river from its floodplain. As such, reinstating a water regime at Loch Garry that better reflects that prior to river regulation is critical for achieving the site management goal.

A wetland watering regime has been derived from the ecological and hydrological objectives, using a seasonally adaptive approach that allows for variability in planned watering actions over time. This means that a watering regime is identified for optimal conditions, as well as maximum and minimum tolerable watering scenarios that may occur in dry or wet years.

The proposed watering regime considers both naturally occurring and managed floods. As such, environmental watering will target the shortfall in desired flooding frequency between naturally occurring events.

The optimum watering regime is to:

*Provide flooding eight years in ten, with dry phases in the deepest parts of the wetland not extending for more than 6 months. Deliver volumes of up to 1,000 ML per season to maintain areas of open water at variable depths of between 1 to 2 metres for 9 to 18 months. Watering actions aim to restore target EVCs and provide breeding opportunities for aquatic biota.*

*Top up flows may be provided following the peak of small to medium floods in the Goulburn River or to support waterbird breeding if it occurs.*

Environmental water will be delivered to Loch Garry using via the East Goulburn 22/12 Outfall Drainage Channel at a rate of approximately 20 ML/day. Loch Garry does not have a delivery share, so water for the environment can only be delivered when there is spare capacity to carry water in the channel. A temporary pump to transfer water from the Goulburn River.

The primary constraint to the management of environmental water at Loch Garry Lagoon is balancing its water requirements against the flood mitigation role it provides. This plan proposes a phased process to addressing this issue by delivering relatively small volumes of environmental water (up to 1,000 ML per season) until these interactions can be better understood and quantified.

A range of complementary actions have been identified to assist with other threats to achieving the site management goal. The high priority risks include fox predation on turtle nests, exotic fish damaging vegetation within the wetland, poor water quality (namely blackwater) reducing the growth of native aquatic plants and potentially causing fish kills, as well as recreational impacts associated with visitation and hunting.

The strategies outlined in this Plan will be reviewed over time and implemented in collaboration with a range of stakeholders including the Goulburn Broken Catchment Management Authority, Parks Victoria, Yorta Yorta Nation Aboriginal Corporation, Goulburn Murray Water and the Department of Environment, Land, Water and Planning. Monitoring actions and knowledge gaps that need to be addressed to support this review process are identified in this Plan and will be implemented where funding is available.

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## ABBREVIATIONS

CAMBA	China Australia Migratory Bird Agreement
CEWO	Commonwealth Environmental Water Office
CMAs	Catchment Management Authorities
DELWP	Department of Environment, Land, Water and Planning
EPBC	<i>Environment Protection Biodiversity Conservation Act 1999 (Cth)</i>
EVC	Ecological vegetation community
EWMP	Environmental Water Management Plan
EWR	Environmental Water Reserve
FFG	<i>Flora and Fauna Guarantee Act 1988 (Vic)</i>
GB CMA	Goulburn Broken Catchment Management Authority
GMW	Goulburn Murray Water
Ha	Hectare
IWC	Index of Wetland Condition
JAMBA	Japan- Australia Migratory Bird Agreement
ML	Megalitre (one million litres)
ROKAMBA	Republic of Korea Australia Migratory Bird Agreement
VEWH	Victorian Environmental Water Holder

## 1. Introduction

### 1.1 Purpose of this plan

This plan is prepared to guide the use of environmental water at Loch Garry, a wetland on the Goulburn River floodplain downstream of Shepparton. Environmental water is a legally recognised amount of water, set aside to meet environmental needs for sites such as Loch Garry.

This watering plan is not a holistic management plan for the site as it is limited to issues related to the management of water dependent values and environmental water. However, consistent with the Memorandum of Understanding between Yorta Yorta Nation Aboriginal Corporation (YYNAC) and the Goulburn Broken Catchment Management Authority (YYNAC & GBCMA, 2014), this plan considers opportunities to support and promote the aspirations and interests of Yorta Yorta peoples (section 3.4).

### 1.2 Important note about this plan

Loch Garry is a multiple use site, which interacts with the scope of this Environmental Water Management Plan. Site use and organisations involved in its management include:

- YYNAC has a formal role in the management of the reserve under the Cooperative Management Agreement (2004) and the Joint Management Agreement for the Lower Goulburn National Park
- Parks Victoria is the designated land manager under the *National Parks Act (Vic) 2018*
- The area is partially a State Game Reserve, managed under a Sustainable Hunting Action Plan (DEDJTR, 2016) by Parks Victoria and the Game Management Authority, and partially a National Park managed by Park Victoria
- The reserve is used for flood mitigation purposes under the management of Goulburn Murray Water
- Goulburn Murray Water is the designated waterway manager for Loch Garry, while the Goulburn Broken Catchment Management Authority (CMA) is responsible for environmental water management at the site.

This plan outlines an approach to balance environmental watering with other site needs. In particular, it proposes the initial introduction of relatively small volumes of environmental water (up to 1,000 ML per season) to enhance the values of the site without compromising its flood storage function. It is anticipated that additional investigations will occur in the future to consider how the water needs of the site can be better satisfied without increasing flood risks to private landholders downstream.

Further information about management and use of the site is provided in section 3.

### 1.3 Context

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. State and Commonwealth environmental watering programs now have the potential to extend beyond those sites that have been watered in the past.

Environmental watering in Victoria has historically been supported by management plans such as this one, that document key information such as the watering requirements of a site, predicted ecological responses and water delivery arrangements. These plans support annual decisions about which sites should receive water and assist managers to evaluate how well those sites respond to the water they receive or what could be done better.



## 1.4 Environmental water in Victoria

Planning (DELWP) and the Victorian Environmental Water Holder (VEWH) are working together to develop 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 dependent 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 (EWMP) for Loch Garry in the Goulburn Broken Catchment Management region.

## 1.5 Environmental water sources for Loch Garry

Environmental water is held in storage (as a legal entitlement) and can be delivered to wetlands or streams to protect their environmental values and health. The entitlements are held by the Minister for Environment, who delegates management to the Victorian Environmental Water Holder.

Environmental water that may be used at Loch Garry environmental water held by the Commonwealth Environmental Water Office (CEWO) and the Victorian Environmental Water Holder (VEWH) stored in Lake Eildon. The amount of water available varies from year to year, depending upon volumes in storage and seasonal water allocations.

Further detail on environmental water available for use at Loch Garry is provided as Appendix A.

## 1.6 Links to the Murray-Darling Basin Plan

The Murray–Darling Basin Plan (MDBA, 2012) was developed to manage the Basin as a whole connected system.

The aim of the Murray–Darling Basin Plan is to bring the Basin back to a healthier and sustainable level, while continuing to support farming and other industries for the benefit of the Australian community. At its heart, the Basin Plan sets the amount of water that can be taken from the Basin each year, while leaving enough for our rivers, lakes and wetlands and the plants and animals that depend on them.

Water for the environment is used to improve the health of our rivers, wetlands and floodplains. Managing water for the environment requires recovering, planning and delivering water to protect vital ecosystems.

The Goulburn River is the largest Victorian tributary to the Murray system. As such, the future management of the river and its floodplain makes is an important part of Victoria’s contribution to the Murray-Darling Basin Plan. This Environmental Water Management is prepared as part the state’s planning activities for the use of water for the environment.

Specifically, it considers the contribution of Loch Garry to the broader ecosystem functions and values of the Goulburn River system and how this aligns with the Basin Plan environmental watering objectives and targets as set out in sections 8.04, 8.05, 8.07 and 8.5, as well as schedules 7 and 9.

## 2. Development of this plan

### 2.1 Consultation

This plan was prepared by Jacobs Australia Pty Ltd, on behalf of the Goulburn Broken Catchment Management Authority (CMA) with input from the Goulburn Broken CMA wetland technical reference group (TRG). The overall site management goal, ecological and hydrological objectives were developed in conjunction with the TRG and CMA staff at a workshop held at the Goulburn Broken CMA on January 23rd, 2019. The workshop was based around the local history of the wetland, knowledge of past and present watering regimes, the water requirements to support existing ecological values and the current condition of the swamp. Workshop attendees included:

- members of the TRG: Damien Cook (Australian Ecosystems), Rhonda Butcher (Waters Edge Consulting), Wayne Koster (Arthur Rylah Institute)
- Goulburn Broken CMA: Simon Casanelia and Sue Kosch, and
- Parks Victoria: Kathryn Stanislawski.

The workshop was also informed by a site visit undertaken in early December 2018 by Jacobs, representatives from the Goulburn Broken CMA, Yorta Yorta Clans Aboriginal Corporation, Parks Victoria and Goulburn Murray Water.

### 2.2 Information sources

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

- Goulburn Broken Waterway Strategy (GBCMA, 2014)
- Lower Goulburn Wetlands Flora and Fauna Surveys (Australian Ecosystems, 2012)
- Overbank flow recommendations for the lower Goulburn River (DSE, 2011)
- Water requirements of selected Victorian wetland biota: a resource guide (DELWP, 2016)
- A guide to water regime, salinity ranges and bioregional conservation status of Victorian wetland Ecological Vegetation Classes (Frood & Papas, 2016)
- Guidelines for preparing wetland Environmental Water Management Plans v5.0 (DEPI, 2014).

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

- Victorian Biodiversity Atlas Species Survey Records (accessed via NatureKit <http://maps.biodiversity.vic.gov.au>)
- Bioregional Conservation Status of Ecological Vegetation Classes (accessed via <https://www.environment.vic.gov.au>)
- Victorian Wetland Environments and Extent - up to 1994 Victorian Wetland Inventory (Current) 2014 (accessed via MapShare <http://mapshare.maps.vic.gov.au/>).

### 2.3 Limitations

The information sources used in the development of this report have a number of limitations. These limitations include the data contained in the Victorian Biodiversity Atlas Species Survey Records comes from a combination of incidental records and systematic surveys. The data varies in accuracy and reliability

due to the distribution and intensity of survey efforts. In addition, the lack of knowledge about the distribution and characteristics of invertebrates and non-vascular plant species means the data is weighted towards the less cryptic elements of flora and fauna, i.e. vascular flora and vertebrates.

The water regime for Loch Garry discussed in this Plan was developed using local knowledge, technical experts, field observations and scientific literature on the water requirements of relevant aquatic flora and fauna where available. This report also draws on material collated from management plans, research documents and published literature. These sources vary in their age and hence the degree to which they reflect the current situation. However, the Plan intends to be a live document and will be amended as new information becomes available.

A limited budget was available for the preparation of this plan. Therefore, some aspects are not considered in the level of detail provided in EWMPs prepared for other wetlands in the Goulburn Broken region.

### 3. Site overview

#### 3.1 Regional setting

Loch Garry is located in the Goulburn Broken catchment area, which comprises the catchments of the Goulburn and Broken Rivers. The catchment covers a total of 2,391,544 hectares or 10.5 per cent of Victoria's total land area (Figure 1) and generates 11 per cent of the Murray Darling Basin's water resources (DNRE, 2002).

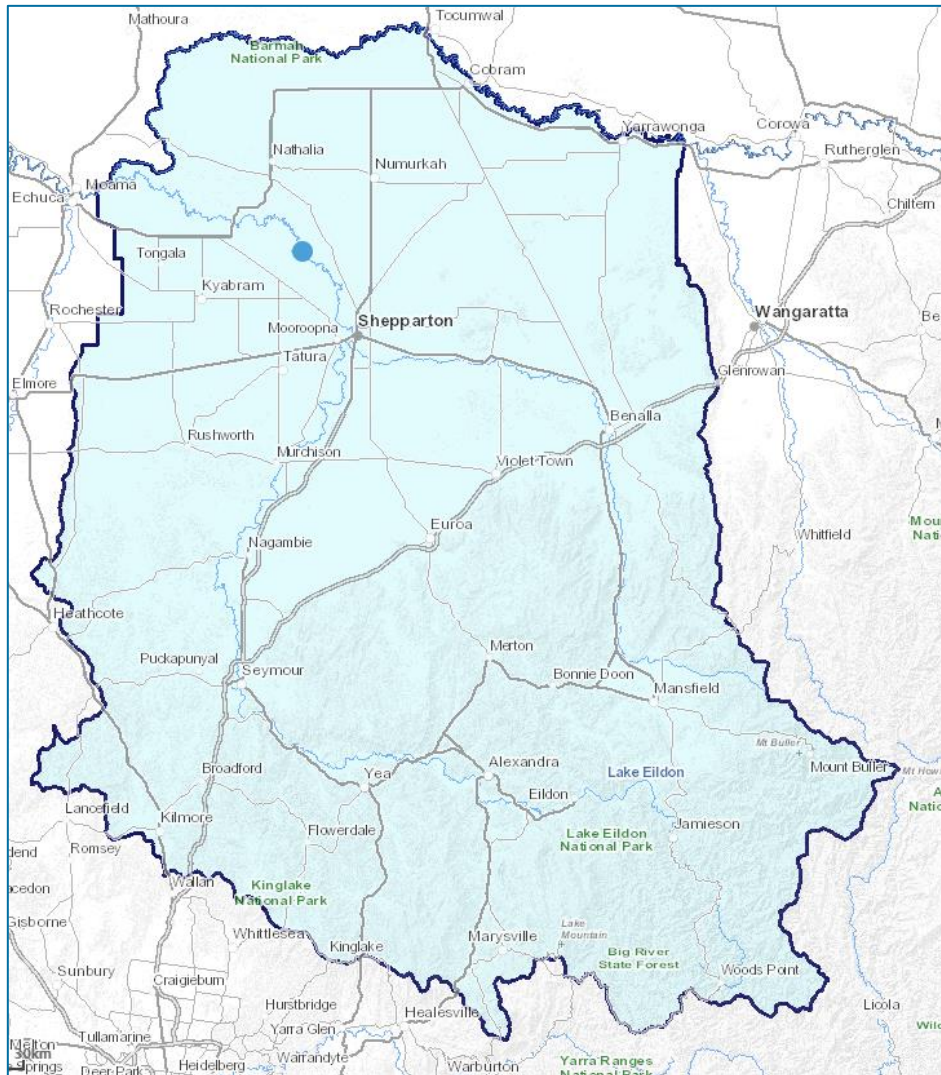


Figure 1: The Goulburn Broken Catchment; the location of Loch Garry is indicated by a blue dot. (Source: Victorian Department of Environment, Land, Water and Planning, <http://maps.biodiversity.vic.gov.au>.)

Within the Goulburn Broken Catchment approximately 2,000 natural wetlands have been recorded including numerous 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, many of the wetlands support state and nationally threatened plant and animal communities, including birds listed on international agreements and conventions.

Over 60 per cent of the Goulburn Broken Catchment has been cleared for agriculture purposes (GBCMA, 2010). The Goulburn Broken catchment includes irrigated and dry land agriculture. Drainage, land forming



and river regulation have also significantly reduced the number and area of wetland habitats. Therefore, the remnant vegetation and wetlands within the catchment form an important corridor in the catchment.

### 3.2 Catchment history

Loch Garry is a 680-hectare wetland on the lower Goulburn River floodplain approximately 20 kilometres north of Shepparton. The complex wetland incorporates a paleochannel of the Goulburn River and is approximately 1m deep at its deepest point (Australian Ecosystems, 2012). It is surrounded by shallow wetland depressions, riverine forest and sand ridges (Figure 2 and Figure 3).



Figure 2: Loch Garry is a paleochannel of the Goulburn River.



Figure 3: Shallow wetland depressions at Loch Garry.

It is situated in the Murray Fans bioregion, located in north central Victoria. It is characterised by a flat to gently undulating landscape on recent unconsolidated sediments with evidence of former stream channels,

braided old river meanders and palaeochannels and broad floodplain areas associated with major river systems and prior streams (known as braided / anastomosing streams). The Goulburn River in this area is incised into the gently undulating clay and sands of the Shepparton Formation. This is typically a mottled orange/red to white sandy clay, to grey plastic clay, overlying cemented sands.

Annual rainfall for the region ranges from 360- 672mm per annum, with an average of around 530mm per annum (based on the Shepparton gauge). The average annual minimum and maximum temperature range is from 3 to 9 °C and 15 to 21 °C respectively. High mean maximum temperatures occur during the warmer months (Figure 4) resulting in high evaporative losses during these periods.

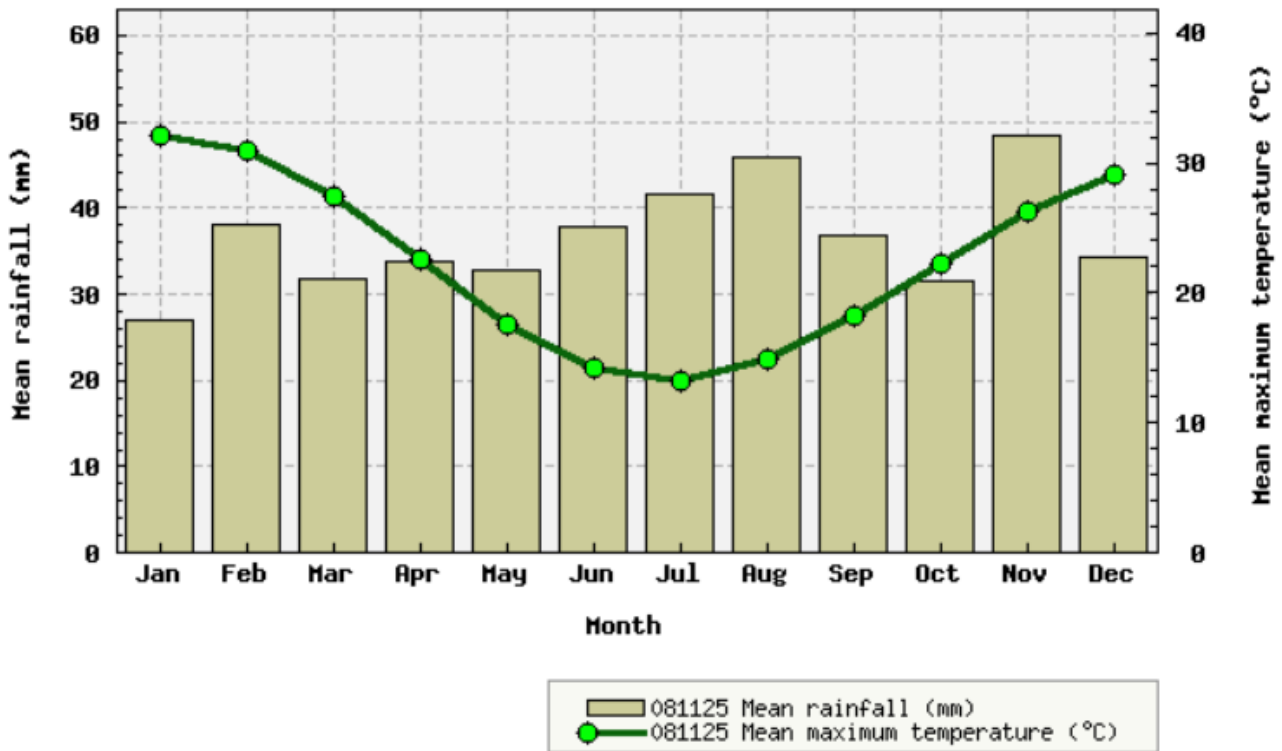


Figure 4: Mean rainfall and daily maximum temperature between 1996 and 2018 for location 81125, Shepparton Airport (Source: <http://www.bom.gov.au>)

Details of the site’s environmental values is provided in section 4.

### 3.3 Land status and management

The Lower Goulburn River floodplain extends from the Goulburn River’s junction with the River Murray upstream toward Shepparton, covering an area of about 13,000 ha. The Lower Goulburn River floodplain is listed as a wetland of national importance (EA, 2001) and is set within the broader floodplain of the lower Goulburn.

Loch Garry is located within the Loch Garry Wildlife Reserve, a 557-hectare reserve managed by Parks Victoria (Figure 5). A narrow section adjoining the Goulburn River is part of the Lower Goulburn River National Park, also managed by Parks Victoria.

The Loch Garry Wildlife Reserve is also classed a State Game Reserve. Hunting of duck and quail, and camping associated with hunting, is permitted at Loch Garry during designated seasons (VEAC, 2008). The Game Management Authority is responsible for regulating all game hunting activity in Victoria and is managed at a local level by Parks Victoria.



A range of management agencies are also responsible for ensuring that management of the study area complies with a broad range of legislative requirements, as discussed in section 3.7.



Figure 5: Aerial image of Loch Garry.

The broader community including adjacent landholders, the Yorta Yorta people, Landcare and recreational users also have an interest and/or role in the management of the planning area. The successful management of the study area therefore relies on effective cooperation and partnership between the government agencies and the broader community.

### 3.4 Cultural values

YYNAC is the state recognised Registered Aboriginal Party on matters of cultural heritage for this region. YYNAC also represents Yorta Yorta people on the management of land and water in their traditional country under a Cooperative Management Agreement (2004) with the Victorian Government. Under this agreement, YYNAC has a formal role in the management of Loch Garry.

Loch Garry contains numerous values and sites important to Yorta Yorta people including artefact scatters, scar trees, oven mounds, totem species, medicine plants and traditional food sources. The reserve is part of a broader landscape made up of a rich network of rivers, wetlands, creeks and wetlands that are a key feature of Yorta Yorta storylines and aspirations for natural and cultural resource management. The Goulburn River, which provides the source of water for Loch Garry, is called Kiaella (father) in Yorta Yorta language (YYNAC & GBCMA, 2014) highlighting the intrinsic value of this landscape as an embodiment of their identity and existence (YYNAC, 2012).

Loch Garry has been identified as a culturally sensitive area under the *Aboriginal Heritage Act 2006* (Vic) as waterways or land within 200m of a waterway. Loch Garry and the surrounding floodplain would have provided Yorta Yorta people with a rich and diverse supply of plant and animal resources for food, shelter

and customary-spiritual materials. All Aboriginal sites, places and objects are protected under the Archaeological and Aboriginal Heritage Act 2006 (Vic.) and the Aboriginal and Torres Strait Islander Heritage Protection Act 1984.

The Yorta Yorta Whole of Country Plan (YYNAC, 2012) recognises Loch Garry as a key place of interest and outlines 12 platforms of actions, some of which overlap with this plan, particularly:

- Manage endangered and threatened flora and fauna species and habitats
- Improve water quality and water flows, and wetland restoration.

Other actions that may be part of the supporting activities around the implementation of this EWMP are discussed in section 10.

### **3.5 Social and recreational values**

Loch Garry is a popular place to fish, boat, picnic or birdwatch and has trail connections to Shepparton. A social event 'Rocking Loch Garry', run by the Goulburn Broken CMA in late 2018 attracted approximately 100 people for macroinvertebrate identification, bird watching, talks and music. Historically, the wetland used to receive irrigation drainage outfalls, (GMW, 2012) which kept the main channel wet for prolonged periods of time. This supported native and introduced fish including Golden Perch and Redfin making the wetland popular for recreational fishing.

### **3.6 Economic values**

The Loch Garry Flood Protection scheme was constructed around 1925 and consists of a large regulating structure (Figure 6) and associated levees to prevent higher river flows escaping from the Goulburn River and inundating properties. Approximately 16,500 ha (140 Goulburn Murray Water customers) is provided some level of flood protection by this scheme (GMW, 2012) providing economic benefits for these people. In larger flood events (above approximately 40,000 ML/day), the regulator is opened to allow water to flow out of the Goulburn River and along Bunbartha Creek to protect Shepparton and Mooroopna townships.

Wetlands provide both direct and indirect economic values to the Goulburn Broken Catchment (Cork, 2001). The direct economic values that Loch Garry provides include non-consumptive uses such as tourism and recreation. Indirect economic values that Loch Garry provides to the Goulburn Broken Catchment include water filtration, flood protection, water storage, groundwater recharge, nutrient discharge, carbon storage and habitat for threatened flora and fauna species.



Figure 6: Regulator used as part of the Loch Garry Flood Protection Scheme

### 3.7 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 influence the management of Loch Garry. Those of most relevance to this Environmental Water Management Plan are summarised below:

- **International treaties, conventions and initiatives**, such as Japan Australia Migratory Birds Agreement (JAMBA) 1974
- **Commonwealth legislation and policy**, such as the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) and the Framework for Determining Commonwealth Environmental Watering Actions (2009)
- **Victorian legislation**, such as the *Catchment and Land Protection Act* 1994 and the *Aboriginal Heritage Act* 2006
- **Victorian policy, codes of practice, charters and strategies**, such as Water for Victoria (DELWP, 2016)
- **Regional plans and strategies**, such as the Goulburn Broken Regional Waterway Strategy 2014- 2022 (GBCMA, 2014), the River Red Gum Parks Management Plan (PV, 2018) and Yorta Yorta's Whole of Country Plan (YYNAC, 2012).

Further information on the legislative, policy and planning setting for Loch Garry is provided as Appendix B.

### 3.8 Site specific management plans

Parks Victoria undertakes land management activities at the site guided by the River Red Gum Parks Conservation Action Plan (Parks Victoria, 2019) and the Sustainable Hunting Action Plan (DEDJTR, 2016). Recent activities include revegetating the sandy rises (Figure 7). Parks Victoria will be developing a precinct plan for the site in the future.





Figure 7: Revegetation of the sandy rises.

## 4. Water dependent environmental values

### 4.1 Wetland type

#### Wetland classification

Wetlands in Victoria are currently classified using a system developed by Corrick and Norman (1980, Appendix C), recently updated in 2014. Using this system, Loch Garry is classified as a temporary freshwater swamp under the current Victorian Wetland Inventory layer.

Table 1: Summary of site characteristics

Characteristics	Description
Name	Loch Garry
Wetland ID	63119
Area (ha)	Reserve: 680 hectares; Wetland: 100 hectares <sup>1</sup>
Bioregion	Murray Fans
Conservation Status	Wetland of National Importance
Land Status	Public
Land Manager	Parks Victoria
Surrounding Land Use	Dryland and irrigated agriculture
Water Supply	Goulburn River, East Goulburn 22/12 Outfall Drainage Channel
1788 Wetland Category	Deep Freshwater Marsh
2014 Wetland Category	Temporary Freshwater Swamp

#### Wetland depletion and rarity

The impact of European settlement and development on Victorian wetlands has been severe, with approximately one-third of the state's wetlands being lost since European settlement and many of those remaining at risk of continuing degradation (EA, 2001).

Temporary freshwater swamps, such as Loch Garry, are amongst the most impacted wetland types in Victoria, with 70 percent of the original area estimated to have been lost (DNRE, 1997). The restoration and protection of these areas is vital to support the life cycle processes for the flora and fauna that rely on them.

<sup>1</sup> Estimated area that may be influenced by environmental watering

Table 2: Wetland type and abundance between Goulburn Weir and Loch Garry (Cottingham, et al., 2003)

Wetland type (1788)	Wetland size class (ha)				Reach total	% of reach total
	1-9	10-25	25-65	>50		
Freshwater meadow	147	60	22	13	242	45
Shallow freshwater meadow	83	44	20	18	165	31
Deep freshwater marsh	17	13	4	5	39	7
Permanent open freshwater	73	5	2	8	88	16
Other	7	1	1	1	10	2

Table 2 shows that larger (>50 ha) wetlands such as Loch Garry are less common on the lower Goulburn floodplain, increasing the importance of protecting this site.

### Ecosystem functions

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

Floodplain wetlands like Loch Garry perform important functions necessary to maintain the hydrological, physical and ecological health of river systems. These functions include:

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

However, the capacity of floodplain wetlands to perform the ecological functions outlined above will depend on their condition (section 6) and on connectedness back to the river.

The water regimes recommended in this plan will improve the ecosystem functions of Loch Garry. Through its implementation, it will contribute to the maintenance of ecosystem functions outlined in Schedule 9 of the Basin Plan, specifically criterion 1 – *the ecosystem function creates and supports the maintenance of vital habitats and populations*.

## 4.2 Fauna

### Fauna listings and significance

Loch Garry provides habitat for a wide variety of wetland and terrestrial fauna species. To date 112 fauna species have been recorded at the site, of which 104 are native (Appendix D). These include 88 native bird species, six fish species, three reptiles, two mammals and four frog species.

Of the species that utilise wetlands, one is listed under the EPBC Act; seven are listed under the FFG Act; eighteen on the VROT list (1988), one under the Bonn Convention, one under the Japan-Australia Migratory Bird Agreement (JAMBA) and two under the China Australia Migratory Bird Agreement (CAMBA) (Table 3).



Table 3: Conservation status of water dependent fauna species recorded at Loch Garry.

Scientific name	Common name	FFG	VROT	EPBC	Treaty	Type
<i>Acrocephalus stentoreus</i>	Clamorous Reed Warbler				B	B
<i>Alcedo azurea</i>	Azure Kingfisher		nt			B
<i>Anas rhynchos</i>	Australasian Shoveler		vu			B
<i>Ardea intermedia</i>	Intermediate Egret	L	en			B
<i>Ardea modesta</i>	Eastern Great Egret	L	vu		C, J	B
<i>Aythya australis</i>	Hardhead		vu			B
<i>Biziura lobate</i>	Musk Duck		vu			B
<i>Chelodina longicollis</i>	Eastern Snake-necked Turtle		dd			R
<i>Chlidonias hybridus javanicus</i>	Whiskered Tern		nt			B
<i>Emydura macquarii</i>	Murray River Turtle		vu			R
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	L	vu		C	B
<i>Maccullochella peelii</i>	Murray Cod	L	vu	VU		F
<i>Macquaria ambigua</i>	Golden Perch		nt			F
<i>Melanotaenia fluviatilis</i>	Murray River Rainbowfish	L	vu			F
<i>Nycticorax caledonicus hillii</i>	Nankeen Night Heron		nt			B
<i>Phalacrocorax varius</i>	Pied Cormorant		nt			B
<i>Platalea regia</i>	Royal Spoonbill		nt			B
<i>Porzana pusilla palustris</i>	Baillon's Crake	L	vu			B
<i>Tandanus tandanus</i>	Freshwater Catfish	L	en			F

**Legend**

Type: Bird (B), Fish (F), Reptile (R)

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

FFG: Listed as threatened (L)

VROT: Critically Endangered (CEn), Endangered (End), Vulnerable (Vul), Near Threatened (NT), Data Deficient (DD)

**Significant fauna**

Forty-six wetland bird species have been recorded at the site, with representatives from functional groups including Ducks; small Grebes and Jacanas; Piscivores; Shorebirds; Large Wading Birds and Herbivores. Loch Garry has been the location of colonial bird nesting in the past, providing a mix of deep and shallow water and overhanging vegetation.

Two turtle species have been recorded at Loch Garry: the Eastern Long-necked Turtle (*Chelodina longicollis*) and the Murray Turtle (*Emydura macquarii*). The loose sand of the sand ridges within Loch Garry would be ideal for egg-laying. Fox control in this area may enhance the breeding success of this species (Australian Ecosystems, 2012).



Figure 8: Murray Turtle (*Emydura macquarii*) at Loch Garry January 2012 (Australian Ecosystems, 2012).

Four frog species have been recorded at Loch Garry – the Common Froglet (*Crinia signifera*), Plains Froglet (*Crinia signifera*), Barking Marsh Frog (*Limnodynastes fletcheri*), Peron's Tree Frog (*Litoria peronii*).

### 4.3 Flora

#### Vegetation communities

A hierarchical system of classification of vegetation classes has been developed in Victoria 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 environments where they are expected to be found. 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.

EVCs at Loch Garry were mapped during 2012 (Figure 9) and found:

- The former river channel supported large areas of deep open water fringed by Giant Rush (*Juncus ingens*) dominated Tall Marsh (EVC 821).
- Shallower areas where water had receded and some of the larger floodplain depressions supported Floodway Pond Herbland (EVC 810).
- The forested margins of the channel and regularly inundated areas of the floodplain supported Riverine Swamp Forest (EVC 814) and Sedgy Riverine Forest (EVC 816).
- Elevated parts of the floodplain supported less frequently inundated EVCs including Riverine Grassy Woodland (EVC 295) and Riverine Swampy Woodland (EVC 815) (Figure 10).
- Sand Ridge Woodland (EVC 264) would have formerly occurred on the low sand ridges within the floodplain; however vegetation in these areas is now highly modified and dominated by exotic species (Australian Ecosystems, 2012).

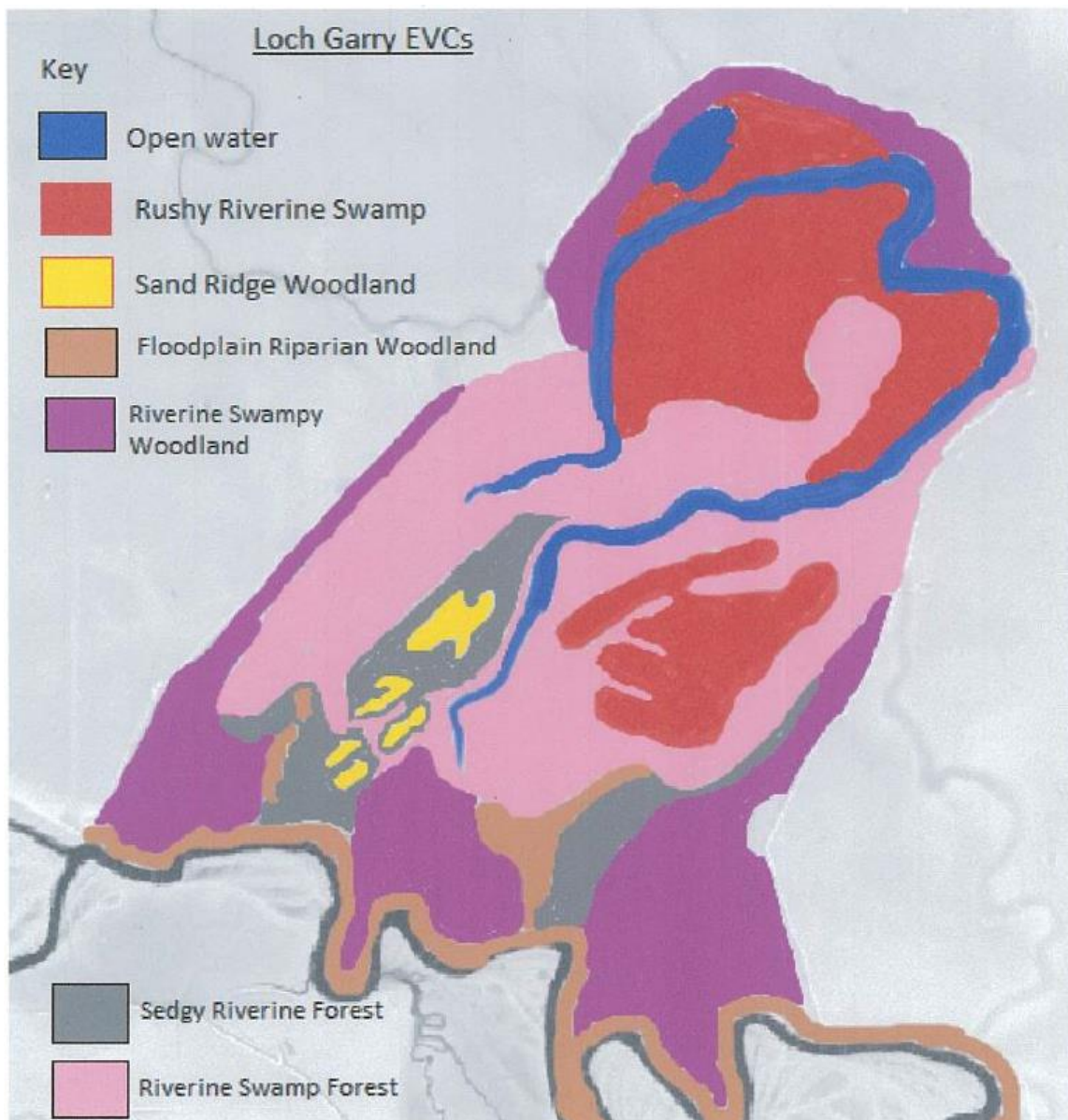


Figure 9: Vegetation communities at Loch Garry

The characteristics of the EVCs likely to benefit from environmental watering at Loch Garry, and their conservation status within the Murray Fans bioregion, is provided in Table 4.

Table 4: Description and conservation status of water-dependent Ecological Vegetation classes recorded at Loch Garry (Australian Ecosystems, 2012).

EVC Number	EVC Name	Description	Bioregional Conservation Status
821	<b>Tall Marsh</b>	Wetland dominated by tall emergent graminoids (rushes, sedges, reeds), typically in thick species-poor swards. Competitive exclusion in core wetland habitat - of optimum growing conditions for species tolerant of sustained shallow inundation. Occupies wetlands usually associated with anabranch creeks. Soils are almost permanently moist. Dominant species are tolerant of relatively deep and sustained inundation, but not total immersion for any sustained period.	Least Concern

EVC Number	EVC Name	Description	Bioregional Conservation Status
810	<b>Floodway Pond Herbland</b>	Low herbland to < 0.3 m tall with occasional emergent life forms, usually with a high content of ephemeral species. Floors of ponds associated with floodway systems. Typically, heavy deeply cracking clay soils. Characteristically smaller wetlands with a more regular flooding and drying cycle in comparison to sites supporting Lake Bed Herbland.	Depleted
814	<b>Riverine Swamp Forest</b>	Open eucalypt forest to 25 m tall with understorey dominated by obligate wetland species (or opportunistic annuals during sustained dry periods) and can range from closed sedgeland or herbland to grassy-herbaceous or extremely sparse and with cover primarily leaf-litter, black water or exposed alluvium. Occupies low-lying areas subject to reasonably regular flooding, typically flood-prone lower river terraces and low-lying areas adjacent to floodways through or within riverine forest.	Depleted
816	<b>Sedgy Riverine Forest</b>	Eucalypt forest to 25 m tall with understorey dominated by larger sedges. Understorey composition indicative of at least occasional shallow flooding and a tolerance of gaps between floods of several years. Typically on heavy soils which can become wet in winter. Sedgy Riverine Forest has some floristic affinities to Red Gum Swamp. It is considered to occupy areas infrequently flooded and in which flood duration may be short, for example, higher ground surrounding the box ridges or occurring along the river levee in a position remote from the channels from which the forest first floods. These areas are therefore the last to flood and the first from which floods quickly recede. Soils are typically heavy clays. The major understorey species <i>Carex tereticaulis</i> is intolerant of total immersion (at least in turbid water).	Depleted
295	<b>Riverine Grassy Woodland</b>	Occurs on the floodplain of major rivers, in a slightly elevated position where floods are rare, on deposited silts and sands, forming fertile alluvial soils. River Red Gum woodland to 20 m tall with a groundlayer dominated by graminoids and sometimes lightly shrubby or with chenopod shrubs.	Vulnerable
815	<b>Riverine Swampy Woodland</b>	Eucalypt woodland to 15 m tall above a grassy to sedgy – herbaceous ground layer, with species indicative of periodic water-logging. Occupies areas subject to shallow inundation only from higher-level flooding on riverine flood plain. Soils are typically heavy, cracking mottled grey-brown clays/clay-loams and water-retentive, often with a gilgai profile which can be wet during winter.	Vulnerable
264	<b>Sand Ridge Woodland</b>	Open pine-box woodland to 15 m tall with a small or medium shrub layer of variable density and including a range of annual herbs, grasses and geophytes, in the dense ground layer. Occupies distinctive sandy rises (or sand mounts) adjacent to major rivers and wetlands. Very sandy, deep, free draining, moderately fertile soil, developed on sand blown up by wind action from a prior stream bed.	Endangered

#### Legend

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

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

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).





Figure 10: Woodland surrounding the main channel of Loch Garry.

#### Flora – species listing and significance

A 2012 assessment recorded seventy-five species of vascular plants, fifty-four (72%) of which were indigenous. A reasonable diversity of emergent grasses, sedges and rushes and wetland herbs that typically colonize the drying mud of riverine wetlands as water levels receded were recorded, however, truly aquatic and semi-aquatic species were poorly represented. This may be attributed to high water turbidity, possibly contributed to by the abundance of Carp, or blackwater present at the time of surveys which may have made conditions unfavourable for the establishment of aquatic plant species (Australian Ecosystems, 2012) (Appendix E).

Five rare or threatened aquatic or semi-aquatic plants have been recorded at Loch Garry. River Swamp Wallaby-grass (*Amphibromus fluitans*) is listed as vulnerable under the federal *Environment Protection and Biodiversity Conservation Act 1999*. Floodplain Fireweed (*Senecio campylocarpus*), Waterbush (*Myoporum montanum*), Veiled Fringe-sedge (*Fimbristylis velata*), and Riverina Bitter-cress (*Cardamine moirensis*) are listed as rare on the Victorian Advisory List of rare and threatened flora (VROT) list (Table 5).



Figure 11: Veiled Fringe Sedge (*Fimbristylis velata*), a rare plant species found at Loch Garry

Table 5: Listed flora species recorded at Loch Garry (Australian Ecosystems, 2012; Victorian Biodiversity Atlas).

Scientific Name	Common Name	EPBC	FFG	VROT
<i>Amphibromus fluitans</i>	River Swamp Wallaby-grass	V	L	
<i>Cardamine moirensis</i>	Riverina Bitter-cress			r
<i>Fimbristylis velata</i>	Veiled Fringe-sedge			r
<i>Myoporum montanum</i>	Waterbush			r
<i>Senecio campylocarpus</i>	Floodplain Fireweed			r

**Legend:**

EPBC: Vulnerable (V)

FFG: Listed as threatened (L)

VROT: rare (r), poorly known (k)

**Flora – significance**

River Swamp Wallaby-grass is an aquatic perennial growing to 120 cm high. It grows mostly in permanent swamps but also wetlands, billabongs, dams and roadside ditches. It requires periodic flooding of habitat to maintain wet conditions and moderately fertile soils with some bare ground; conditions that are caused by seasonally-fluctuating water levels. The main identified threats to River Swamp Wallaby-grass are grazing and trampling by livestock, hydrological changes; and invasion of remnant habitats by exotic grasses and weeds (Department of the Environment, Water, Heritage and the Arts, 2008; Department of the Environment 2019).

Figure 12: The nationally vulnerable River Swamp Wallaby-grass (*Amphibromus fluitans*) (Australian Ecosystems, 2012).





## 5. Hydrology and system operations

### 5.1 Water management and delivery

Wetland hydrology is the most important determinant in the establishment and maintenance of wetland types and processes. It affects the chemical and physical aspects of the wetland which in turn affects the type of flora and fauna that the wetland supports (DSE, 2007b). A wetland's hydrology is determined by surface and groundwater inflows and outflows in addition to precipitation and evapotranspiration (DSE, 2007b). Duration, frequency and seasonality (timing) are the main components of a wetland's hydrological regime.

### 5.2 Historic water regime

Lake Eildon (originally known as Sugarloaf Reservoir) was constructed between 1915 and 1929 to provide irrigation water in the Goulburn Valley. The dam was modified in 1929 and again in 1935 to increase its storage capacity. However, this was still inadequate to provide the Goulburn Valley with sufficient water during drought. In 1951 the construction of a large dam (now known as Lake Eildon) began. This was completed in 1955 and supplies approximately 60 per cent of water to the Goulburn Murray Irrigation District (Cottingham et al., 2014b).

Lake Eildon has a capacity of 3,334 GL, which is approximately twice the average annual inflow in the Goulburn River (GBCMA, 2015). The storage and release of water in Lake Eildon has significantly altered the hydrology of the Goulburn River, with high flows in the mid Goulburn River now occurring in summer to autumn rather than winter to spring. Below Lake Eildon flows increase progressively due to tributary inflows (Figure 13). The natural seasonal flow pattern is partially retained below Goulburn Weir (where water is diverted to meet demands) but is substantially reduced in volume from natural conditions (GBCMA, 2015).

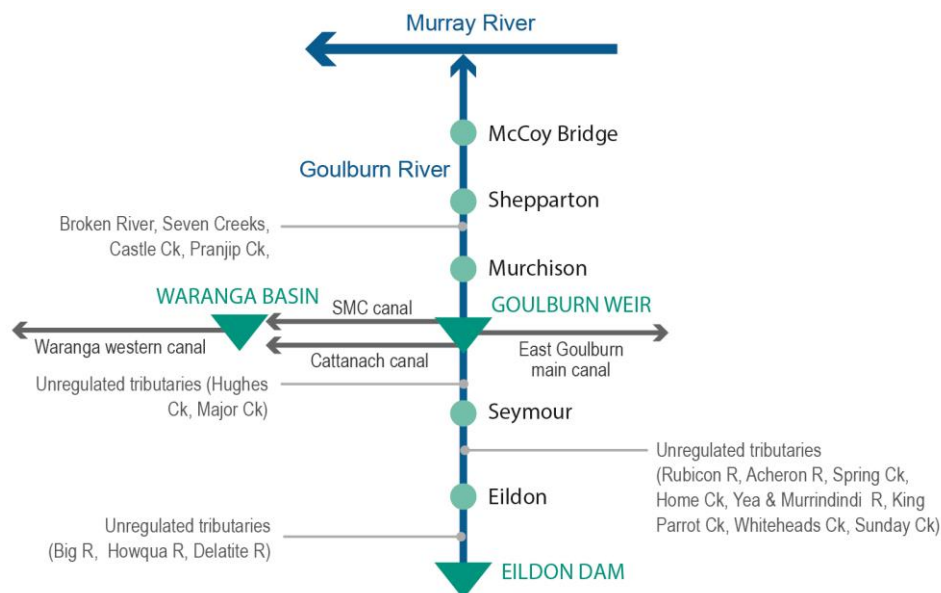


Figure 13: Schematic representation of the Goulburn River system

Loch Garry is located at the upstream end of what is known as Reach 5 of the Goulburn River for environmental water management purposes. Prior to construction of the Loch Garry Regulator, complete inundation of the reserve would have occurred at flows of around 20,000 ML/day in the Goulburn River (DSE, 2011). Flows of this magnitude would have occurred on an almost annual basis (Table 6) prior to the construction of Lake Eildon resulting in near permanent inundation of the wetland.

Historically, Loch Garry also used to receive irrigation drainage outfalls, which kept the main channel wet for prolonged periods of time. This supported native and introduced fish including Golden perch and Redfin making the wetland popular for recreational fishing.

### 5.3 Current water regime

Flow along the Goulburn River has been highly modified by two major features: Lake Eildon and Goulburn Weir (Figure 13). Current regulated operation of the river system is largely based on irrigation requirements and minimum flow provisions provided for under Goulburn Bulk Entitlements.

Goulburn Weir is approximately 235 km downstream of Lake Eildon (Figure 13). It holds 25 GL and is held close to full capacity to facilitate diversion for irrigation. Water is diverted at the weir to the Waranga Basin, which has a storage capacity of 432 GL (GBCMA, 2015a), and is used to capture winter and spring flows from tributaries downstream of Lake Eildon. Goulburn Weir and its operation (along with Lake Eildon) have reduced the average annual downstream flow to 1,340 GL, less than half the estimated pre-regulated flow (GBCMA 2015).

Along the lower Goulburn River, from near Loch Garry to the River Murray, a system of levees limits the extent of inundation of the floodplain, protecting farmland from flooding in 4 out of 5 years on average. As discussed in section 3.5, the Loch Garry Flood Protection Scheme (Figure 6) prevents the flow of water to the north of the Goulburn River main channel during unregulated flow events of up to 40,000 ML/day at Shepparton.

A comparison of the natural and current flows at the Shepparton (Table 6) shows how flows in the range that result in inundation of Loch Garry now occur significantly less often, for shorter durations and with much greater periods between events.

Table 6: Comparison of natural and current flow patterns at Shepparton (source: DSE, 2011)

Flow threshold:	20,000 ML/day	
	Natural	Current
Flood frequency (number)	25	7.5
Mean duration in spring (days)	9	6
Maximum period between events (years)	2.8	7

*Flood frequency:* average number of flood events per ten years

*Duration:* mean duration of high spells during September to November

*Maximum period between events:* based on modelled daily flow at Shepparton from July 1896 – June 2006

### 5.4 Environmental water

No environmental water has previously been delivered to Loch Garry. As discussed in section 1.5, a range of environmental water sources may be drawn on for use at the site.

## 6. Threats and condition

### 6.1 Water dependent threats

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

#### Altered water regime

Hydrology is the most important component of wetland ecosystems. It drives the physical and chemical properties of a wetland, and the biota it supports. The natural hydrological regime of Loch Garry has been significantly altered by regulation of the Goulburn River. It is now inundated less frequently and for shorter periods of time than under a natural regime.

#### Poor Water Quality

Poor water quality including low dissolved oxygen may reduce habitat available for native aquatic biota, reducing its diversity and abundance. The main water quality concerns at Loch Garry include:

- Hypoxic blackwater events that may limit growth of aquatic plants or cause harm, possibly death, of aquatic biota (SKM, 2011)
- Increased turbidity, as a result of exotic fish such as Carp (*Cyprinus carpio*) stirring up sediment from feeding activities
- Increased water temperatures unfavourable for aquatic biota.

#### Exotic flora and fauna

The invasion of native vegetation by pest plants is listed as potentially threatening process under the Schedule 3 of Victoria's *Flora and Fauna Guarantee Act* (1988) and is considered to be one of the major threats to 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, and the nutrient content of soil and disturbance regimes including fire, grazing and insect activity (PV, 2003).

Twenty-one environmental weeds were recorded at Loch Garry during the 2012 surveys, which assessed less than one percent of the wetland. The recorded weeds included one CaLP Act listed species, the regionally restricted Spear Thistle (*Cirsium vulgare*). High threat weeds recorded included Aster-weed (*Aster subulatus*), Lesser Quaking-grass (*Briza minor*), Great Brome (*Bromus diandrus*), Ox-tongue (*Helminthotheca echioides*), Wimmera Rye-grass (*Lolium rigidum*), Prostrate Knotweed (*Polygonum aviculare*), Narrow-leaf Clover (*Trifolium angustifolium* var. *angustifolium*) and Hare's-foot Clover (*Trifolium arvense* var. *arvense*). No Vic Alert, National Alert, or Weeds of National Significance (WONS) were identified.

Pest animals threaten the ecological values of wetlands by preying on native species, transmitting diseases, and competing for food and habitat. Pest animals that threaten ecological values at the site include:

- Foxes: fox predation is listed as a threatening process under the EPBC Act (1999) and FFG Act (1988).
- Rabbits: competition and land degradation by rabbits is listed as a threatening process under the EPBC Act (1999) and the FFG Act (1988).
- Carp, Goldfish and Gambusia: large numbers of carp have been observed during the drying phases of Loch Garry (SKM, 2011).

To maximise the ecological outcomes of environmental water deliveries and natural flood events e.g. to increase the breeding success of turtles and the survival, growth and reproduction of aquatic plants, the management of pest animals needs to be undertaken including control of foxes, rabbits and exotic fish species.

### Loss of woody habitat complexity

The main channel of Loch Garry lacks complexity of woody material that provides vital habitat for fish, algae and macroinvertebrates. Woody habitat provides shelter, food, breeding sites, territory markers and protection from predation for native fish. Macroinvertebrates and algae that rely on woody material provide a food source for high order organisms and can play a role of maintaining water quality. Birds, reptiles and mammals also use woody habitat for resting, foraging and lookout sites. Lack of woody habitat may pose a constraint to the restoration of native fish populations within the wetland. The reintroduction of woody debris will need to be undertaken in consultation with GMW and PV to ensure it doesn't pose a risk during flood events.

### Hunting and recreational access

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

## 6.2 Current condition

The condition of Loch Garry was assessed in December 2012 (following floods in the Goulburn River and natural inundation of the wetland) using a method developed by the then Department of Sustainability and Environment called the Index of Wetland Condition (IWC; Appendix F). The IWC defines wetland condition as the state of the biological, physical, and chemical components of the wetland ecosystem and their interactions (DSE, 2007b).

Loch Garry recorded an Overall Wetland Condition Score of 8 which – in accordance with the Index of Wetland Condition Methods Manual v.14 – is considered to be a wetland of Good condition (Table 7).

Table 7: Index of Wetland Condition scores for Loch Garry (Australian Ecosystems, 2012)

Sub index	Score	Maximum Possible Score	Condition Category
Wetland catchment	17.4	20	Excellent
Physical form	20	20	Excellent
Hydrology	10	20	Moderate
Water properties	15	20	Good
Soils	19.75	20	Excellent
Biota	17.5	20	Good
<b>Overall Wetland Condition</b>	<b>8</b>	<b>10</b>	<b>Good</b>

A December 2018 site visit showed Loch Garry in a partially dry phase, with a low diversity of vegetation in the littoral zone (Figure 14).





Figure 14: Littoral zone of Loch Garry, dominated by grasses and Pale Knotweed (*Persicaria lapathifolia*) (December 2018).

### 6.3 Condition trajectory

Ongoing management including the delivery of environmental water, monitoring and complementary works at Loch Garry is key to protecting the ecological values at the site. If no intervention occurs, Loch Garry will continue to receive water primarily from high flows of the Goulburn, at a reduced frequency and duration than under natural conditions. With an increasingly dry climate this may occur less frequently than appropriate for the wetland vegetation and dependent aquatic fauna.

## 7. Management objectives and adaptive approaches

### 7.1 Overall site management objective

The water management goal for Loch Garry was developed collaboratively during the development of this EWMP. The overall site objective considers the values of the wetland and its contribution to the goals of other strategies at a regional, state and basin scale.

*Provide a watering regime at Loch Garry that protects ecosystem functions and provides the vital habitat needed to support the life cycles of water dependent plants and animals over the longer term.*

### 7.2 Ecological objectives

Ecological objectives are the desired ecological outcomes of the site. In line with the draft policy Victorian Strategy for Healthy Rivers, Estuaries and Wetlands (VSHREW), the ecological objectives are based on the key values of the site (section 3 – Water Dependent Values) and the framework provided by the Basin Plan.

The ecological objectives are intended to be measurable over time and have been expressed as one of the following trajectories for each key value:

- *Protect* – maintain the current condition of the value while allowing natural processes of regeneration, disturbance and succession to occur.
- *Restore* – improve the condition of the value while allowing natural processes of regeneration, disturbance and succession to occur.

The ecological objectives for Loch Garry are based on values that the wetland provides for the mid Goulburn River system, its ability to support species listed under the *Environmental Protection Biodiversity Conservation Act* (1999) and the *Flora and Fauna Guarantee Act* (1988), and its provision of habitat important for the life cycles of waterbirds, frogs and turtles.

The ecological objectives for Loch Garry are:

- *Vegetation objective 1 (V1)*: Restore diversity, recruitment and regeneration of target EVCs from the 2015 - 2019 benchmark by 2025.
- *Vegetation objective 2 (V2)*: Ensure the protection of threatened plant species by establishing benchmark condition by 2024 and setting an objective by 2025.
- *Aquatic biota objective (AB1)*: Protect refugia to support the long-term survival and resilience of waterbirds and turtles, to allow for re-colonisation beyond the refugia following dry periods, assessed by the presence of priority species.
- *Amphibian objective (A1)*: Protect the diversity of frog species in 80% of years to 2025
- *Fish objective (F1)*: Protect the diversity of wetland fish species by restoring self-sustaining population and expanding the range of species known to occur in the lower Goulburn system by 2035.

Further definitions of each of the ecological objectives and their justification for selection is provided in Table 8.



Table 8: Ecological objectives for Loch Garry

Objective	Definition	Justification
<b>Flood dependent vegetation</b>		
<p><b>Objective V1: Restore diversity, recruitment and regeneration of target EVCs from the 2015 - 2019 benchmark by 2025.</b></p>	<ul style="list-style-type: none"> <li>Target EVCs include Rushy Riverine Swamp (804), Tall Marsh (821), Riverine Swamp Forest (814), Sedgy Riverine Forest (EVC 816), Floodway Pond Herbland (810) and possibly Floodway Riparian Woodland (56).</li> <li>'Water-dependent vegetation' referred to in the Basin Environmental Watering Strategy objectives is the collective reference to these EVCs.</li> <li>'Diversity' of EVCs is defined within the EVC benchmark and will require further definition</li> </ul>	<ul style="list-style-type: none"> <li>The vegetation community at Loch Garry is in moderate condition therefore the focus of the objective is to restore condition.</li> <li>Target EVCs represent those vegetation communities expected to be inundated by environmental watering (recognising management constraints at the site).</li> <li>This supports platform 6 and 8 of the Whole of Country Plan (YYNAC, 2012)</li> </ul>
<p><b>V2: Ensure the protection of threatened plant species by establishing benchmark condition by 2024 and setting an objective by 2025.</b></p>	<ul style="list-style-type: none"> <li>Threatened plant species include River Swamp Wallaby-grass (<i>Amphibromus fluitans</i>) and Floodplain fireweed (<i>Senecio campylocarpus</i>) both of which occur in EVC 804, as well as EVCs 810 and 810 for swamp wallaby grass.</li> <li>Protection of threatened plant species will be measured in the short term by the presence of these species in plant surveys.</li> </ul>	<ul style="list-style-type: none"> <li>Limited historical survey data makes it difficult to set meaningful and measurable objectives at Loch Garry</li> <li>The objective, as currently written, guides site managers to build a better understanding before setting benchmarks and objectives for those species</li> <li>This supports the Basin Plan section 8.05 in relation to the protection and restoration of threatened species and platform 7 of the Whole of Country Plan (YYNAC, 2012)</li> </ul>
<b>Aquatic biota</b>		
<p><b>Objective AB1: Protect refugia to support the long-term survival and resilience of waterbirds and turtles, to allow for re-colonisation beyond the refugia following dry periods, assessed by the presence of priority species in 50% of years to 2025.</b></p>	<ul style="list-style-type: none"> <li>Turtle populations includes the Eastern long necked (<i>Chelodina longicollis</i>) and Murray River (<i>Emydura macquarii</i>) turtles.</li> <li>Priority waterbirds include wetland specialist species of conservation significance identified in Appendix D of the EWMP.</li> </ul>	<ul style="list-style-type: none"> <li>This supports the Basin Plan section 8.07 (3) in relation to the provision of refugia, as well as 8.05 (3) in relation to protecting biodiversity.</li> <li>Objective will be measured by the detection of each species once in every five years, reflecting the anticipated frequency of survey effort.</li> <li>The health and status of turtle populations are of particular concern to Yorta Yorta, which are culturally significant as a food source and totem species (YYNAC, 2012)</li> </ul>

Objective	Definition	Justification
<p><b>Objective A1: Protect the diversity of frog species in 80% of years to 2025</b></p>	<ul style="list-style-type: none"> <li>Four species of frog have been previously recorded at the site including Plains froglet (<i>Crinia parinsignifera</i>), Common froglet (<i>Crinia signifera</i>), Barking Marsh Frog (<i>Limnodynastes fletcheri</i>) and Peron’s tree frog (<i>Litoria peronii</i>). Pobblebonk (<i>Limnodynastes dorsalis</i>) is also expected to occur.</li> </ul>	<ul style="list-style-type: none"> <li>Focus is on ensuring expected species remain present into the future.</li> <li>Abundance is not included in the objective as monitoring is unlikely to accurately measure this</li> <li>This supports platform 8 of the Whole of Country Plan (YYNAC, 2012)</li> </ul>
<p><b>Objective F1: Protect the diversity of wetland fish species by restoring self-sustaining populations and expanding the range of species known to occur in the lower Goulburn system by 2035.</b></p>	<ul style="list-style-type: none"> <li>Wetland fish species known to occur in the lower Goulburn system include Freshwater Catfish (<i>Tandanus tandanus</i>), Murray River Rainbowfish (<i>Melanotaenia fluviatilis</i>), Australian Smelt (<i>Retropinna semoni</i>), Flat-headed Gudgeon (<i>Philypnodon grandiceps</i>), Obscure Galaxias (<i>Galaxias sp. 1</i>), Carp Gudgeon (<i>Hypseleotris spp.</i>) and Unspecked Hardyhead (<i>Craterocephalus stercusmuscarum fulvus</i>)</li> </ul>	<ul style="list-style-type: none"> <li>Goulburn River identified in the Basin Environmental Watering Strategy as a potential priority asset for expanding the core range of Flathead galaxias, however reintroduction at Loch Garry is not anticipated within the timeframe of the objective.</li> <li>Focus of the objective is to (a) expand the range of fish known to currently occur in the lower Goulburn system and (b) ensure that no loss of current species occurs.</li> <li>Anticipated that reintroduction of species into Loch Garry may be required therefore the objective aims to achieve self-sustaining populations.</li> <li>Basin Plan focus is on diversity, distribution (or range), breeding success and numbers.</li> <li>This supports platform 8 of the Whole of Country Plan (YYNAC, 2012)</li> </ul>

### 7.3 Hydrological objectives

The water requirements of the vegetation communities that will be targeted by environmental watering at Loch Garry and are presented in Table 9. The water requirements presented in this table have been adapted from Rakali (2015) and Frood & Papas (2016).

Due to the lack of research and literature on the threatened plant species (objective V2) it is difficult to determine a singular watering regime for these species. However, it is known that River Swamp Wallaby-grass is a cool growing species and is likely to benefit from deliveries during the autumn-winter period. Monitoring of these species should occur to better understand their response to water deliveries at Loch Garry (Section 10).

Table 9: Water requirements of ecological vegetation classes expected to benefit from environmental watering at Loch Garry

Ecological objective	Ecological vegetation class	Hydrological Objectives										
		Frequency (years in 10)			Ponding duration (months)			Tolerable dry period (months)			Maximum depth	Timing
		Min	Opt	Max	Min	Opt	Max	Min	Opt	Max		
<i>V1: Protect diversity, recruitment and regeneration of target EVCs from the 2012 - 2019 benchmark by 2025.</i>	Rushy Riverine Swamp (804)	6	<b>8</b>	10	1	<b>8</b>	12	3	<b>6</b>	24	<1m	autumn to spring
	Tall Marsh (821)	6	<b>8</b>	10	6	<b>8</b>	11	6	<b>18</b>	24	<0.4m	autumn to spring
	Riverine Swamp Forest (814)	6	<b>8</b>	9	3	<b>6</b>	12	3	<b>6</b>	24	<1m	autumn to spring
	Sedgy Riverine Forest (816)	4	<b>6</b>	7	1	<b>2</b>	3	6	<b>10</b>	60	<0.5	autumn to spring
	Floodway Pond Herbland (810)	6	<b>8</b>	10	6	<b>18</b>	36	3	<b>6</b>	12	<2m	autumn to spring

The hydrological objectives and water regimes outlined in this EWMP focus on the needs of the vegetation communities expected to occur at Loch Garry. Providing the water for these vegetation communities also provides the habitat used by aquatic biota. This approach is considered reasonable as:

- **Waterbirds:** The ecological objective for waterbirds focusses on the provision of roosting and feeding habitat. Meeting the water requirements of vegetation is also expected support aquatic food webs and provide roosting habitat for waterbirds. In the event waterbird breeding occurs in response to natural or managed inundation, top up flows specified in the optimal watering regime may be provided to extend the availability of habitat until fledging of young birds occurs. As such, separate hydrological objectives for waterbirds have not been recommended.
- **Turtles:** The water requirements for the Eastern long necked turtle are provided in Appendix F. In summary, Eastern long necked turtles use both permanent and semi-permanent water bodies, migrating between habitat areas if wetlands dry out. Breeding is typically stimulated by season not flooding, although availability of food is important. They may lay up to three clutches of eggs per year between spring and later summer. The water requirements of the vegetation at Horseshoe Wetland, combined with the presence of deep pool areas, are expected to meet the requirements of the Eastern long necked turtle.
- **Frogs:** The water requirements for frogs expected to be found at Loch Garry are provided in Appendix G. While the proposed water regime will not provide extensive habitat for frog communities, the presence of water in deeper areas of the wetlands is anticipated to provide some refuge areas during the summer periods, with more extensive habitat opportunities available during the winter and spring months. As such, separate hydrological objectives for frogs have not been recommended.
- **Fish:** The ecological objectives for fish represent longer term aspirations for the site. The short term goal is to facilitate the recovery and food and shelter resources, to support the future restoration of fish communities at the site. As such, separate hydrological objectives for fish have not been recommended.

#### 7.4 Watering regime

The wetland watering regime has been derived from the ecological and hydrological objectives. 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 watering regimes are described below based on different climatic scenarios that may occur in a given year. Due to the inter-annual variability of these estimates (particularly the climatic conditions), determination of the predicted volume requirements in any given year will need to be undertaken by the environmental water manager when watering is planned.

The proposed watering regime considers both naturally occurring and managed floods. As such, environmental watering will target the shortfall in desired flooding frequency between naturally occurring events.

Variability should be incorporated into planned watering actions over time, better reflecting what happens during natural flooding. Differences from year to year may include changes to the timing of delivery, depth of inundation or the length of the dry phase.

The below watering regime considers the period to 2025. Beyond this date, management strategies at the site may shift toward the reestablishment of native fish populations. As such, the optimal watering regime will need to be revised to provide some permanency of habitat for fish.



### **Proposed watering regime for dry years**

*Provide flooding in six years in ten, with dry phases not extending to more than two consecutive years. Deliver volumes of up to 1,000 ML per season to protect target EVCs and provide vital habitat for aquatic biota. Target duration should be 6 months in deeper areas of the wetland.*

### **Proposed watering regime for average years**

*Provide flooding eight years in ten, with dry phases in the deepest parts of the wetland not extending for more than 6 months. Deliver volumes of up to 1,000 ML per season to maintain areas of open water at variable depths of between 1 to 2 metres for 9 to 18 months. Watering actions aim to restore target EVCs and provide breeding opportunities for aquatic biota. Top up flows may be provided following the peak of small to medium floods in the Goulburn River or to support waterbird breeding if it occurs.*

### **Proposed watering regime for wet years**

*Provide flooding in each year, allowing for short periods of wetland drying within each ten year cycle. Deliver volumes of up to 1,000 ML per season to restore target EVCs and fringing vegetation communities by pushing water out into higher areas surrounding the wetland. A precautionary approach will be taken to the delivery of water in wet years due to the higher probability of inflows from the Goulburn River system.*

Note: the depths, timing and duration of events provided are estimates only and will be further validated during the implementation of the recommended regimes.

## 8. Potential risks and mitigation measures

Although environmental watering actions are designed to achieve improved ecological outcomes, they also need to consider the potential environmental risks and how they can be managed. Potential environmental risks include things that may limit the achievement of management objectives set for the site or adverse environmental outcomes as a result of environmental watering.

Risk management is part of existing environmental water planning processes including the:

- *Commonwealth Environmental Water Holder's Framework for Determining Commonwealth Environmental Water Use* - that requires environmental watering actions to consider potential environmental risks, including downstream environmental risks, and measure that may be taken to minimise those risks (CEWO, 2013).
- *Victorian Environmental Water Holder's (VEWH) Seasonal Watering Planning process* - which has established an over-arching risk management framework that requires all parties to identify and control foreseeable adverse outcomes.
- *VEWH's Delivery Planning process* – this focuses on specific risks associated with each delivery of environmental water including risks to public and private assets.

A summary of potential threats associated with environmental watering activities at Loch Garry is provided in Table 10.

Table 10: Priority threats to the cultural and ecological values of Loch Garry

Threat	Impact	Priority	Main objective(s) affected	Mitigating action
<b>Fox predation</b>	<ul style="list-style-type: none"> <li>• Foxes are known to prey on waterbirds and raid turtle nests for eggs impacting on the successful completion of breeding cycles</li> </ul>	<b>High</b> – foxes are known to be present at the site and their impacts are well known	<ul style="list-style-type: none"> <li>• AB1</li> </ul>	<ul style="list-style-type: none"> <li>• Work collaboratively with Parks Victoria, YYNAC and neighbouring landholders to implement complementary fox control programs.</li> </ul>
<b>Exotic fish</b>	<ul style="list-style-type: none"> <li>• Exotic fish species such as Carp, Gambusia and Goldfish may outcompete native fish species for habitat and food resources or predate on native fish species. Carp and Goldfish may also disturb sediment through feeding behaviour increasing turbidity and limiting plant responses.</li> </ul>	<b>High</b> – carp are known to enter the wetland and the impacts are well understood	<ul style="list-style-type: none"> <li>• V1, V2, A1</li> </ul>	<ul style="list-style-type: none"> <li>• Delivery during cooler months may limit the entry of carp or goldfish eggs into the wetland. If causing a significant impact, options to screen for fish at the outfall could be explored.</li> <li>• Implement drying regimes to reduce population numbers.</li> </ul>
<b>Recreation impacts</b>	<ul style="list-style-type: none"> <li>• More frequent water in the wetland may increase recreational use impacting on the site's ecological or cultural values (known or unknown).</li> <li>• Hunting may impact on waterbird responses.</li> </ul>	<b>High</b> – threat given higher priority due to the potential impact on cultural sites	<ul style="list-style-type: none"> <li>• AB1, F1</li> </ul>	<ul style="list-style-type: none"> <li>• Work collaboratively with Parks Victoria and YYNAC to manage potential visitor impacts</li> <li>• Survey significant cultural sites within the reserve</li> </ul>
<b>Poor water quality - blackwater</b>	<ul style="list-style-type: none"> <li>• Low levels of dissolved oxygen in the water may cause fish deaths, public complaints about odour or create blackwater condition which reduces the ability of light to penetrate limiting plant responses.</li> </ul>	<b>High</b> – stratification and blackwater known to occur within the wetland	<ul style="list-style-type: none"> <li>• V1, V2, F1</li> </ul>	<ul style="list-style-type: none"> <li>• Implement proposed water regime which may reduce the impact of blackwater over time</li> <li>• Consider the delivery of top up flows to provide a dilution effect</li> </ul>
<b>Exotic plants</b>	<ul style="list-style-type: none"> <li>• Weeds may displace native species leading to reduced vegetation response and habitat for aquatic biota</li> </ul>	Moderate – the proposed watering regime is expected to favour native species	<ul style="list-style-type: none"> <li>• V1, V2, A1, F1</li> </ul>	<ul style="list-style-type: none"> <li>• Work collaboratively with Parks Victoria, YYNAC and GMW to control pest plants</li> </ul>

Threat	Impact	Priority	Main objective(s) affected	Mitigating action
<b>Invasive native species</b>	<ul style="list-style-type: none"> <li>River Red Gums may encroach into open water areas, or excessive growth of rushes may occur changing the structural characteristics of the wetlands</li> </ul>	Moderate - water regimes can be adapted if undesirable responses are observed	<ul style="list-style-type: none"> <li>V1, V2, AB1</li> </ul>	<ul style="list-style-type: none"> <li>Monitoring of vegetation response to occur and water regimes to be adapted to mitigate potential impacts.</li> </ul>
<b>Inappropriate water regime</b>	<ul style="list-style-type: none"> <li>Recommended watering regime does not support the desired vegetation response</li> <li>Shallow water deliveries may support the encroachment of emergent aquatic vegetation reducing the open water areas of the wetland</li> </ul>	Moderate – water regimes can be adapted if undesirable responses are observed	<ul style="list-style-type: none"> <li>V1, V2</li> </ul>	<ul style="list-style-type: none"> <li>Undertake vegetation monitoring and evaluate observed vegetation responses to adapt and refine the water regime over time.</li> <li>Cool burning of rushes may be considered.</li> </ul>
<b>Poor water quality – algal blooms</b>	<ul style="list-style-type: none"> <li>Elevated nutrient levels in the wetland result in algal blooms that may be harmful to aquatic biota</li> </ul>	Low – the concentrations of phosphorus in the Goulburn River is low	<ul style="list-style-type: none"> <li>AB2</li> </ul>	<ul style="list-style-type: none"> <li>If threat becomes an increased priority over time, investigate options to reduce nutrient loads in runoff from adjacent land</li> </ul>



## 9. Environmental water delivery infrastructure

### 9.1 Delivery options

The wetland lies within the Shepparton Irrigation Area and can receive environmental water via the East Goulburn 22/12 Outfall Drainage Channel (Figure 15).

The Outfall Drainage Channel can deliver water at a rate of approximately 20 ML/day. Loch Garry does not have a delivery share, so water for the environment can only be delivered when there is spare capacity to carry water in the channel.



Figure 15: Delivery channel enabling the delivery of water to Loch Garry

### 9.2 Constraints

The primary constraint to the management of environmental water at Loch Garry is balancing its water requirements against the flood mitigation role it provides. As discussed in section 1.2, this plan proposes a phased process to addressing this issue by delivering relatively small volumes of environmental water (up to 1,000 ML per season) until these interactions can be better understood and quantified.

As discussed in section 5.3, operating rules for the Goulburn system are managed to avoid inundation of the floodplain adjacent to the river. This constraint, combined with an obligation to avoid overbank flows when delivering environmental water, constrains environmental releases to the river channel. As noted in the previous section, maximising the benefits of environmental water delivery in alluvial systems includes connection of river channels to their floodplains. This contributes to the overall diversity of river-floodplain systems and contributes allochthonous sources of carbon to the river, thus contributing to in-stream productivity.

Opportunities to deliver higher flows in the Goulburn River system are being investigated through the Constraints Management project, an initiative under the Murray-Darling Basin Plan (MDBA 2013). This project is targeting near bankfull flows in the lower Goulburn River. It is possible that Loch Garry will be

able to receive deliveries of environmental water targeted at inundating areas of the lower Goulburn River floodplain in the near future.

There is a knowledge gap around the subsurface hydrologic connection between Loch Garry and the Goulburn River. Alluvial floodplain wetlands that are located close to rivers often have deep gravel formation as the underlying sediment which can have very high hydraulic conductivity. This means that if water is pumped into the wetland when the river levels are low and the watertable is lower than the base level of the wetland, water may drain out through the subsurface connection back to the river resulting in an inundation event of very short duration. This may mean that the ecological objectives for Loch Garry are not achieved because the duration of flooding is unexpectedly short. Groundwater monitoring during an environmental watering event would help to establish the nature of the subsurface connection and the extent to which this would risk achieving ecological objectives through pumping into the wetland.

### 9.3 Infrastructure

A network of roads occur within the Loch Garry reserve which affect the movement of water within the site. These roads may provide a barrier to the low level flows proposed by this management plan, reducing connectivity between low lying areas on the floodplain. Road culverts placed in the floodrunners that connect different wetland areas may also provide a barrier to fish movement (Figure 16).

The potential impact of road infrastructure on the spread of water and movement of fish within the reserve is not well understood. Field observations should be undertaken during the deployment of environmental water to better understand its significance.



Figure 16: Road culvert acting as a floodrunner constraint.



## 10. Management actions and recommendations

Table 11 summarises the various knowledge gaps and supporting actions identified within this EWMP. While most of these do not prevent the ability to provide water to the wetland and generate ecological benefits, addressing these would significantly improve the long-term ecological understanding and outcomes at the site.

Each of the recommendations are reference to the relevant section where they are addressed within this plan.

Table 11: Recommended future actions to support environmental watering at Horseshoe Wetland

Recommendation	Actions	Lead agency
Undertake monitoring to support continual improvement and enable reporting against site based objectives	<p>Develop a monitoring program that supports reporting and evaluation against the management objectives (section 7). In the short term (to 2025) this includes:</p> <ul style="list-style-type: none"> <li>• vegetation monitoring (objectives V1 and V2)</li> <li>• incidental monitoring of turtles and waterbird species presence (objective AB1)</li> <li>• monitoring of frog species (objective A1).</li> </ul>	GBCMA
Improve understanding of the status of threatened plant species at Loch Garry	<ul style="list-style-type: none"> <li>• Undertake targeted surveys of threatened plant species - River Swamp Wallaby-grass and Floodplain fireweed</li> <li>• Benchmark status of current communities and revise objective V2 (section 7.2)</li> </ul>	GBCMA
Flood risk assessment	<ul style="list-style-type: none"> <li>• Evaluate the risks of compromising the flood mitigation function of the wetland to identify opportunities to increase the volume of water delivered to the site to better meet its water needs.</li> </ul>	GBCMA, GMW
Complementary land management activities	<p>Work collaboratively with Parks Victoria and YYNAC to secure funding to assist with:</p> <ul style="list-style-type: none"> <li>• Eradication of high threat weeds within the reserve (section 6.1)</li> <li>• Control fox populations within the reserve and its adjoining land (Table 10)</li> <li>• Assessment of options and implementation of works to assist with managing visitor impacts (Table 10)</li> <li>• Evaluate the feasibility of using cool burns to assist with the control of high threat weeds within the reserve.</li> <li>• Preparation of a precinct management plan to manage visitor impacts and experiences within the reserve</li> </ul>	Parks Victoria

Recommendation	Actions	Lead agency
Build capacity to develop cultural objectives for the wetland	<ul style="list-style-type: none"> <li>Explore opportunities to partner with the GBCMA during ecological surveys to improve understanding of culturally significant plant and animal species within the reserve and facilitate the setting of future cultural objectives</li> </ul>	YYNAC
Installation of depth gauges	<ul style="list-style-type: none"> <li>Install water depth gauges to better understand the relationship between inflow volumes and extent of inundation within the wetland. Refine the proposed watering regime as new information becomes available.</li> </ul>	GBCMA
Improve connectivity within the wetland	<ul style="list-style-type: none"> <li>Investigate options to improve connectivity within the wetland (section 9.3)</li> </ul>	GBCMA
Improve understanding of the cultural heritage values of the site	<ul style="list-style-type: none"> <li>Undertake a survey of cultural heritage at Loch Garry to identify priority areas for protection and any opportunities to support these through environmental watering (section 3.4)</li> </ul>	YYNAC
Reinstatement of woody habitat	<ul style="list-style-type: none"> <li>Investigate options to reinstate woody habitat within the main channel of the wetland prior to any actions to reintroduce native fish species</li> </ul>	GBCMA
Reintroduction of native fish species	<ul style="list-style-type: none"> <li>Explore the feasibility of reintroducing native fish species into Loch Garry in order to meet fish objectives set by this plan</li> </ul>	GBCMA



## 11. Roles and responsibilities

Management of environmental water involves a number of agencies including the Victorian Environmental Water Holder, the Commonwealth Environmental Water Office, the Murray-Darling Basin Authority and Goulburn Murray Water. Table 12 provides an outline of the agencies and groups involved in environmental water management in the Goulburn River system.

Table 12: Parties involved in Environmental Water Management.

Party	Involvement
<b>Goulburn Broken Catchment Management Authority (GBCMA)</b>	<ul style="list-style-type: none"> <li>Identify regional priorities for environmental water management in the regional waterway strategy.</li> <li>Assess water regime requirements of priority rivers and wetlands to identify environmental watering needs to meet agreed objectives. Identify opportunities for and implement, environmental works to use environmental water more efficiently.</li> <li>Propose annual environmental watering actions to the Victorian Environmental Water Holder and implement its environmental watering decisions.</li> <li>Provide critical input to management of other environmental water (e.g. passing flows management) and report on environmental water management activities undertaken.</li> </ul>
<b>Parks Victoria (PV)</b>	<ul style="list-style-type: none"> <li>Land Managers. Implement relevant components of Environmental Water Management Plans.</li> <li>Operate, maintain and replace (as agreed), the infrastructure required for delivery of environmental water, where infrastructure is not part of the GMW irrigation system</li> </ul>
<b>Traditional Owners Yorta Yorta</b>	<ul style="list-style-type: none"> <li>Engaged through the development of the seasonal watering proposal and input to matters of interest to Yorta Yorta.</li> <li>Joint land management activities with Parks Victoria</li> </ul>
<b>Goulburn Murray Water (GMW)</b>	<ul style="list-style-type: none"> <li>Water Corporation – Storage Manager, Resource Manager and Loch Garry Flood Protection Scheme operation</li> <li>Work with the Victorian Environmental Water Holder and waterway managers in planning for the delivery of environmental water to maximise environmental outcomes.</li> <li>Operate water supply infrastructure such as dams and irrigation distribution systems to deliver environmental water.</li> <li>Ensure the provision of passing flows and compliance with management diversion limits in unregulated and groundwater systems.</li> </ul>
<b>Victorian Environmental Water Holder (VEWH)</b>	<ul style="list-style-type: none"> <li>Make decisions about the most effective use of Water Holdings, including use, trade and carryover. Authorise waterway managers to implement watering decisions.</li> <li>Liaise with other water holders to ensure coordinated use of all sources of environmental water.</li> <li>Communicate all environmental watering decisions and outcomes.</li> </ul>
<b>Commonwealth Environmental Water Office (CEWO)</b>	<ul style="list-style-type: none"> <li>Make decisions about the use of Commonwealth water Holdings, including providing water to the Victorian Environmental Water Holder for use in Victoria. Liaise with the Victorian Environmental Water Holder to ensure co-ordinated use of environmental water in Victoria.</li> </ul>

Party	Involvement
	<ul style="list-style-type: none"> <li>• Report on management of Commonwealth water holdings.</li> </ul>
<p><b>Department of Environment, Land, Water and Planning (DELWP)</b></p>	<ul style="list-style-type: none"> <li>• Manage the water allocation and entitlements framework.</li> <li>• Develop state policy on water resource management and waterway management approved by the Minister for Water and Minister for Environment and Climate change.</li> <li>• Develop state policy for the management of environmental water in regulated and unregulated systems.</li> <li>• Act on behalf of the Minister for Environment and Climate change to maintain oversight of the Victorian Environmental Water Holder and waterway managers in their roles as environmental water managers.</li> </ul>
<p><b>Murray-Darling Basin Authority (MDBA)</b></p>	<ul style="list-style-type: none"> <li>• Implementation of the Murray-Darling Basin Plan. The plan sets legal limits on the amount of surface water and groundwater that can be taken from the Basin from July 1 2019 onwards.</li> <li>• Integration of Basin wide resource management and manager of The Living Murray water entitlements.</li> </ul>
<p><b>Game Management Authority</b></p>	<ul style="list-style-type: none"> <li>• Independent statutory authority responsible for game management and hunting in Victoria</li> <li>• Work with public land managers to improve the management of State Game Reserves and other public land where hunting is permitted</li> <li>• Game management involves the monitoring and management of habitats and game populations to achieve sustainable harvest objectives.</li> </ul>

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## Appendix A: Environmental water sources

Environmental water	Responsible Agency	Description	Conditions
<b>Bulk Entitlement (Eildon – Goulburn Weir) Conversion Order 1995</b>			
Minimum flow	GMW	Minimum flow of 120 ML/day at Eildon Pondage Weir	Daily rate to be no less than 200 ML/day <sup>2</sup>
Minimum flow	GMW	Minimum average weekly flow of 250 ML/day at Goulburn Weir	Daily rate to be no less than 300 ML/day <sup>2</sup>
Minimum flow	GMW	Minimum average monthly flow of 350 ML/day from November to June (inclusive) at McCoy's Bridge	Daily rate to be no less than 350 ML/day <sup>2</sup>
Minimum flow	GMW	Minimum average monthly flow of 400 ML/day from July to October (inclusive) at McCoy's Bridge	Maintenance of water quality
Goulburn Water Quality Allowance	GMW and VEWH*	30 GL per year	Inflows to Lake Eildon for previous 24 months must reach a specified volume <sup>2</sup>
Additional passing flow below Eildon Pondage Weir	GMW	Minimum passing flows at Eildon Pondage Weir increased to 250 ML/day	Inflows to Lake Eildon from previous 12 and 24 months must reach specified volumes and VEWH confirms the need for a release <sup>2</sup>
Additional Passing Flow below Eildon Pondage Weir	VEWH	Up to 80 GL in November to provide up to 16,000 ML/day peak flow for one day	
<b>Environmental Water Entitlements</b>			
Goulburn System NVIRP Stage 1	VEWH	One third of water savings created in the Goulburn system resulting from modernisation works completed as Stage 1 of the Northern Victorian Irrigation Renewal Project (NVIRP) 30GL is assumed to be available for 2017/18 (this includes 20 GL of carry over)	Volume based on works implemented and water losses saved in previous year's climate
Goulburn River Environmental Entitlement	7,417 ML HRWS 1A 3,140 ML LRWS 1A 1,434 ML HRWS 1B (used in Loddon)	This water is generally used in Goulburn catchment wetlands, however is also available to the river	
Environmental Entitlement (Goulburn-System – The Living Murray) 2007	MDBA	39,625 ML high reliability entitlement 156,980 ML low reliability entitlement	Water allocated to this entitlement must be used for the Living Murray 'icon sites'. However, this water can provide environmental benefits in the Goulburn River on route to the Murray River
Commonwealth Environmental Water Holdings	CEWH	276,175 ML Goulburn high reliability water share 29,435 ML Goulburn low reliability water share (as at 31 January 2017)	Water use is subject to agreement with the CEWH

<sup>2</sup> Minimum flows in the Goulburn Bulk Entitlement can be reduced under drought conditions and banked for later use

\* The VEWH has delegated their role in the management of the Goulburn Water Quality Allowance to the GBCMA

## Appendix B: Legislative framework

### International Acts, Agreements and Conventions

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

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

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

These agreements require that the parties protect migratory birds by:

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

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

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

### Acts (National)

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

**Aboriginal and Torres Strait Islander Heritage Protection Act 1984** - An Act to preserve and protect places, areas and objects of 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)

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

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

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

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

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

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

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

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

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

**Advisory lists of rare 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 – 2014
- Advisory list of Threatened Vertebrate Fauna in Victoria – 2013
- Advisory list of Threatened Invertebrate Fauna in Victoria – 2009.

### Policy and Frameworks (National)

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

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

### Policy and Frameworks (Victoria)

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

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

**Water for Victoria** - A statewide plan setting a new long-term direction for managing Victoria's water resources in the context of climate change and population growth. The plan sets out 69 actions ranging from waterway projects aimed at protecting and restoring waterway health to supporting resilience of farmers with new infrastructure and skills and building understanding of Aboriginal ecological knowledge in water management. The actions in the plan aim to support a healthy environment, a prosperous economy with growing agricultural production and thriving communities.

### Policy and Frameworks (Regional)

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

**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.

**Goulburn Broken CMA Waterway Strategy 2014-2022** – A strategy underpinning the Regional Catchment Strategy that presents an integrated catchment planning framework for waterways in the Goulburn Broken region and is the primary guide for priority setting, maintenance and improvement of waterways.

## Appendix C: Corrick and Norman classification of wetland categories

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

### **Freshwater meadow**

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

### **Shallow freshwater marsh**

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

### **Deep freshwater marsh**

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

### **Permanent open freshwater**

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

### **Semi-permanent saline**

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

### **Permanent saline**

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



## Appendix D: Fauna species list

Table 13: Fauna list of Loch Garry (Australian Ecosystems 2012, Victorian Biodiversity Atlas).

Scientific Name	Common name	FFG	VROTS	EPBC	Treaty	Wetland species
<b>Birds</b>						
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill					
<i>Acrocephalus stentoreus</i>	Clamorous Reed Warbler				BONNA2H	W
<i>Alcedo azurea</i>	Azure Kingfisher		nt			W
<i>Anas castanea</i>	Chestnut Teal					W
<i>Anas gracilis</i>	Grey Teal					W
<i>Anas rhynchotis</i>	Australasian Shoveler		vu			W
<i>Anas superciliosa</i>	Pacific Black Duck					W
<i>Anhinga novaehollandiae</i>	Darter					W
<i>Aquila audax</i>	Wedge-tailed Eagle					
<i>Ardea intermedia</i>	Intermediate Egret	L	en			W
<i>Ardea modesta</i>	Eastern Great Egret	L	vu		CAMBA, JAMBA	W
<i>Ardea pacifica</i>	White-necked Heron					W
<i>Artamus cyanopterus</i>	Dusky Woodswallow					
<i>Artamus leucorhynchus</i>	White-breasted Woodswallow					
<i>Artamus superciliosus</i>	White-browed Woodswallow					
<i>Aythya australis</i>	Hardhead		vu			W
<i>Biziura lobata</i>	Musk Duck		vu			W
<i>Cacatua galerita</i>	Sulphur-crested Cockatoo					
<i>Cacatua sanguinea</i>	Little Corella					
<i>Cacatua tenuirostris</i>	Long-billed Corella					
<i>Chenonetta jubata</i>	Australian Wood Duck					W
<i>Chlidonias hybridus javanicus</i>	Whiskered Tern		nt			W
<i>Chrysococcyx basalis</i>	Horsfield's Bronze-Cuckoo					
<i>Circus approximans</i>	Swamp Harrier					W
<i>Colluricincla harmonica</i>	Grey Shrike-thrush					
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike					

Scientific Name	Common name	FFG	VR0TS	EPBC	Treaty	Wetland species
<i>Corcorax melanorhamphos</i>	White-winged Cough					
<i>Corvus coronoides</i>	Australian Raven					
<i>Cracticus nigrogularis</i>	Pied Butcherbird					
<i>Cracticus tibicen</i>	Australian Magpie					
<i>Cygnus atratus</i>	Black Swan					W
<i>Dacelo novaeguineae</i>	Laughing Kookaburra					
<i>Egretta novaehollandiae</i>	White-faced Heron					W
<i>Eseyornis melanops</i>	Black-fronted Dotterel					W
<i>Eolophus roseicapillus</i>	Galah					
<i>Erythrogonys cinctus</i>	Red-kneed Dotterel					W
<i>fam. Anatidae gen. Anas</i>	Dabbling ducks					W
<i>fam. Corvidae gen. Corvus</i>	Ravens and Crows					
<i>Fulica atra</i>	Eurasian Coot					W
<i>Gallinula tenebrosa</i>	Dusky Moorhen					W
<i>Grallina cyanoleuca</i>	Magpie-lark					
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	L	vu		CAMBA	W
<i>Haliastur sphenurus</i>	Whistling Kite					
<i>Himantopus himantopus</i>	Black-winged Stilt					W
<i>Hirundo neoxena</i>	Welcome Swallow					
<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater					
<i>Malacorhynchus membranaceus</i>	Pink-eared Duck					W
<i>Malurus cyaneus</i>	Superb Fairy-wren					
<i>Manorina melanocephala</i>	Noisy Miner					
<i>Megalurus gramineus</i>	Little Grassbird					
<i>Merops ornatus</i>	Rainbow Bee-eater					
<i>Microcarbo melanoleucos</i>	Little Pied Cormorant					W
<i>Microeca fascinans</i>	Jacky Winter					
<i>Ninox novaeseelandiae</i>	Southern Boobook					
<i>Nycticorax caledonicus</i>	Nankeen Night-heron					W
<i>Ocyphaps lophotes</i>	Crested Pigeon					
<i>Pachycephala pectoralis</i>	Golden Whistler					

Scientific Name	Common name	FFG	VROTS	EPBC	Treaty	Wetland species
<i>Pardalotus striatus</i>	Striated Pardalote					
<i>Pelecanus conspicillatus</i>	Australian Pelican					W
<i>Petrochelidon ariel</i>	Fairy Martin					
<i>Petrochelidon nigricans</i>	Tree Martin					
<i>Phalacrocorax carbo</i>	Great Cormorant					W
<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant					W
<i>Phalacrocorax varius</i>	Pied Cormorant		nt			W
<i>Philemon corniculatus</i>	Noisy Friarbird					
<i>Platalea flavipes</i>	Yellow-billed Spoonbill					W
<i>Platalea regia</i>	Royal Spoonbill		nt			W
<i>Platycercus elegans</i>	Crimson Rosella					
<i>Platycercus eximius</i>	Eastern Rosella					
<i>Podiceps cristatus</i>	Great Crested Grebe					W
<i>Poliiocephalus poliocephalus</i>	Hoary-headed Grebe					W
<i>Porphyrio porphyrio</i>	Purple Swamphen					W
<i>Porzana fluminea</i>	Australian Spotted Crake					W
<i>Porzana pusilla palustris</i>	Baillon's Crake	L	vu			W
<i>Porzana tabuensis</i>	Spotless Crake					W
<i>Psephotus haematonotus</i>	Red-rumped Parrot					
<i>Rhipidura leucophrys</i>	Willie Wagtail					
<i>Smicrornis brevirostris</i>	Weebill					
<i>Tachybaptus novaehollandiae</i>	Australasian Grebe					W
<i>Tadorna tadornoides</i>	Australian Shelduck					W
<i>Threskiornis molucca</i>	Australian White Ibis					W
<i>Threskiornis spinicollis</i>	Straw-necked Ibis					W
<i>Todiramphus sanctus</i>	Sacred Kingfisher					W
<i>Tribonyx ventralis</i>	Black-tailed Native-hen					W
<i>Tyto alba</i>	Barn Owl					
<i>Vanellus miles</i>	Masked Lapwing					W
<b>Mammals</b>						
<i>Phascolarctos cinereus</i>	Koala					

Scientific Name	Common name	FFG	VROTS	EPBC	Treaty	Wetland species
<i>Pseudocheirus peregrinus</i>	Common Ringtail Possum					
<b>Fish</b>						
<i>Hypseleotris klunzingeri</i>	Western Carp Gudgeon					W
<i>Maccullochella peelii</i>	Murray Cod			VU		W
<i>Macquaria ambigua</i>	Golden Perch					W
<i>Melanotaenia fluviatilis</i>	Murray River Rainbowfish					W
<i>Retropinna semoni</i>	Australian Smelt					W
<i>Tandanus tandanus</i>	Freshwater Catfish					W
<b>Reptiles</b>						
<i>Chelodina longicollis</i>	Eastern Snake-necked Turtle		dd			W
<i>Emydura macquarii</i>	Murray River Turtle		vu			W
<i>Notechis scutatus</i>	Tiger Snake					
<b>Amphibians</b>						
<i>Crinia parinsignifera</i>	Plains Froglet					W
<i>Crinia signifera</i>	Common Froglet					W
<i>Limnodynastes fletcheri</i>	Barking Marsh Frog					W
<i>Litoria peronii</i>	Peron's Tree Frog					W

**Legend**

\* Introduced species

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

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

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

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

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

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

w = Water dependent species or Waterbirds

BONNA2H = listed on the Bonn Convention (species is member of a family listed in Appendix 2 of the convention)

CAMBA = Listed on the China- Australia Migratory Bird Agreement 2007

JAMBA = Listed on the Jamba- Australia Migratory Bird Agreement

ROKAMBA = Listed on the Republic of Korea- Australia Migratory Bird Agreement

Any incidental observations – e.g. Kangaroo, Lace Monitor, Rakali

## Appendix E: Flora species list

Table 14: Flora list of Loch Garry (Australian Ecosystems 2012).

Scientific name	Common Name	Origin	FFG	VROT	EPBC
<i>Acacia acinacea</i>	Gold-dust Wattle				
<i>Acacia dealbata</i>	Silver Wattle				
<i>Alternanthera denticulata</i> s.s.	Lesser Joyweed				
<i>Alternanthera denticulata-nodiflora</i> group	Lesser-Common Joyweed group				
<i>Amphibromus fluitans</i>	River Swamp Wallaby-grass		X		V
<i>Anthosachne scabra</i> s.l.	Common Wheat-grass				
<i>Arthropodium minus</i>	Small Vanilla-lily				
<i>Asperula conferta</i>	Common Woodruff				
<i>Aster subulatus</i>	Aster-weed	*			
<i>Atriplex semibaccata</i>	Berry Saltbush				
<i>Austrostipa</i> spp.	Spear Grass				
<i>Azolla filiculoides</i>	Pacific Azolla				
<i>Brachyscome basaltica</i> var. <i>gracilis</i>	Woodland Swamp-daisy				
<i>Brachyscome paludicola</i>	Woodland Swamp-daisy				
<i>Briza minor</i>	Lesser Quaking-grass	*			
<i>Bromus diandrus</i>	Great Brome	*			
<i>Callitriche sonderi</i>	Matted Water-starwort				
<i>Cardamine moirensis</i>	Riverina Bitter-cress			r	
<i>Cardamine paucijuga</i> s.l.	Annual Bitter-cress				
<i>Carex bichenoviana</i>	Plains Sedge				
<i>Carex inversa</i>	Knob Sedge				
<i>Carex tereticaulis</i>	Poong'ort				
<i>Cassinia arcuata</i>	Drooping Cassinia				
<i>Cassinia</i> sp. aff. <i>arcuata</i> (Midlands)	Drooping Cassinia				
<i>Centaurium erythraea</i>	Common Centaury	*			
<i>Centipeda cunninghamii</i>	Common Sneezeweed				
<i>Centipeda minima</i> subsp. <i>minima</i> s.s.	Spreading Sneezeweed				



Scientific name	Common Name	Origin	FFG	VROT	EPBC
<i>Chamaesyce drummondii</i>	Flat Spurge	#			
<i>Cirsium vulgare</i>	Spear Thistle	*			
<i>Conyza bonariensis</i>	Flaxleaf Fleabane	*			
<i>Cullen parvum</i>	Small Scurf-pea		L	e	
<i>Cycnogeton</i> spp.	Water Ribbons				
<i>Cynodon dactylon</i>	Couch				
<i>Cyperus eragrostis</i>	Drain Flat-sedge	*			
<i>Damasonium minus</i>	Star Fruit				
<i>Digitaria sanguinalis</i>	Summer Grass	*			
<i>Dysphania glomulifera</i> subsp.	Globular Pigweed				
<i>Einadia nutans</i> subsp. <i>nutans</i>	Nodding Saltbush				
<i>Elatine gratioloides</i>	Waterwort				
<i>Eleocharis acuta</i>	Common Spike-sedge				
<i>Eleocharis pusilla</i>	Small Spike-sedge				
<i>Eleocharis sphacelata</i>	Tall Spike-sedge				
<i>Enteropogon acicularis</i>	Spider Grass				
<i>Epilobium hirtigerum</i>	Hairy Willow-herb				
<i>Eryngium ovinum</i>	Blue Devil				
<i>Eucalyptus camaldulensis</i>	River Red-gum				
<i>Eucalyptus melliodora</i>	Yellow Box				
<i>Eucalyptus microcarpa</i>	Grey Box				
<i>Euchiton collinus</i> s.s.	Creeping Cudweed				
<i>Euchiton sphaericus</i>	Annual Cudweed				
<i>Eutaxia microphylla</i>	Common Eutaxia				
<i>Fimbristylis velata</i>	Veiled Fringe-sedge			r	
<i>Glinus lotoides</i>	Hairy Carpet-weed				
<i>Glinus oppositifolius</i>	Slender Carpet-weed				
<i>Glycine tabacina</i> s.l.	Variable Glycine				
<i>Gnaphalium polycaulon</i>	Indian Cudweed				
<i>Helichrysum luteoalbum</i>	Jersey Cudweed				

Scientific name	Common Name	Origin	FFG	VROT	EPBC
<i>Helminthotheca echioides</i>	Ox-tongue	*			
<i>Hemarthria uncinata</i> var. <i>uncinata</i>	Mat Grass				
<i>Hypochaeris radicata</i>	Flatweed	*			
<i>Juncus australis</i>	Austral Rush				
<i>Juncus flavidus</i>	Gold Rush				
<i>Juncus ingens</i>	Giant Rush				
<i>Juncus usitatus</i>	Billabong Rush				
<i>Lachnagrostis filiformis</i>	Common Blown-grass				
<i>Lactuca saligna</i>	Willow-leaf Lettuce	*			
<i>Lactuca serriola</i>	Prickly Lettuce	*			
<i>Landoltia punctata</i>	Thin Duckweed				
<i>Lemna disperma</i>	Common Duckweed				
<i>Leontodon taraxacoides</i> subsp.	Hairy Hawkbit	*			
<i>Linum marginale</i>	Native Flax				
<i>Lolium rigidum</i>	Wimmera Rye-grass	*			
<i>Lotus corniculatus</i>	Bird's-foot Trefoil	*			
<i>Ludwigia peploides</i> subsp. <i>montevidensis</i>	Clove-strip				
<i>Marsilea costulifera</i>	Narrow-leaf Nardoo				
<i>Mentha diemenica</i>	Slender Mint				
<i>Myoporum montanum</i>	Waterbush			r	
<i>Myriophyllum papillosum</i>	Robust Water-milfoil				
<i>Myriophyllum simulans</i>	Amphibious Water-milfoil				
<i>Myriophyllum variifolium</i>	Varied Water-milfoil				
<i>Ottelia ovalifolia</i> subsp. <i>ovalifolia</i>	Swamp Lily				
<i>Oxalis perennans</i>	Grassland Wood-sorrel				
<i>Paspalidium jubiflorum</i>	Warrego Summer-grass	#			
<i>Persicaria lapathifolia</i>	Pale Knotweed				
<i>Persicaria prostrata</i>	Creeping Knotweed				
<i>Phragmites australis</i>	Common Reed				
<i>Poa labillardierei</i>	Common Tussock-grass				

Scientific name	Common Name	Origin	FFG	VROT	EPBC
<i>Polygonum aviculare</i> s.s.	Hogweed	*			
<i>Polygonum plebeium</i>	Small Knotweed				
<i>Potamogeton sulcatus</i>	Furrowed Pondweed				
<i>Potamogeton tricarinatus</i> s.l.	Floating Pondweed				
<i>Pseudognaphalium luteoalbum</i>	Jersey Cudweed				
<i>Pseudoraphis spinescens</i>	Spiny Mud-grass				
<i>Rorippa palustris</i>	Marsh Yellow-cress	*			
<i>Rorippa</i> spp.	Bitter Cress				
<i>Rumex brownii</i>	Slender Dock				
<i>Rytidosperma caespitosum</i>	Common Wallaby-grass				
<i>Rytidosperma duttonianum</i>	Brown-back Wallaby-grass				
<i>Rytidosperma setaceum</i>	Bristly Wallaby-grass				
<i>Sclerolaena muricata</i>	Black Roly-poly				
<i>Senecio campylocarpus</i>	Floodplain Fireweed			r	
<i>Senecio quadridentatus</i>	Cotton Fireweed				
<i>Solanum nigrum</i> s.s.	Black Nightshade	*			
<i>Solenogyne dominii</i>	Smooth Solenogyne				
<i>Sonchus oleraceus</i>	Common Sow-thistle	*			
<i>Sphaeromorphaea littoralis</i>	Spreading Nut-heads				
<i>Stellaria angustifolia</i> subsp. <i>angustifolia</i>	Swamp Starwort				
<i>Stellaria angustifolia</i> subsp. <i>tenella</i>	Matted Starwort				
<i>Tribulus terrestris</i>	Caltrop	#			
<i>Trifolium angustifolium</i> var. <i>angustifolium</i>	Narrow-leaf Clover	*			
<i>Trifolium arvense</i> var. <i>arvense</i>	Hare's-foot Clover	*			
<i>Typha orientalis</i>	Broad-leaf Cumbungi				
<i>Vittadinia gracilis</i>	Woolly New Holland Daisy				
<i>Wahlenbergia fluminalis</i>	River Bluebell				
<i>Wahlenbergia</i> spp.	Bluebell				

Legend:

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

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

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

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

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

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

# = Native to Victoria but grows outside natural range

\* = exotic species

## Appendix F: Water requirements of Eastern long-necked turtle and Broad-shelled turtle (Source: DELWP, 2016)

Flow component	Eastern long-necked turtle, <i>Chelodina longicollis</i>	Broad-shelled turtle, <i>Chelodina expansa</i>
<b>Stimulus</b>	Lays clutches of 6 to 23 eggs between spring and late summer; may lay up to 3 clutches per year (Kennett et al. 2009). Season/temperature more likely to stimulate breeding than flooding, although food availability resulting from watering is important.	Lays clutches of between 5 and 28 eggs (Bower and Hodges 2014). Embryos can enter a diapause cued by low temperatures which enable them to overwinter in the nest. Consequently, the eggs can have incubation times that can vary considerably from 192 to 522 days.
<b>Frequency</b>	Frequency less important than access to permanent and semi-permanent water bodies. Can migrate between habitats if wetlands dry out (Kennett et al. 2009).	Frequency less important than access to permanent water bodies.
<b>Depth</b>	The species utilises a broad range of habitats including ephemeral wetlands, rivers pools, backwaters and dams. Greatest abundance occurs in shallow ephemeral wetlands in the absence of other turtle species (Kennett et al. 2009). Migrates to new habitat when current localities dry.	Abundance is only weakly correlated with water depth and distance from the river.
<b>Duration</b>	Prefers semi-permanent water in the absence of other turtle species. Can undergo estivation of up to 480 days to survive dry periods.	Prefers permanent water bodies, even in disturbed state (Bower and Hodges 2014).
<b>Timing/preferred season</b>	Spring to late summer breeding season.	Nesting occurs predominantly through autumn and winter and occasionally in spring.
<b>Rate of rise and fall</b>	Preference not known.	Preference not known.
<b>Dry period</b>	Annual; individuals can survive by estivation for up to 480 days.	Variable, so long as permanency is retained.
<b>Other habitat requirements</b>	The Eastern long-necked turtle is a floodplain specialist, preferentially occupying ephemeral habitats and retreating to permanent habitat in times of drought (Kennett and Georges 1990, Singh et al. unpub. data). This species is well adapted to overland migration (Chessman 1984a), utilising terrestrial corridors for both migration and aestivation (dormancy), with home ranges typically encompassing 2-3 wetlands (Roe and Georges 2007). Eastern long-necked turtles are opportunistic carnivores and their diet primarily consists of aquatic insects (Chessman 1984b, Georges et al. 1986).	The Broad-shelled turtle has been captured in a wide range of habitats including main rivers and their permanent wetlands, backwaters, anabranches and swamps (Chessman 1988, Howard et al. 2013a, Howard et al. 2013b). This species rarely leaves the water except to nest (Thompson 1993), and is an obligate carnivore eating decapod crustaceans, small fish and aquatic bugs (Chessman 1983).



## Appendix G: Water requirements of Common froglet (Source: DELWP, 2016)

Table 15: Overview of the water requirements of the Common froglet (adapted from DELWP, 2016)

Flow component	Common eastern froglet, <i>Crinia signifera</i>
<b>Stimulus</b>	Breeding occurs during cooler temperatures, but also following rainfall and may occur at different times of the year (Wassens 2011). Therefore, it is likely that season/temperature is a primary stimulus and flooding or rainfall a secondary stimulus.
<b>Frequency</b>	<p>In the Southwestern Slopes and Riverina Bioregions of New South Wales, and in 2010, Wassens et al (2013) found that the closely-related Plains froglet or Eastern sign-bearing froglet (<i>Crinia parainsignifera</i>) was capable of undergoing two breeding events after responding to winter-rains, including:</p> <ul style="list-style-type: none"> <li>• Early and late-stage tadpoles in March–May;</li> <li>• Drying of the wetland in mid-May; and</li> <li>• Refilling in late May; and</li> <li>• Egg masses, early-stage and mid-stage tadpoles.</li> </ul> <p>Wassens (2011) and Wassens et al. (2013) suggested that this flexibility and rapid breeding time may increase the resilience of this species to changes in seasonality of rainfall and wetland hydrology than more water dependent species.</p>
<b>Depth</b>	<p>Lower numbers of Common eastern froglets were heard calling in dry years, compared to wet years at Barmah Forest (McGinness et al. 2014).</p> <p>McGinness et al. (2014) also recorded a positive relationship between wetting frequency (i.e. the number of times the site was recorded as ‘wet’ proportional to the number of times a site was surveyed between 2000 and 2006) and number of calling male Common eastern froglets.</p> <p>Mac Nally et al. (2009) found in central Victoria, as did McGinness et al. (2014) at Barmah Forest, that Common eastern froglets significantly declined in abundance during the pro-longed millennium drought (2000-2009). River regulation has also reduced overbank flooding and subsequent availability of floodwaters during spring, resulting in reduced breeding in spring-breeding frog species, including Common eastern froglets.</p>
<b>Duration</b>	<p>Anstis (2013) found that females laid an average of 216 eggs (range 125-394 eggs). Mortality of eggs may be high as eggs are often deposited in ephemeral pools that may dry up. However, these frogs are frequent breeders.</p> <p>Hatching occurs 7-10 days after eggs are laid (Anstis 2013). Tadpole development times are variable and the duration of larval life may take from 6 weeks at 15°C, to 3 months, depending upon environmental conditions (Rogers 2011; Anstis 2013).</p> <p>Tadpole development times are species-specific and reflect the hydro periods of wetlands the species occupies (Wassens et al. 2013). Species with rapid tadpole development times (including Common eastern froglet) generally have a higher breeding success rate in temporary wetlands, compared with species with tadpoles that have long development times (Wassen et al. 2013).</p> <p>Wetlands should retain pooled water for a minimum period of 6 weeks if flooded in spring or summer, and a minimum of 3 months if flooded in winter to enable froglets to complete their breeding cycle (Wassens 2011).</p>
<b>Timing/preferred season</b>	<p>Common eastern froglet prefers cooler temperatures for breeding, and typically breeds through winter, autumn and spring, but may breed at any time depending on habitat and temperature (Rogers 2011; Anstis 2013).</p> <p>Male calling has recorded in all seasons and metamorphs have been recorded in spring (September and October), summer (December to February) and autumn (April) (Rogers 2011; Anstis 2013).</p> <p>At Barmah Forest, tadpoles or metamorphs have been recorded in September, October, November, December and February (McGinness et al. 2014). Male Common eastern froglets were also heard calling in greatest number in September than in any other month, though they were also commonly heard in October.</p>
<b>Rate of rise and fall</b>	<p>Wetlands should retain pooled water for a minimum period of 6 weeks if flooded in spring or summer, and a minimum of 3 months if flooded in winter to enable froglets to complete their breeding cycle (Wassens 2011).</p> <p>Floodwaters could recede at a slow, moderate or fast rate as long as the minimum flooding periods of 6 weeks and 3 months are met in spring/summer and winter, respectively (Rogers 2011).</p>
<b>Inter-flood dry period</b>	<p>Wassens (2011) noted that during the 2009 winter watering of in the Lower Lowbidgee floodplain (Lower Murrumbidgee Catchment), the Plains froglet was common in wetlands that had been dry since 2006. This species was also shown to be capable of a breeding event prior to mid-May drying of a wetland, and a second event following refilling of the wetland in late May. Rapid breeding enables opportunistic use of recently flooded (and formerly dry) areas.</p>
<b>Other habitat requirements</b>	<p>Common eastern froglet is a highly adaptable species that can occupy a diversity of permanent and semi-permanent wetlands, including rain-filled depressions, ditches, oxbow wetlands, creeks and rivers, farm dams, irrigation channels, flooded grasslands and urban ponds (Hazell et al. 2004; Mac Nally et al. 2009, 2014; Wassens 2011; Anstis 2013; McGinness et al. 2014). Common eastern froglets prefer to breed in wetlands supporting diverse aquatic vegetation or submerged grasses (Wassens 2011; McGinness et al. 2014).</p> <p>In Greater Melbourne, Hamer et al. (2012) found that at 81 wetland cells within 30 stormwater treatment wetlands, Common eastern froglet abundance increased with the size of the waterbody, and higher numbers were recorded at ponds with a shallow gradient. Hamer et al. (2012) suggested that shallow shores provide habitat with emergent vegetation for the Common eastern froglet to call from and deposit eggs.</p> <p>Eggs are laid in water and are usually attached to submerged grass stems, twigs, leaves, woody debris or substrate (Wassens 2011; Anstis 2013).</p> <p>Tadpoles are bottom-dwellers and generalist detritivores and herbivores and feed on biofilms, detritus and microscopic algae, and shelter under leaf litter, vegetation and among rocks (Wassens 2011; Anstis 2013). Froglets shelter away from drainage lines/wetlands under rocks, logs and leaf litter; may also shelter under pebbles in dry creek beds.</p>

Table 16: Timing of frog breeding events (Table extracted from Rogers and Ralph 2011.).

Frog species	Preferred hydrology of breeding site (Months)			Timing of breeding				Tadpole lifespan (months)
	< 3	3-6	>6	Spring	Summer	Autumn	Winter	
<b>Common Froglet</b> ( <i>Crinia signifera</i> )	*	*	*	C	C, B	C, B	C	2-4
<b>Plains Froglet</b> ( <i>Crinia parsignifera</i> )	*	*	*	C	C, B	C, B	C	2-4
<b>Pobblebonk</b> ( <i>Limnodynastes dumerili</i> )		*	*	C, T	C, B	C, B	C	5-6
<b>Barking Marsh Frog</b> ( <i>Limnodynastes fletcheri</i> )		*	*	C	C, B	B		3-4
<b>Perons Tree Frog</b> ( <i>Litoria peronii</i> )	*	*	*	C	C, B	B		3-4

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

## Appendix H: Index of wetland condition method

Table 17 below shows what is assessed for each of the six subindices and how they are scored

Table 17: IWC subindices and measures.

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

Adapted from DSE letter 29 April 2010

## Scoring method

Each subindex is given a score between 0 and 20 based on the assessment of a number of measures. Weightings are then applied to the scores as shown in Table 18. 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 18: Weights of each subindex

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

Five wetland condition categories have been assigned to the subindex scores (Table 19) and total IWC scores (Table 20), 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 19: Wetland condition categories assigned to subindex scores

Wetland condition category	Very poor	Poor	Moderate	Good	Excellent	Insufficient data
<b>Biota sub-index score range</b>	0 - 8	9 - 13	14 - 16	17 - 18	19 - 20	NA
<b>IWC sub-index score range (except biota):</b>	0 - 4	5 - 8	9 - 12	13 - 16	16 - 20	NA

Table 20: Wetland condition categories assigned to total IWC scores

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

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.