RMCG

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Environmental Water Management Plan - Wimmera River, Yarriambiack Creek and their terminal lakes

Final Report

Wimmera Catchment Management Authority

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Executive Summary

This Environmental Water Management Plan sets out long-term objectives for environmental values of the Wimmera River, Yarriambiack Creek and their terminal lakes including Lake Hindmarsh, Lake Albacutya and the Ross Lakes.

This Environmental Water Management Plan (EWMP) includes the Wimmera River, Yarriambiack Creek and their terminal lakes including Lake Hindmarsh, Lake Albacutya and the Ross Lakes. The EWMP also covers Mount William Creek, a key regulated tributary of the Wimmera River, and Dock Lake, a terminal lake of the Green Lake system. The EWMP is an important part of the Victorian Environmental Water Planning Framework. It provides guidance for environmental watering actions for the next decade, based on scientific information and stakeholder consultation. It can be used by a number of government departments and agencies including the Wimmera and Mallee Catchment Management Authorities (CMAs), Victorian Environmental Water Holder, Commonwealth Environmental Water Office and the Victorian Department of Energy, Environment and Climate Action for both short and long-term water planning.

Another EWMP covers the remaining part of the catchment that receives environmental water directly (MacKenzie River, Burnt Creek, Bungalally Creek).

The EWMP complements existing strategic plans (Wimmera Regional Catchment Strategy 2021-2027 and Wimmera Waterway Strategy 2014-2022) but is focussed on environmental water management so that the waterways of the Wimmera CMA region can continue to provide many environmental, social, cultural and economic values for the community.

The main sections of the EWMP are briefly summarised here.

Major updates to the EWMP and reasons for change/s

This EMWP updates the previous Environmental Water Management Plan – Wimmera River System completed in 2015. It has been updated to align with the recent release of the Environmental Water Management Plan Guidelines for Rivers and Wetlands (Version 6) (DELWP, 2022a). Other key updates include:

- Separation of a single EMWP for Wimmera River system into the following two key waterway components:
  - Wimmera River, Yarriambiack Creek and their terminal lakes including Lake Hindmarsh and Lake Albacutya and the Ross Lakes
  - MacKenzie River, Burnt Creek, and Bungalally Creek.

Asset overview and characteristics

The Wimmera River System is a large and geographically diverse system which experiences great variability in climate, in particular rainfall, which in turn influences water regimes for creeks, rivers and wetlands. Much of the land where the Wimmera River System is located is classified as Crown land as stream frontage or set aside as a reserve for nature conservation or water supply.

Variability in rainfall leads to substantial fluctuations in streamflows in the Wimmera region although in general the seasonal pattern of rainfall means that streamflows are much lower (or non-existent) during summer and autumn, increasing during early winter and then reducing in late spring. The series of storages, weirs and channels that comprise the Wimmera Mallee Headworks System are very effective at harvesting and transferring streamflows. Historically, this had also impacted downstream waterways by dramatically reducing flows through diversions into the former stock and domestic channel system. However, with water recovery works through the completion of the Wimmera Mallee pipeline, which has led to an increased environmental entitlement for the river and 13 wetlands in the catchment, this system now also provides a range of opportunities to direct environmental water back into a number of different waterways in the Wimmera River system.

Partnerships and consultation undertaken for EWMP preparation and implementation

A variety of mechanisms have been used to gather information from stakeholders and the community on ecological and social values and observations from previous environmental watering events. This in turn has been incorporated into the EWMP. The Wimmera CMA's annual Environmental Water Reserve forum comprised of community member and agency representatives plays an important role in advising the Wimmera CMA on environmental watering planning and delivery in the Wimmera River and terminal lakes. There are also processes in place for public consultation around ongoing environmental watering activities.

Water dependent environmental values present

The Wimmera River flows from the forested Pyrenees through to the semi-arid plains of the Mallee. It supports diverse and abundant ecosystems reliant on water in what can be a very dry landscape. This includes a number of threatened flora species such as Spiny Lignum as well as substantial tracts of riparian and wetland vegetation including iconic species like River Red Gum and Black Box. Notable water-dependent fauna include significant fish species such as Freshwater Catfish, River Blackfish, Golden Perch and Silver Perch, large numbers of waterbirds, including international migratory species that take advantage of the terminal lakes when they contain water for habitat and breeding and the nationally listed Growling Grass Frog.

Water-related threats to the environmental values

The Wimmera River has a number of factors which have led to deterioration in its condition. Systemic issues around over-extraction of water have been compounded by poor water quality, particularly salinity and impacts from exotic species including carp. However, a body of evidence is now showing an improvement in condition brought about by integrated waterway improvement works such as environmental water management, erosion control and riparian fencing.

Management goal

The long-term management goal for the Wimmera River is aligned to the recently updated Wimmera Regional Catchment Strategy (RCS) 2021-2027[1], which is detailed below. Management of water for the environment is aligned to these RCS outcomes based on the ecological requirement for each target reach, requirements for specific flora and fauna species, and the social and economic values of the water in the region balancing water availability with potential future inflow forecasts.

RCS outcomes relevant to management of water for the environment include:

- **20-year outcomes**
  - The knowledge and experience of First Nations people is informing water planning, management and delivery in the Wimmera.
  - The Wimmera Heritage River's values are maintained or improved.
  - The connectivity and condition of native vegetation along riparian corridors are improved.

[1] Wimmera CMA (2021)

- Water quality is improved at important areas for water supply, environmental and recreational values.
- Rivers and streams with high environmental, social, cultural and economic values are improving their value despite climate change.

- **Six-year outcomes**
  - Ongoing collaboration and two-way learning in river and stream planning and management by supporting and strengthening partnerships with First Nations people.
  - Recreational participation numbers on the Barringgi Gadyin (Wimmera River) are increasing.
  - More river and stream reaches have improved management of and access for recreation.
  - Healthier rivers and streams enable more on Country activities for First Nations people.
  - Blue green algal blooms and fish deaths are prevented where possible in the Barringgi Gadyin (Wimmera River).
  - No new pest plants and animals are established beyond small, localised populations.
  - More rivers and stream reaches have less stock access.
  - More reaches have improved riparian width and connectivity.
  - More river reaches are permanently protected through management agreements.
  - Drought refuges are protected and retain water during drought.
  - Net rates of streamflow interception are stabilising.
  - Native fish and platypus are increasing their abundance and distribution.
  - Native fish numbers are greater than carp numbers in most fish surveys and fishing competitions.

The ecological and hydrological objectives that sit under the long-term management goal have been informed by environmental flow studies and technical reports that prescribe the environmental watering regime for the Wimmera River system and lakes contained within this EWMP.

These flows studies are used as a guidance for environmental flows planning, conducted each year for a range of model climate scenarios, and are used to inform annual seasonal watering proposals finalised each April for the following water year (July-June). Accordingly, these studies need to be updated periodically to ensure the latest information on climate variability, climate change scenarios and operational constraints are included. The accumulated knowledge of 10 years of environmental watering also highlights a need to ensure future watering actions are adaptable and outcome driven, and guided by conditions in the river at the time. This could include, for example, watering when certain water quality parameters are declining, or delivery of freshes to mimic known spawning requirements for fish or to meet the water requirements for habitat that promotes movement of regionally specific fauna.

Risks associated with environmental water delivery

There are a number of challenges that need to be addressed in order to achieve the desired ecological outcomes using water for the environment. These challenges include threats such as exotic species, instream infrastructure and system constraints, and saline groundwater intrusions. The risks associated with these threats are outlined and mitigation actions are prescribed.

Delivery constraints

Availability of water for the environment is often less than the water needed to deliver the recommended flows. For example, most of the larger flow components (such as bankfull or overbank) cannot be delivered through regulated releases in most cases due to the physical restrictions of upstream dams and weirs. Other factors (such as prohibitive channel losses and risks around inundation of private land) mean most of these releases are also not feasible. As a consequence, overbank flow recommendations can only be met by natural events.

Climate impacts

Climate change and a drying climate also influence the use of the water for the environment. For example, the recent climatic water cycle has a seen a large rain event every six or so years that fills the headwork storages and causes minor to moderate flooding (i.e. flash-flooding storm events potentially replacing the gradual wetting of the catchment of past years). Whilst this meets the larger flow components of the flow studies, management of the environmental water reserve is needed to occur between these high flow periods to ensure flows still meet the river's ecological requirements.

If the river or tributaries are meeting optimal ecological requirements, planned flows for the period may be reduced to preserve water for use in subsequent seasons.

Objectives of monitoring and assessment activities

In order to enable adaptive management and highlight the outcomes of environmental watering to stakeholders and the community, a comprehensive monitoring program needs to be implemented. It needs to encompass the broad range of ecological objectives and so involves a range of endpoints. As the State progresses the Victorian Environmental Flows Monitoring and Assessment Program (VEFMAP), the Wimmera River EWMP recommends a suite of intervention and long-term condition monitoring activities that will meet these requirements.

Knowledge gaps to address

Whilst there has been a long history of environmental watering in the Wimmera, and a lot of information gathered in this time, there remains a number of important questions that need answering – particularly around the effect of flows on saline pools, weir pool hydrology, instream loss rates and the cultural values of the Wimmera River and how these could be enhanced with environmental watering actions. There is also a need to:

- undertake an assessment of the attribution of climate variability on annual monitoring outcomes (for example recent climate conditions and weather patterns that has seen an increase in storage flows from major flash-flooding storm events)
- better understand the travel times of flows between gauging points.

Figure ES-1: Wimmera River at Jeparit, September 2022 (Source: WCMA)

ACKNOWLEDGEMENT OF COUNTRY

We acknowledge the Wotjobaluk, Jaadwa, Jadawadjali, Wergaia and Jupagalk Peoples as the Traditional Owners of the Country on which this project has been conducted. We recognise their continuing connection to land, waters and culture and pay our respects to their Elders past and present. Moreover, we express gratitude for the knowledge and insight that Traditional Owners and other Aboriginal and Torres Strait Islander people contribute to our shared work in Australia.

Abbreviations, acronyms and glossary

ABBREVIATIONS AND ACRONYMS

AHD	Australian Height Datum
BGLC	Barnegi Gadjin Land Council
CEWO	Commonwealth Environmental Water Office
CMA	Catchment Management Authority
COAG	Council of Australian Governments
DCCEEW	Australian Government Department of Climate Change, Energy, and Environment and Water
DEECA	Victorian Department of Energy, Environment and Climate Action
EHNV	Epizootic Haemotopoietic Necrosis Virus
EPBC	Environment Protection and Biodiversity Conservation Act
EOS	Environmental Operating Strategy
ERS	Environmental Reference Standard
EWMP	Environmental Water Management Plan
EWR	Environmental Water Reserve
FFG	Flora and Fauna Guarantee Act
ICAG	Inter Catchment Advisory Group
ISC	Index of Stream Condition
IWC	Index of Wetland Condition
LiDAR	Light Detection and Ranging
GWMWater	Grampians Wimmera Mallee Water Corporation
MBI	Macroinvertebrate Biotic Index
MDBA	Murray Darling Basin Authority
MWS	Mallee Waterway Strategy
NES	National Matters of Environmental Significance
NTU	Nephelometric Turbidity Units
NWI	National Water Initiative
PAL	Portable Automated Logger
RBA	Rapid Biological Assessment
RCS	Regional Catchment Strategy
SCADA	Supervisory Control and Data Acquisition
SRA	Sustainable Rivers Audit
SWS	Sustainable Water Strategy
TRG	Technical Reference Group
VEFMAP	Victorian Environmental Flows Monitoring and Assessment Program
VEWH	Victorian Environmental Water Holder
VWMS	Victorian Waterway Management Strategy
WetMAP	Wetland Monitoring and Assessment Program
WRAG	Western Rivers Advisory Group
WWS	Wimmera Waterway Strategy

GLOSSARY

Aeolian	Relating to the action of the wind
Anastomosing	Channels that separate and reconnect
Bankfull	Very high flow that fills but is contained within the river channel
Cease to flow	Period with no flow
Channelised	Removal of hydraulic diversity (runs, riffles, ponds) due to excavation/erosion
Chain-of-ponds	Type of streamform with deep pools that are separated by raised areas
Deflation basin	Shallow depression created by wind blowing sediment
Endemic	Native to the local area
Episodic	Takes place after significant episodes (i.e. floods)
Exotic	Not native to Australia
Ferruginised	Sandstone containing high levels of iron which is more resistant to erosion
Fresh	Higher flow than baseflow that would naturally take place following a modest rainfall event. Important for improving water quality, inundating habitat and providing biological cues
Fresh water	Salinity level below approximately 1,000 µS/cm
High value waterway	Waterway (river/creek/lake/wetland) with a value (environmental/social/cultural/economic) that is deemed to be above a certain threshold defined within a regional waterway strategy
Hydraulic	Related to the movement of water over a surface
Hydrologic	Related to the distribution of water in space and time
Hypersaline water	Salinity levels over approximately 40,000 µS/cm
Intermittent	Takes place temporarily typically less frequently than annually
Lunette	Crescent shaped high point created by wind movement of sediment
Overbank	Very large flow that exceeds the capacity of the river channel (flood)
Passing flow	Flows that must be passed at regulating infrastructure (Lake Lonsdale, Huddleston's Weir, Stawell Diversion Weir) under conditions specified within the Environmental Entitlement
Priority waterway	Subset of high value waterways that have a range of feasible management activities that can be undertaken to maintain or improve their values.
Refuge	Location (e.g. deep pool) that possesses many attributes that means that aquatic communities (fish, platypus) can resist stresses of drought, bushfire etc.
Regulated	Water controlled by headworks infrastructure (weirs, channels, dams). Regulated environmental water is that allocated within the entitlement framework and can be called on to be released from headworks infrastructure subject to approval by the storage manager.
Reach	Sub-section of a river or creek based on distance or common attribute (geomorphology/hydrology). Generally, at least several kilometres in length.
Seasonal	Takes place during particular seasons
Translocated	Species moved from one location to establish another one elsewhere.

1 Introduction

Environmental water management practices within the Murray-Darling Basin have advanced significantly since the mid-2000's. The completion of various water recovery and purchase programs combining with enhanced policy and greater scientific knowledge has resulted in onground change. The most dramatic change in the Wimmera River System was the completion of the Northern Mallee and Wimmera Mallee Pipelines and purchase of the Wimmera Irrigators' Association entitlement.

Completion of these environmental water recovery initiatives has resulted in:

- 40.5 GL high reliability regulated entitlement shared between the Wimmera and Glenelg River Systems;
- 28 GL low reliability former irrigation entitlement for the Wimmera River; and
- An average of 36.8 GL/y of passing flows and additional unregulated flows for the Wimmera River System.

Policy documents developed in consultation with the community such as Securing Our Water Future Together (DSE, 2004), Western Region Sustainable Water Strategy (DSE, 2011), Basin Plan (Commonwealth of Australia, 2012) and Victorian Waterway Management Strategy (DEPI, 2013) progressed the development of water sharing arrangements to ensure water is used effectively and efficiently. Local scientific information on responses of fish, platypuses, macroinvertebrates and water quality to environmental water releases has also been collected through monitoring for a number of years to enable adaptive management.

The development of the Environmental Water Management Plan (EWMP) for the Wimmera River provides an opportunity to consolidate these advancements and develop a solid foundation document for environmental water management for the Wimmera River for the next decade.

1.1 PURPOSE AND SCOPE

This Wimmera River EWMP is a 10-year management plan that:

- Describes the ecological values present
- Establishes long-term ecological objectives and water requirements of the Wimmera River, Yarriambiack Creek and their terminal lakes; Mount William Creek and Dock Lake
- Identifies and addresses risks associated with environmental watering and mitigating actions for those risks.

The purpose of the Wimmera River EWMP is to:

- Synthesise technical information relating to environmental values, condition, hydrology, threats and water resource infrastructure
- Identify the long-term ecological objectives and their water requirements for the Wimmera River, Yarriambiack Creek and their terminal lakes; Mount William Creek and Dock Lake
- Provide a vehicle for community consultation, including setting of long-term objectives and water requirements of these waterways
- Operationalise flow studies, including providing guidance on the environmental watering targets appropriate under different seasonal conditions to inform the development of Seasonal Watering Proposals and Plans
- Inform the Long-term Watering Plan for the Wimmera-Mallee Water Resource Plan area, as required under the Basin Plan (Chapter 8).

1.2 ASSET CHARACTERISTICS

The Wimmera River EWMP includes the Wimmera River and Yarriambiack Creek, and their terminal lakes; Mount William Creek and Dock Lake. Other tributaries of the Wimmera River including the MacKenzie River, Burnt Creek, and Bungalally Creek are not included in this EWMP. The EWMP is limited to issues related to the management of environmental water and flow dependent values and does not constitute a holistic management plan for the Wimmera River system.

A map showing the main features of the Wimmera River catchment is shown in Figure 1-1. The reaches covered in this EWMP are Mount William Creek, Wimmera River Reaches 2 and 3, Wimmera River Reach 4, and terminal lakes including Outlet Creek, Yarriambiack Creek and Lake Corrong. A map showing the location of Dock Lake is shown in Figure 1-2.

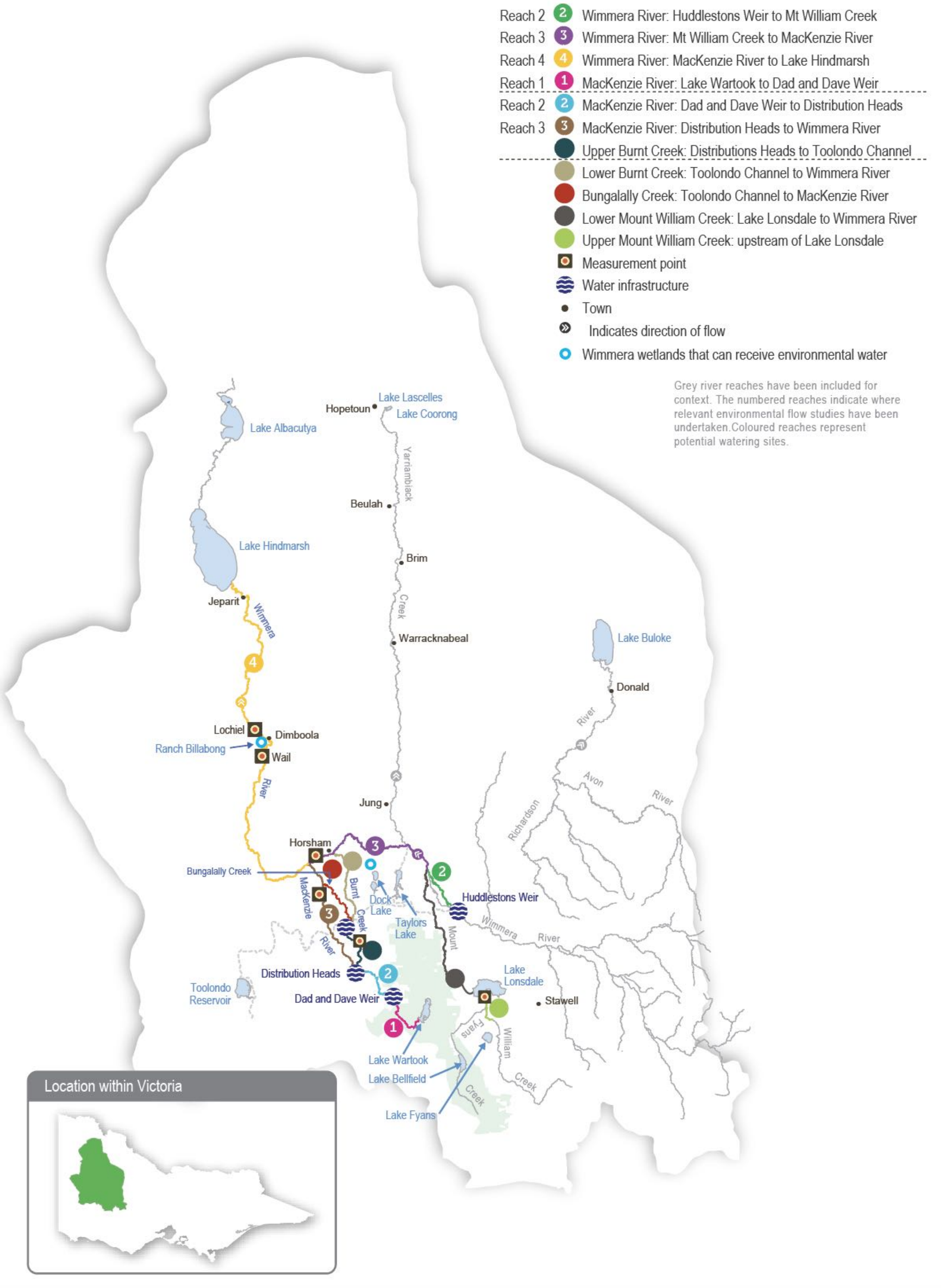

Figure 1-1: Map showing the Wimmera River system. Reaches covered in this EWMP are Wimmera River 2 and 3, Wimmera River 4, Outlet Creek and the terminal lakes including Lake Hindmarsh and Lake Albacutya, and Yarriambiack Creek (VEWH, 2024)

Figure 1-2: Map showing Dock Lake as it relates to this EWMP (Jacobs, 2015).

1.3 PROCESS USED TO UPDATE THE EWMP.

The Wimmera CMA has been funded through the Department of Energy, Environment and Climate Change (DEECA) 'Victorian Basin Plan Environmental Water Management Plan (EWMP) Program' to update this EWMP for the Wimmera River. Initial development of this EWMP was a management activity specified in the Wimmera Waterway Strategy (Wimmera CMA, 2014).

The EWMP has been developed in consultation with the community as well as including input from technical specialists in waterway ecology and water resource management to provide a robust and thorough planning document for the next decade. It will form the basis for future Seasonal Watering Proposals for the Wimmera River and their terminal lakes; Mount William Creek and Dock Lake.

1.4 POLICY CONTEXT

Environmental water in Victoria is managed as an integral part of the Victorian Waterway Management Program, with the state-level Victorian Waterway Management Strategy (VWMS) providing the overarching framework for environmental water management (Figure 1-3). Regional Waterway Strategies (RWSs) drive the implementation of the VWMS at the regional level. Information from the region's RWS is a key input to environmental water planning arrangements, including the selection of eligible assets to receive environmental water. Environmental water management plans are site-specific plans developed for those assets deemed a priority to receive environmental water through the RWS development process.

Environmental water management in Victoria is now firmly established with water recovery enabling the return of significant volumes of water to the environment. The increased environmental water availability has provided opportunities to protect, restore and reinstate high value ecosystems throughout Victoria.

Environmental watering in Victoria has historically been supported by management plans such as this one, that document key information including the watering requirements of an asset, 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 assets respond to the water they receive or what could be done better.

In the Murray-Darling Basin, environmental water management is further underpinned by the Murray-Darling Basin Plan 2012 (Commonwealth) and the associated Basin-wide environmental watering strategy. In accordance with Basin Plan requirements, Victoria has also developed relevant Water Resource Plans and Long-Term Watering Plans.

Victoria's Catchment Management Authorities (CMAs), Melbourne Water, DEECA, the Victorian Environmental Water Holder (VEWH) and Traditional Owner groups have worked together to develop a number of Environmental Water Management Plans for watered assets throughout Victoria. These plans are continually updated through an adaptive management process. A primary purpose of the plans is to provide a consistent set of documents that support seasonal watering proposals to be submitted by asset managers to the VEWH annually. The supporting information includes:

- Lead management agencies and their management responsibilities
- The water-dependent environmental, social and economic values of the asset
- The asset's environmental condition and threats
- Environmental objectives and intended watering regime
- Contributions from Traditional Owner groups (included in an EWMP with free, prior and informed consent) that may include information about cultural values, management goals, environmental objectives and intended watering regime
- Opportunities for improved water delivery, efficiency or capacity through structural works or other measures
- Scientific knowledge gaps and recommendations for future work.

This document is the Environmental Water Management Plan (EWMP) for the Wimmera River in the Wimmera Catchment Management region.

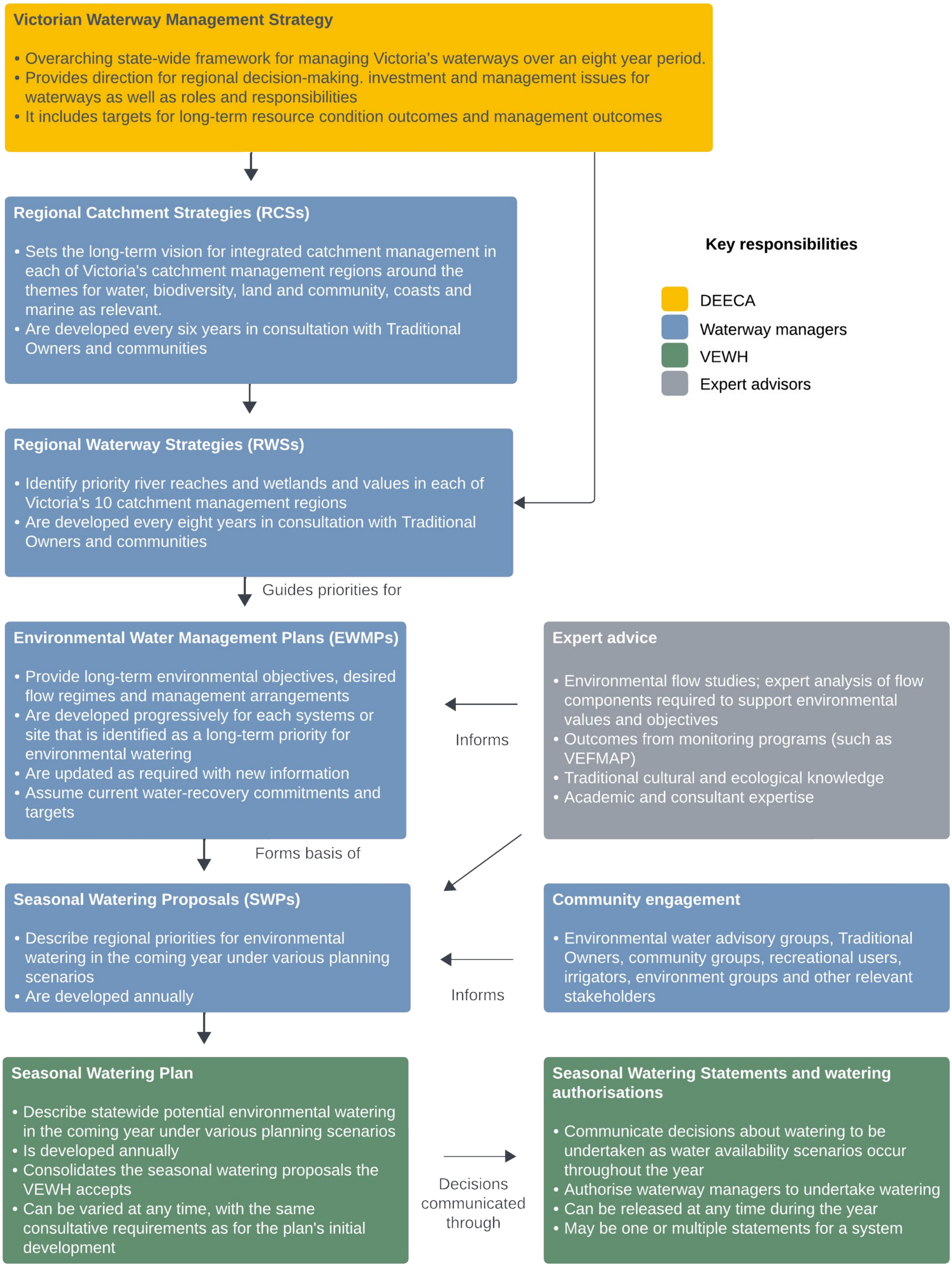

Figure 1-3: Victoria's environmental watering program planning framework (adapted from (VEWH, 2024)).

Table 1-1: Roles and responsibilities with respect to environmental watering in the Wimmera River, Mount William Creek, Dock Lake, Yarriambiack Creek and Terminal Lakes

PARTNERS	ROLES AND RESPONSIBILITIES/LINKS WITH WATERWAYS
Wimmera CMA	Catchment Management Authorities (CMAs) are responsible for the integrated planning and coordination of land, water and biodiversity management in their respective catchment and land protection regions. Under the *Water Act 1989*, the CMAs also have specific functions in relation to waterway management, floodplain management and regional drainage as the regional waterway manager. This includes identifying regional priorities for environmental watering and facilitating environmental water delivery. In line with these functions, the Wimmera CMA is responsible for the development of environmental water management plans and annual seasonal watering proposals, and for coordinating the implementation of the Victorian Seasonal Watering Plan as it applies to the Wimmera CMA region.
Department of Energy, Environment and Climate Action (DEECA)	DEECA is the lead agency for waterway management. It is responsible for the development of waterway policy, co-ordination of regional delivery and prioritisation of Government investment in waterways. DEECA is also responsible for other aspects of natural resource management that are of relevance to environmental water management, including: ▪ sustainable management of Victoria’s water resources through managing the water allocation and entitlements framework ▪ developing state policy for water resource and waterway management. DEECA also has a number of other responsibilities that relate to broader waterway management such as oversight of Crown land and integrated catchment management.
Victorian Environmental Water Holder (VEWH)	The VEWH is appointed under the *Water Act 1989* to manage Victoria’s environmental water entitlements. The VEWH works with waterway managers, Commonwealth Environmental Water Holder, Murray–Darling Basin Authority, storage operators and land managers to ensure environmental water entitlements are used to achieve the best environmental outcomes in line with the Environmental Water Management Plan.
Murray–Darling Basin Authority (MDBA)	The MDBA was established under the federal *Water Act 2007* as an independent, expertise based statutory agency. The primary roles of the Authority as outlined in the Water Act 2007 include: ▪ Preparing and reviewing the Basin Plan ▪ Measuring, monitoring and recording the quality and quantity of the Basin's Water resources ▪ Supporting, encouraging and conducting research and investigations about the Basin's Water Resources ▪ Developing equitable and sustainable use of Basin water resources ▪ Disseminating information about the Basin's water resources ▪ Engaging and educating the Australian community about the Basin’s water resources.
Commonwealth Environmental Water Office (CEWO)	The CEWO manages an entitlement in the Wimmera CMA region to assist in its role to protect or restore the environmental assets of the Murray-Darling Basin. Water will be managed in accordance with the environmental watering plan that will be part of the Murray-Darling Basin Plan.

PARTNERS	ROLES AND RESPONSIBILITIES/LINKS WITH WATERWAYS
Grampians Wimmera Mallee Water (GWMWater)	Water corporations in Victoria are established under the *Water Act 1989* and provide a range of water services to customers within their service areas. GWMWater provides a combination of irrigation services, domestic and stock services, bulk water supply services and urban water and wastewater services in most of the Wimmera CMA region. Their link with environmental water management is in their role as resource and storage manager – responsible for determining and delivering allocations to holders of environmental water entitlements. They also conduct water transfers using waterways as conduits, which present both risks and opportunities in achieving ecological objectives for these waterways. Regionally they are also responsible for coordinating the management of major outbreaks of blue-green algae, and also for take and use surface water and groundwater licensing. They also manage land on which their infrastructure is located (e.g. weirs and storages).
Hindmarsh Shire, Horsham Rural City, and Yarriambiack Shire	A unique aspect of environmental water management in the Wimmera is the role of local government in managing town weirs, which can affect the passage of flows down the Wimmera River and Yarriambiack Creek.
Barengi Gadjin Land Council Aboriginal Council (BGLC)	BGLC can provide advice on how management of water for the environment can improve or maintain cultural values, and care for and heal Country.
Community members/ representatives	Community members who have a detailed understanding of these waterways can provide advice and feedback on the effect of management of water for the environment on local waterways. Often, they are responsible for managing riparian land either as freehold landowner or licensee of Crown land.
Parks Victoria	Parks Victoria is the responsible public land manager for much of the lower sections of the Wimmera River (including its terminal lakes).

Figure 1-4: Wimmera River at Dimboola

2 Partnership and engagement

Engagement for the development of this EWMP builds on a wide array of consultation which has been undertaken for previous strategies and plans pertaining to the management of water for the environment in the Wimmera CMA region. This includes the following key documents:

- Wimmera Regional Catchment Strategy (Wimmera CMA, 2021 – 2027)
- Wimmera River Environmental Flows Study (Alluvium, 2013)
- Review of the environmental flow requirements of the Wimmera terminal lakes (Jacobs, 2019)
- Dock Lake FLOWS Study (Jacobs, 2015)
- Mount William Creek Streamflows Study (Alluvium, 2015).

Wimmera RCS

As detailed above, management of water for the environment has been aligned to six- and 20-year outcomes in the Wimmera RCS 2021 – 2027. Engagement that was undertaken to develop the Wimmera RCS 2021 – 2027 involved:

- Meetings with community stakeholders to discuss feedback on the previous strategy, and focus on looking forward, identifying regional and Local Area priorities, challenges and issues.
- Preparation of working drafts, collating a range of information and discussing content with stakeholders
- Preparation of a Stakeholder Consultation Draft for review by a range of partner and stakeholder organisations and groups
- Public exhibition of a full draft was released for public consultation from 31 March until 3 May 2021

Wimmera River Environmental Flows Study

The Wimmera River Environmental Flows Study (Alluvium, 2013) which formed a key component of this EWMP involved the development of the environmental objectives by Wimmera CMA staff and technical specialists in flow ecology, fish biology, vegetation, macroinvertebrates and geomorphology. The draft environmental objectives were presented for feedback to the Wimmera CMA's Rivers and Streams Advisory Committee for review, comment and endorsement. This advisory committee was comprised of both community members and agency representatives (Table 2-1).

Table 2-1: **Advisory Committee Members involved in the development of the Wimmera River Environmental Flows Study (Alluvium, 2013)**

ADVISORY COMMITTEE MEMBER	AFFILIATION
Gary Aitken	Wimmera River Improvement Committee Member
Graham Campbell	Senior Property Officer, DEECA
Andrea Cooper	Landholder near the Wimmera River (Glenorchy)
Ken Flack	Wimmera Anglers' Association Secretary
Michael Greene	Project Platypus Landcare Network Board Member
Peter Hallam	Landholder near the Yarriambiack Creek (Hopetoun)
James McFarlane	Landholder near the Yarriambiack Creek (Brim)
Jim McGuire	Former Superintendent of Fisheries and Wildlife Division for the Wimmera and Mallee – Department of Natural Resources and Environment
Brad Mitchell	Federation University - Head of School of Ecology and Environment
Michael Stewart	Barengi Gadjin Land Council - CEO

Review of the environmental flow requirements of the Wimmera terminal lakes

The 2019 Review of the Wimmera Terminal Lakes Environmental Water requirements also involved consultation with a Project Advisory Committee made up of a number of local landholders and agency representatives from Parks Victoria, Hindmarsh Shire Council, the Commonwealth Environmental Water Office, Mallee CMA and Wimmera CMA. The Project Advisory Committee contributed to the background understanding of the system, helped to set environmental flow objectives for the terminal lakes and reviewed the environmental flow requirements. Community members involved in the Project Advisory Committee are identified in Table 2-2.

Table 2-2: Community project advisory group members involved in the review of the environmental flow requirements of the Wimmera terminal lakes (Jacobs, 2019)

NAME	AFFILIATION
Ron Ismay	Hindmarsh Shire Mayor and long-term resident
Colin Drendel	Landholder near Ross Lakes and Lake Albacutya
Marg Krelle	Landholder near Ross Lakes and Lake Albacutya
Peter Gosling	Landholder near Lake Albacutya and Wyperfeld National Park
Barry Clugston	Former landholder near Rainbow and Wyperfeld
Clive Crouch	Community member very familiar with the lakes' nature features
Roger Aiken	Landholder near Lake Hindmarsh
Yolande Hutson	Jeparit Caravan Park Manager and Jeparit Town Committee Member
Gayle Newcombe	Landholder near terminal lakes and bird specialist
Jonathan Starks	Hindmarsh Landcare coordinator and bird specialist
Mick Gawith	Landholder near Lake Hindmarsh

Dock Lake FLOWS Study

Similarly for the Dock Lake FLOWS Study (Jacobs, 2015), there was involvement from a handful of community members who had a strong knowledge of the lake's values, particularly when it contained water in the 1990's.

Table 2-3: Community project advisory group members involved in the Dock Lake FLOWS Study (Jacobs, 2015)

ADVISORY COMMITTEE MEMBER	AFFILIATION
Bernard Gross	Former landholder near Dock Lake
Russell Peucker	Landholder near Dock Lake
Jim McGuire	Former Superintendent of Fisheries and Wildlife Division for the Wimmera and Mallee – Department of Natural Resources and Environment
Tim Mintern	Local bird specialist

Mount William Creek Streamflows Study

The Mount William Creek Streamflows Study (Alluvium, 2015) also involved community members who had a detailed understanding of the creek including Ray Howard, Peter Jackman, Geoff Launder and Joe Facey. Furthermore, the development of broader strategies for waterway management in the region, for example the

Wimmera Waterway Strategy (WWS) and Mallee Waterway Strategy (MWS) also involved wide consultation, involving a number of agencies and community groups. Furthermore, the strategies were released as a public draft for comment. Through the development process there was widespread support for the goals, targets and management activities prescribed in the document including many that relate to environmental water management. Information was also gleaned on environmental values and threats associated with the Wimmera River and terminal lakes system.

Information Sources

Information used in the development of this plan was compiled from various sources including the studies listed above, as well as:

- Environmental Water Management Plan – Wimmera River System (WCMA, 2015)
- Environmental Water Needs of the Wimmera River Terminal Lakes (Ecological Associates, 2004)
- Review of the Wimmera Terminal Lakes Environmental Water Requirements (Jacobs, 2019)
- Maximising cultural benefits and Aboriginal community outcomes from managing water for the environment in the lower Wimmera River (RMCG, 2020)
- Environmental Water Requirements of Lake Corrong and Lake Lascelles (Ecological Associates, 2006)
- Wimmera Waterway Strategy 2014-2022 (WCMA, 2014)
- Wimmera River and Terminal Lakes: Environmental Water Management Plan, Preliminary Draft (Jacobs, 2020)
- Wimmera River Seasonal Watering Proposals (WCMA, various years)

As with the engagement processes for the studies and Wimmera RCS listed above, this information was supplemented through engagement with stakeholders with an intimate knowledge of the river, its environmental values and the management and operation of the system (refer Appendix A-4).

2.1 TRADITIONAL OWNERS

Barengi Gadjin Land Council (BGLC) represents Traditional Owners from the Wotjobaluk, Jaadwa, Jadawadjali, Wergaia and Jupagulk peoples, who were recognised in a 2005 Native Title Consent Determination, the first in south-eastern Australia. The organisation is also the only body in the region with the legislative authority to make legal decisions about cultural heritage. BGLC is also the Prescribed Body Corporate for the Wotjobaluk claim area, as outlined in the Native Title Act, giving them the legal authority and obligation to work on behalf of the region’s Traditional Owners.

BGLC is also a Registered Aboriginal Party, as appointed by the Victorian Aboriginal Heritage Council, under the Aboriginal Heritage Act 2006. As a Registered Aboriginal Party, BGLC is the primary source of advice and knowledge for the Victorian Government on matters relating to Aboriginal places located in or Aboriginal objects originating from the area for which the party is registered. BGLC participates in the preparation of Cultural Heritage Management plans and evaluates plans written by other cultural heritage advisors. They also consider and advise the State and Local Governments on applications for Cultural Heritage Permits, negotiate and enter into Cultural Heritage Agreements and advise on and negotiate the repatriation of Aboriginal cultural heritage.

Many Aboriginal cultural sites in the western region of Victoria are on or near waterways, and streams and water bodies are still important sources of food and medicine. Waterways are important meeting places for families and communities to come together for cultural, social and recreational activities, and to teach culture to young people. Access to healthy waterways is vitally important for these activities. This relationship, between people and water is demonstrated by the Creation Stories about the formation of the Wimmera River and other waterways in the region.

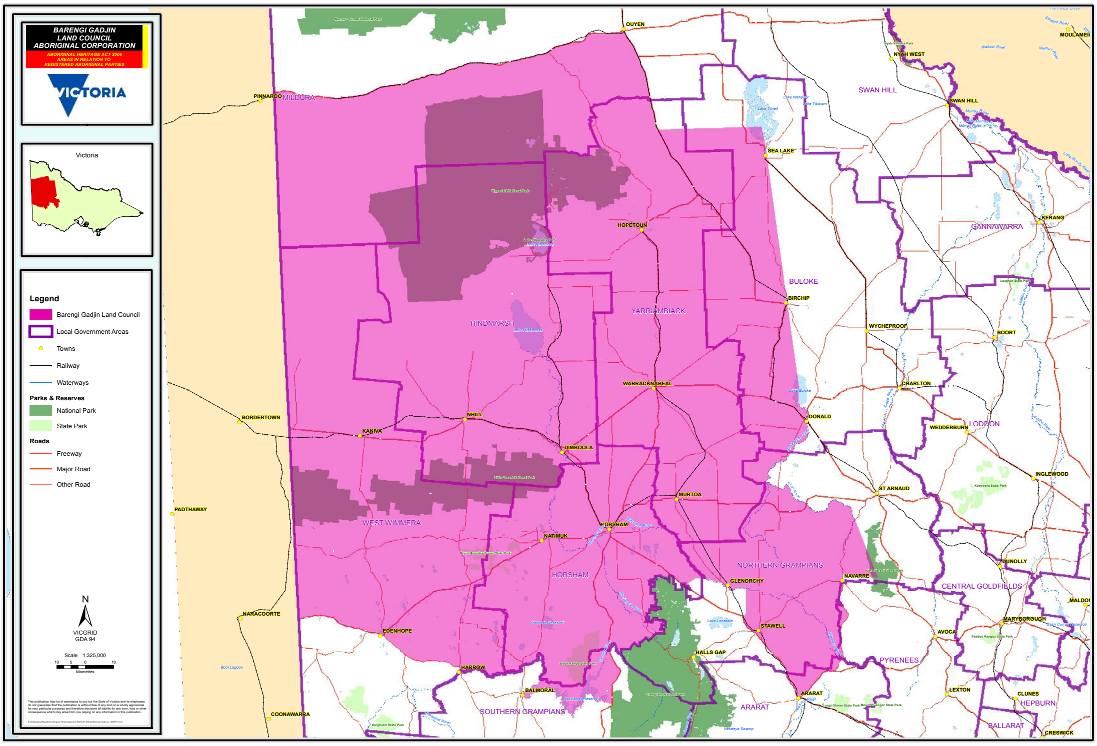

Figure 2-1: Boundary of the BGLC Registered Aboriginal Party (RAP)[2]

Through the delivery of its key activities, the Wimmera CMA has built strong foundations and significant momentum in supporting BGLC and the Wotjobaluk Traditional Owners to:

- engage in the planning and management of waterway management outcomes
- achieve cultural benefits and Aboriginal community outcomes from managing water for the environment in the lower Wimmera River.

Some notable achievements include (RMCG, 2020):

- The delivery of 24.2 ML of environmental water over four seasons to the Ranch Billabong, which has strengthened partnerships and supported Traditional Owners to engage with this Special Place and care for Country
- The roll out of the River Yarns community gatherings and support for other subsequent community gatherings along the Wimmera River. This has facilitated Traditional Owner awareness, engagement and participation in the management of water for the environment and the sharing of cultural and ecological knowledge of the river, while recognising and celebrating connections to Country.
- The extensive cultural survey work, incorporating Traditional Owner employment and training opportunities, delivered within the cultural landscape of the lower Wimmera River. This work has documented significant and ongoing Aboriginal community cultural connections to the lower Wimmera River. It has also provided an important baseline of the cultural health of the waterway system that can inform and support the delivery of complementary benefits from future environmental watering.

These activities have highlighted the Wotjobaluk Peoples' close and continual connections with the Wimmera River (Barringgi Gadyin) and its associated waterways. They have also highlighted the relationship that often exists between the health of cultural heritage places and broader waterway health. This includes localised examples of improvements to culturally and environmentally important plant and animal species through the Ranch Billabong watering pilot.

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[2] Source: BGLC website (https://www.bglc.com.au/native-title)

Figure 2-2: River Yarns Promotional Brochure (March 2017)

These activities have also assisted the Wotjobaluk Traditional Owners to identify and articulate their values, aspirations and interests to its water sector delivery partners, the Wimmera CMA, VEWH and GWMWater. These partnerships and increased knowledge sharing will be crucial to realising further cultural benefits and Aboriginal outcomes from managing water for the environment.

Figure 2-3: Wotjobaluk Community members at the River Yarns gathering

3 Asset overview

3.1 CATCHMENT SETTING

The Wimmera CMA region covers approximately 23,500 km2, or 13 %, of Victoria and is largely cleared for agriculture. Although, there are sizeable tracts of public land including the Grampians and Little Desert National Parks, the Black Range and Mt Arapiles-Tooan State Parks, as well as the Pyrenees and Mt Cole State Forests. About 50,000 people live in the region, with most of the region’s income derived from agriculture (dryland cropping and sheep grazing) (Wimmera CMA, 2013). The part of the Mallee CMA region that is included in this EWMP is typically flat broadacre cropping country, in the southern Mallee, and includes parts of the Wyperfeld National Park.

Hydrophysical Characteristics

The Wimmera River commences in the Pyrenees north-east of Ararat, flowing north-west out of state forest through undulating grazing and cropping country where a number of tributaries such as Concongella, Heifer Station and Mt Cole Creeks provide significant streamflows during wet conditions. Mount William Creek rises in the eastern slopes of Mount William in the Grampians Ranges and flows north through the dissected fluvial and aeolian plains along the eastern margin of the Grampians National Park towards the Wimmera River, north of Dadswell’s Bridge. The channel and floodplain morphology of the Mount William Creek is complex with numerous minor tributaries, anabranches and flood runners distributing regulated and flood flow across the floodplain from the Mount William Creek to the Wimmera River.

There has been a long history of modifications to Wimmera River catchment, which in turn has affected its hydrology. Since European settlement much of the catchment has been cleared and converted to broadacre cropping and grazing, which has led to an increase in runoff and streamflows. Although there is a proliferation of stock and domestic dams in the upper catchment (See Section 3.3), their impact is insufficient to offset the increases in streamflows brought about by land clearing, although climate and land use change are creating major cumulative effects of reducing streamflows.

Dock Lake is one of the Boga Lakes (also including Green Lake, Taylors Lake and Pine Lake) as named by Major Mitchell, located near Horsham. Dock Lake and Green Lake are separated by about 300m with the Western Highway passing between them. Dock Lake would have naturally received water when Green Lake filled and overflowed following significant inflows from Diggers Creek and Mibus Creek.

3.2 LAND STATUS AND MANAGEMENT

Waterway land ownership and management across Victoria is inherently complex, with combinations of freehold and Crown land, often depending on the timing of settlement and purchase by pastoralists in the 1800’s as well as government surveying. Therefore, throughout the Wimmera River System there is a mosaic of land management (Table 3-1) and (Figure 3-1).

Statistics around the land tenure of the Wimmera River, Mount William Creek, Yarriambiack Creek and Outlet Creek are outlined in Table 3-1. Much of the Wimmera River flows through Crown land, including reserves managed by DEECA such as the Wail State Forest or Parks Victoria such as the Barabool Flora Reserve and Little Desert National Park and with Crown stream frontage managed by the adjacent landholders under licence from DEECA. Much of the lower Wimmera River is part of the Wimmera River Heritage River Reserve, managed by Parks Victoria. There are a number of locations where landholders own land right to the top of the riverbank or even land where the river channel is located, especially around Horsham and Dimboola.

It is important to note that non-exclusive native title has been granted for Crown land that comprises the Wimmera Heritage River (downstream of Polkemmet Bridge). Therefore, co-management of this land is being undertaken by Barengi Gadjin Land Council (BGLC) on behalf of Traditional Owners and Parks Victoria.

Yarriambiack Creek is mostly licenced Crown stream frontage for grazing, with small sections of land managed by Parks Victoria such as Darlot Swamp Wildlife Reserve. There is some freehold land covering Yarriambiack Creek, mostly north of Warracknabeal.

The terminal lakes of the Wimmera River are contained within Crown land (Lake Hindmarsh Lake Reserve, Lake Albacutya Park and Wyperfeld National Park). For the terminal lakes of the Yarriambiack Creek, Lake Corrong is located within the Lakes Corrong and Lascelles Lake Reserve, Lake Myall is in the Cambacanya Flora and Fauna Reserve and the rest are on freehold land. The land manager of Dock Lake is Grampians Wimmera Mallee Water (GWMWater).

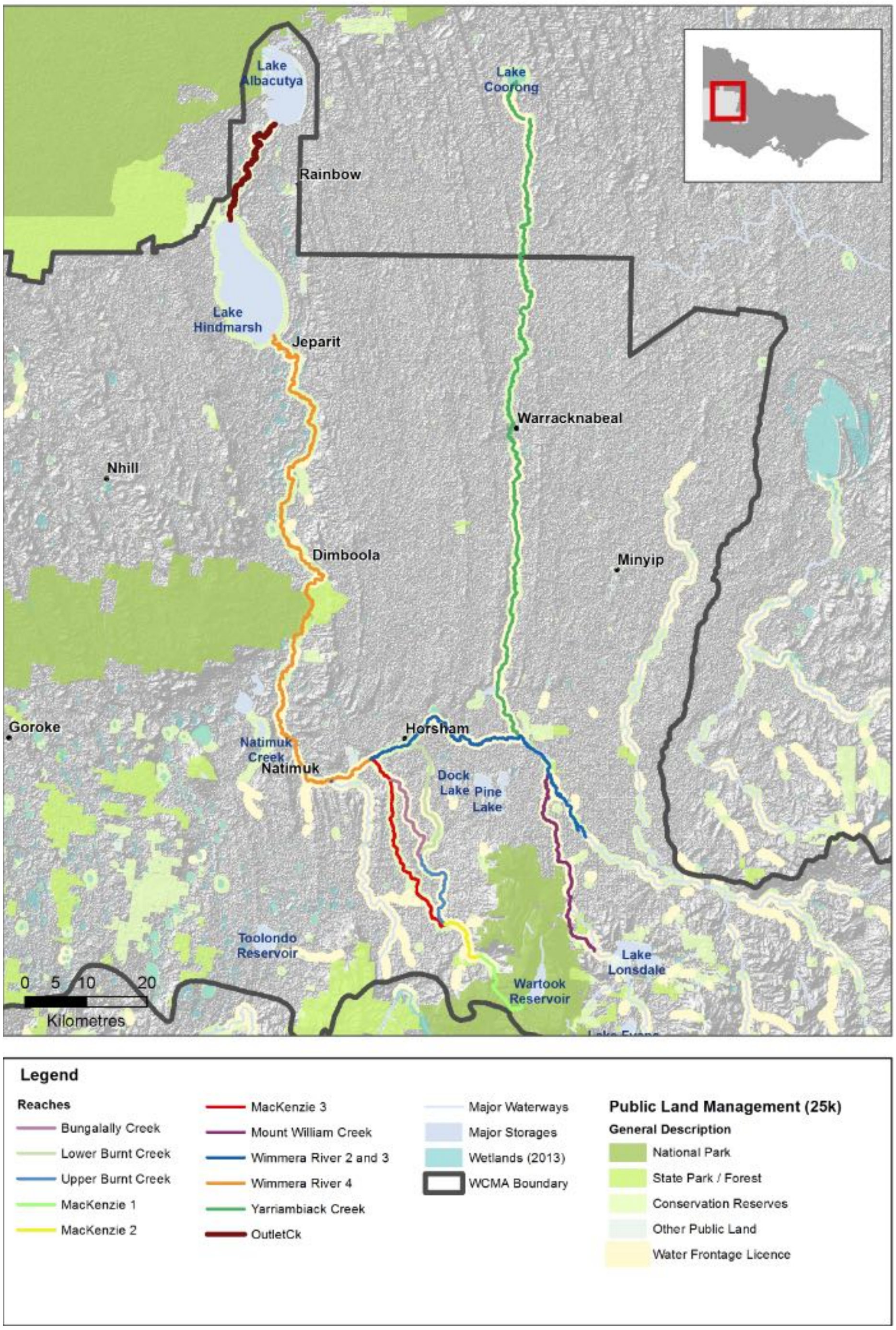

Figure 3-1: Land management arrangements for Wimmera waterways (Source: WCMA).

Table 3-1: Summary of statistics with respect to land tenure for the reaches of the Wimmera River, Mt William Creek, Outlet Creek and Yarriambiack Creek

WATERWAY	DISTANCE (KM)	DISTANCE CROWN LAND (KM)	% CROWN LAND
Wimmera River	212.5	189.5	89
Mt William Creek	42.8	28	66
Yarriambiack Creek	150.2	133.7	89
Outlet Creek	40.6	40.6	100

3.3 ENVIRONMENTAL WATER SOURCES

Water in the Wimmera system is stored in three onstream reservoirs — Lake Wartook on the MacKenzie River, Lake Lonsdale on Mount William Creek and Lake Bellfield on Fyans Creek, and in several off-stream storages, Taylors Lake, Lake Fyans and Toolondo Reservoir. A channel system enables water to be moved between several storages. Water can also be transferred from Rocklands Reservoir in the Glenelg system to the Wimmera system via the Rocklands–Toolondo Channel and from Moora Moora Reservoir via the Moora Channel. The connected storages and channels are collectively called the Wimmera—Mallee System Headworks, and harvested water is used for towns and stock and domestic supply throughout the Wimmera catchment and parts of the Avoca, Hopkins, Loddon, Glenelg and Mallee catchments. Passing flows are provided to the Wimmera River and to lower Mt William Creek.

The Environmental Water Reserve (EWR) is the legally recognised amount of water set aside to meet environmental needs. The EWR can include minimum river flows (passing flows), unregulated flows and regulated environmental allocations specified within entitlements. Regulated environmental allocations are released from storage according to pre-determined environmental needs when needed and delivered to wetlands or streams to maintain their environmental values and condition.

The VEWH is responsible for holding and managing Victoria's regulated environmental water entitlements and making decisions on their use. The Commonwealth Environmental Water Office also holds an entitlement to be used for environmental purposes, albeit at a lower reliability. Both the VEWH and Commonwealth Environmental Water Office work closely with the Wimmera CMA who, as the regional waterway manager, coordinates the planning and delivery of the two entitlements through its seasonal water planning and delivery processes.

Environmental water for the Wimmera River, Yarriambiack Creek, Mount William Creek, Dock Lake and terminal lakes may be sourced from the water entitlements listed in Table 3-2.

Table 3-2: Summary of managed environmental water sources for the Wimmera River and terminal lakes

WATER ENTITLEMENT	VOLUME (ML)	RESPONSIBLE AGENCY
Wimmera and Glenelg Rivers Environmental Entitlement	40,560 ML high reliability[3]	Victorian Environmental Water Holder
	Passing flows at various locations	
Commonwealth Environmental Water Holdings	28,000 ML low reliability	Commonwealth Environmental Water Office

[3] Note this entitlement is shared with the Glenelg River system.

The Wimmera and Glenelg Rivers Environmental Entitlement also states that it includes all surface water resources beyond those permitted to be extracted under the Water Act 1989 under licences and consumptive Bulk Entitlements. This would include flows provided by operational spills (when storages exceed the maximum operating levels) and physical spills (flows entering storages and channels exceeded outlet capacities).

Although not environmental water per se, transfers between storages (from Lakes Bellfield, Lonsdale and Wartook to Taylor’s Lake) use various regulated waterways (Fyans Creek, Mount William Creek, MacKenzie River and Burnt Creek) which can contribute to meeting ecological objectives in these reaches, depending on how flows are managed.

The Wimmera River is defined within this EWMP as Mount William Creek from Lake Lonsdale to the Wimmera River confluence, the main stem of the Wimmera River and terminal lakes shown in Figure 3-2 and is located in the Wimmera CMA region and the southern part of the Mallee CMA region. The Wimmera River and terminal lakes are broken into separate ‘reaches’ for planning purposes based on a major hydrologic influence (e.g. confluence or water harvesting infrastructure). Yarriambiack Creek, a distributary of the Wimmera River, is directly affected by environmental water releases down the Wimmera River. Although floods are the main factor, regulation of upstream waterways also influences the water regimes of the terminal lakes of the Wimmera River and Yarriambiack Creek and so they are also included within this EWMP. Dock Lake has also been included in the EWMP. These are outlined as follows:

- Mount William Creek downstream of Lake Lonsdale
- Wimmera River downstream of Huddleston’s Weir:
  - Reaches 2/3 – Wimmera River from Huddleston’s Weir to MacKenzie River
  - Reach 4 – Wimmera River at MacKenzie River to Lake Hindmarsh
  - Terminal lakes and Outlet Creek
- Yarriambiack Creek and Lake Corrong
- Dock Lake, a terminal lake of the Diggers Creek, Mibus Creek and Green Lake system.

The Wimmera River upstream of Huddleston’s Weir is unregulated and outside the scope of this EWMP.

3.3.1 MOUNT WILLIAM CREEK

Lake Lonsdale near Stawell is the major water storage on the Mount William Creek. It is known for its episodic hydrology, filling rapidly during wet years but also enduring high rates of evaporation given its shallow characteristics. Water quality in the lake varies considerably depending on water levels, when the lake is nearly full water quality can be very good. However, during dry years, salt and nutrient levels concentrate (given the abundant waterbird population) and inflows from upstream can be quite saline given saline groundwater intrusions immediately upstream of Lake Lonsdale.

Due to its size, Lake Lonsdale can hold a comparatively large proportions of the environmental entitlement for the Wimmera system during wet years making Mount William Creek an essential delivery point for the Wimmera River. Over the past 100 years the flow regime of the lower Mount William Creek has been heavily regulated and influenced by the construction of many flow regulation structures including Trudgeon’s and Sheepwash Weirs (both now decommissioned with the latter still use by locals), Dadswell’s Bridge weir and other structures which control the flow of water between Mount William Creek, the Wimmera Inlet Channel and the Wimmera River.

During wet conditions the creek can receive inflows from the north-eastern edge of the Grampians (e.g. Briggs Creek, Back Creek) which tends to be of a very high water quality and so is often harvested into Taylors Lake via the Wimmera Inlet Channel. In recent years Mt William Creek has also been watered upstream of Lake Lonsdale at a series of deep refuge pools at Mokepilly. Water for these refuge pools is sourced from Lake Fyans and is delivered via an outlet specifically constructed for this purpose on the Fyans Outlet Channel. The flow continues down a small tributary before entering the Mt William Creek.

3.3.2 REACHES 2 & 3 – WIMMERA RIVER FROM HUDDLESTON'S WEIR TO MACKENZIE RIVER

Huddleston's Weir near Dadswell's Bridge marks the first major river regulation infrastructure (Section 3.4) following the decommissioning of Glenorchy Weir (the remaining structure which still impedes flows). Historically, Huddleston's Weir diverted most low-medium flows into the Wimmera Inlet Channel for supply to Pine and Taylors Lakes. Just prior to the completion of the Wimmera Mallee Pipeline, the weir was upgraded to improve the passage of environmental flow releases downstream and fish upstream. Pine Lake is no longer required for water supply purposes. Extended cease to flow periods which occurred for this reach in the past, (leading to this section being called 'The Dead River') are now less frequent due to passing flow capability provided by infrastructure improvements, water savings from the Wimmera Mallee Pipeline and subsequent Bulk Entitlement rules. Water quality considerations have also limited water harvesting at Huddleston's Weir since the Wimmera Mallee Pipeline was completed.

Just downstream from Huddleston's Weir there is the confluence with the Mt William Creek and a number of kilometres downstream receives inflows from Golton Creeks as well as regulated releases from the Taylor's Lake Outlet Channel. The offtake to the Yarriambiack Creek is located about two hundred metres downstream of the Taylor's Lake Outlet Channel which diverts a portion of the Wimmera River's flow northwards. The Yarriambiack Creek naturally would have flowed periodically when the Wimmera River was experiencing high flows however under current conditions receives more frequent flow with the aid of a small concrete weir and offtake structure. Located close to Horsham, the Burnt Creek and MacKenzie River are the most downstream significant tributaries of the Wimmera River in this reach although high proportions of their flow are diverted for regulated water supply.

The Wimmera River through this reach consists of sections with a primary channel with intermittent depositional features and numerous flood runners that would be engaged at higher flows. One such location near Longerenong and Lubeck resulted from a several kilometre long section where reaches of the Mt William Creek and Wimmera River flow in parallel have avulsed (SKM, 2002). Other parts, particularly downstream of Longerenong consists of a large primary channel with only flood flows breaking out over bank. The Horsham Weir also creates a significant weir pool for recreation and extraction for watering parks/gardens in Horsham.

3.3.3 REACH 4 - WIMMERA RIVER AT MACKENZIE RIVER TO LAKE HINDMARSH

The river's direction becomes more northerly following the MacKenzie River confluence and receives periodic inflows from the unregulated Norton, Sandy and Darragan Creeks. Norton Creek is the most significant of these waterways, commencing near the Black Range. The river then flows past the townships of Dimboola and Jeparit to Lake Hindmarsh, Victoria's largest freshwater lake when full and the first in a series of terminal lakes. On its journey, the waterway flows through strips of riparian vegetation (mostly Crown land) surrounded by broadacre cropping and grazing land including several larger areas of public land like the Little Desert National Park and Barabool Flora Reserve.

Much of the Wimmera River is characterised by deep pools, particularly in Reach 4, from Quantong through Wail to Dimboola (Figure 1-1). The reach is characterised by sections with relatively wide shallow primary channel with large permanent pools and other sections of multi-thread channels. There are anastomosing sections where larger flows (i.e. winter/spring freshes and greater) pass along multiple channels such as the section near Natimuk due to the presence of a ridge of ferruginised sandstone which has resisted erosion (Earth Tech, 2005). Datchak Creek near Antwerp is the most notable high flow channel of the Wimmera River.

Jeparit and Dimboola Weirs also create major weir pools for recreation and occasional water supply (stock and domestic and parks). There was another weir at Antwerp which has been decommissioned.

3.3.4 TERMINAL LAKES AND OUTLET CREEK

The Wimmera River terminates in a series of terminal lakes. These lakes are lunette deflation basins caused by Aeolian processes and are connected by meandering lowland creeks. The terminal lakes of the Wimmera River are mostly surrounded by public land such as the Wyperfeld National Park (Figure 3-2).

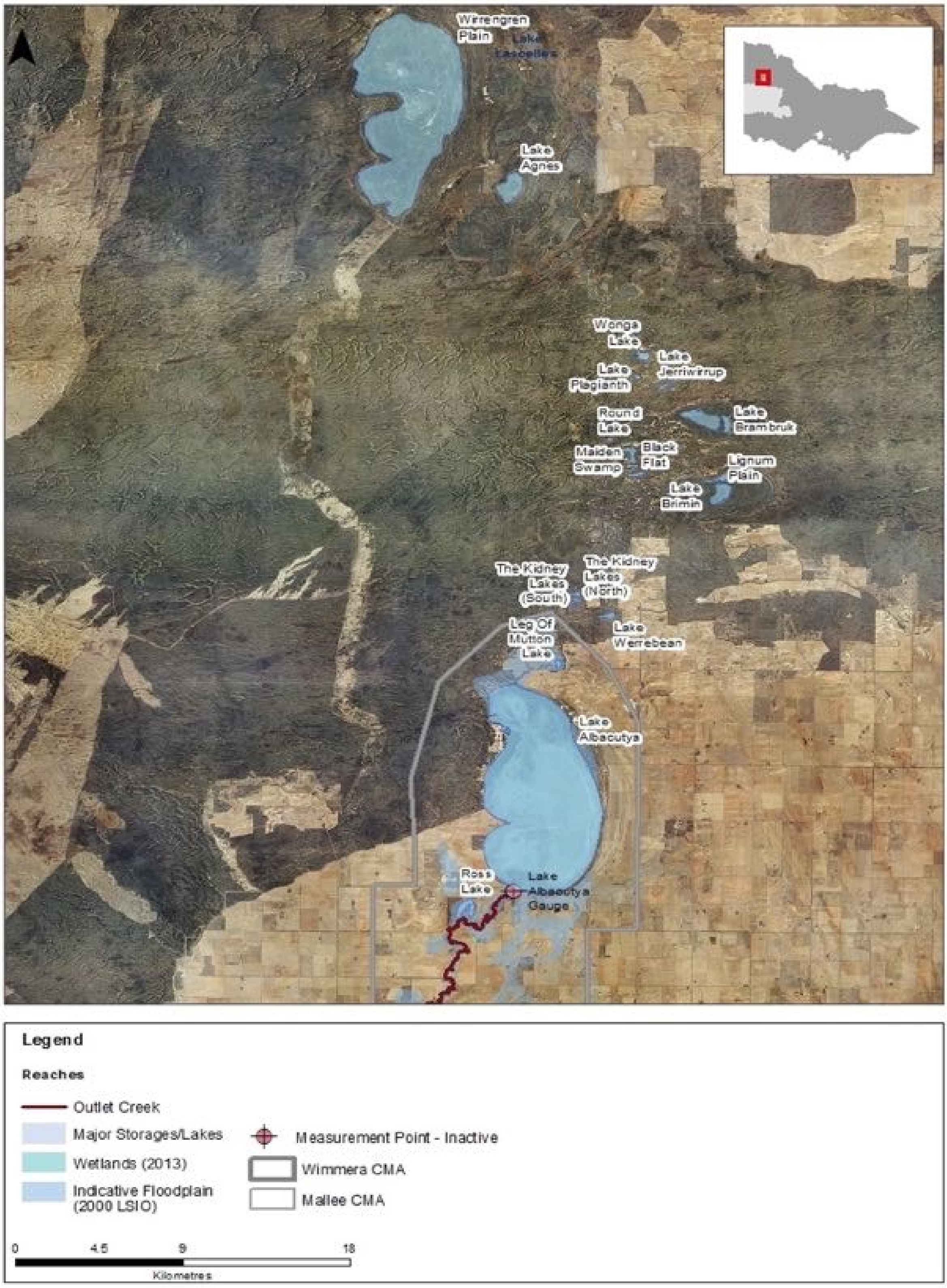

Figure 3-2: Wimmera River Terminal Lakes System (Source: WCMA)

Several years of well above average rainfall are required to generate sufficient inflows to fill Lake Hindmarsh. When Lake Hindmarsh fills, it overflows into Outlet Creek which connects with Lake Albacutya, another large lake and Ramsar-listed wetland. In exceptionally wet conditions (several times a century) Lake Albacutya fills and overflows into another reach of Outlet Creek which in turn supplies a number of smaller wetlands (e.g. Lake Brambruk, Leg of Mutton, Lake Agnes). It also backs water up Outlet Creek towards Lake Hindmarsh which spills into the Ross Lakes. Beyond this, the true terminal lake of the Wimmera River is the Wirrengren Plain in the southern Mallee (Figure 3-2) which has not contained water for well over a century. Lake Hindmarsh and Lake Albacutya are deflation basins with a lunette on the prevailing downwind (eastern) side. Lake Hindmarsh and Albacutya are Victoria's two largest (by area) natural freshwater lakes and so provide massive expanses of habitat when they contain water. When full, Lake Albacutya is up to 8m deep whereas Lake Hindmarsh is approximately 3.4 m deep (Ecological Associates, 2004).

As a result of spring rain in the region and continued high inflows and floods over summer 2022/23, water started flowing into the previously dry Lake Hindmarsh, reaching 50% of its capacity (Wimmera CMA, 2023).

3.3.5 YARRIAMBIACK CREEK

Whilst flows in the Dunmunkle Creek dissipate in the southern Mallee, the Yarriambiack Creek terminates in Lake Corrong at Hopetoun. On its northwards journey, the Yarriambiack Creek flows through strips of riparian vegetation (mostly Crown land) surrounded by broadacre cropping and grazing land.

3.3.6 DOCK LAKE

Dock Lake was used for water storage from 1932 to supply the Riverside Irrigation District. Prior to this, it was a wetland and part of the Boga Lakes system near Horsham. Water quality issues, in particular high salinity, meant that water from the lake was often unsuitable for irrigation supply. The completion of the Wimmera-Mallee Pipeline in 2010 meant that Dock Lake was no longer required as part of the supply system. Dock Lake dried out during the Millennium Drought in the late 1990's and remained dry until 2016. In late 2016, large-scale flooding in the catchment partially filled Dock Lake when Green Lake filled and overflowed. Managed water deliveries could be delivered through a small channel from Green Lake, when there is enough water in Green Lake to gravity-feed Dock Lake, however, the inlet remains in need of de-silting and repair (Jacobs, 2015). Water from Dock Lake could be transferred from the outlet back into Lower Burnt Creek; however, the channel and outlet require work for this to occur, including engagement with the landholder.

As a result of spring rain in the region and continued high inflows and floods over summer 2022/23, Dock Lake started to fill reaching 95% of its capacity (Wimmera CMA, 2023).

4 Current/historical hydrological regime and system operations

4.1 RIVER HYDROLOGY

The hydrology of the Wimmera River system is characterised by extreme fluctuations from season to season and year to year due to the variability in climate. Over summer and autumn waterways typically do not flow for long periods of time, if at all. The exception is during and immediately following summer storms which, when they provide intense rainfall results in short-lived streamflows. Although the dryness of the catchment may not lead to any flows. During winter and spring, once the catchments are wet, inflows will fill and connect pools generating streamflows reaching the lower parts of the system.

Data from the streamflow gauge on the Wimmera River at Glynwylln (415206) is presented following (Figure 4-1) to highlight the variability in annual flow. The mean daily release for this period is 55.9 ML/day. Prior to the completion of the Wimmera Mallee Pipeline, this was the most downstream unregulated reach of the Wimmera River.

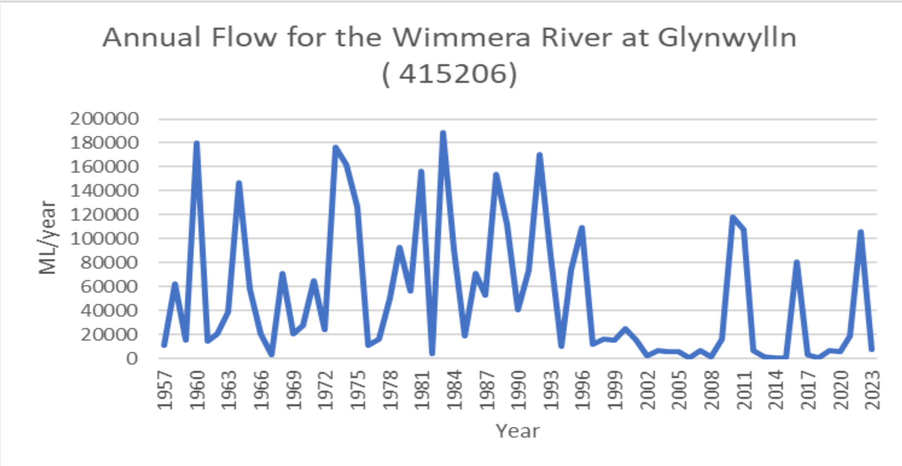

Figure 4-1: Flow data for the Wimmera River at Glynwylln (Source: Wimmera CMA)

As discussed in Section 3 there has been a long history of modifications to the Wimmera River catchment which in turn has affected its hydrology. Since European settlement much of the catchment has been cleared and converted to broadacre cropping and grazing which has led to an increase in runoff and streamflows (Figure 4-2). Although there is a proliferation of stock and domestic dams in the upper catchment (See Section 4.3), their impact is insufficient to offset the increases in streamflows brought about by land clearing. However, climate and land use change are understood to be creating major impacts on streamflows.

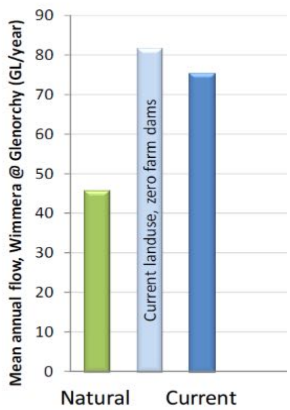

Figure 4-2: Effect of catchment changes to mean annual flow in the Wimmera River at Glenorchy (SKM, 2011)

The most significant impact on waterway hydrology in the Wimmera River and terminal lakes is the Wimmera-Mallee Headworks System. Prior to 2010, stock and domestic and irrigation demands were supplied by thousands of small dams fed by leaky and inefficient earthen channels meaning large volumes of water were required to complete channel runs to fill dams and irrigate land and compensate for system losses. This inefficient system combined with modest and variable rainfall in the region led to significant impacts on flows within the region's regulated waterways. The Wimmera River was determined to have the smallest proportion of flow reaching the end of the system of any major river in the Murray Darling Basin (CSIRO, 2008). An assessment of flow stress at 551 sites across Victoria had sites on the MacKenzie River and lower Mt William Creek as the most and third most flow stressed sites in Victoria, with the Wimmera River in the top 0.5% of most flow stressed sites as well. Figure 4-3 illustrates the effect of water harvesting on flows across the range of the hydrograph (cease to flow to floods) for the Wimmera River.

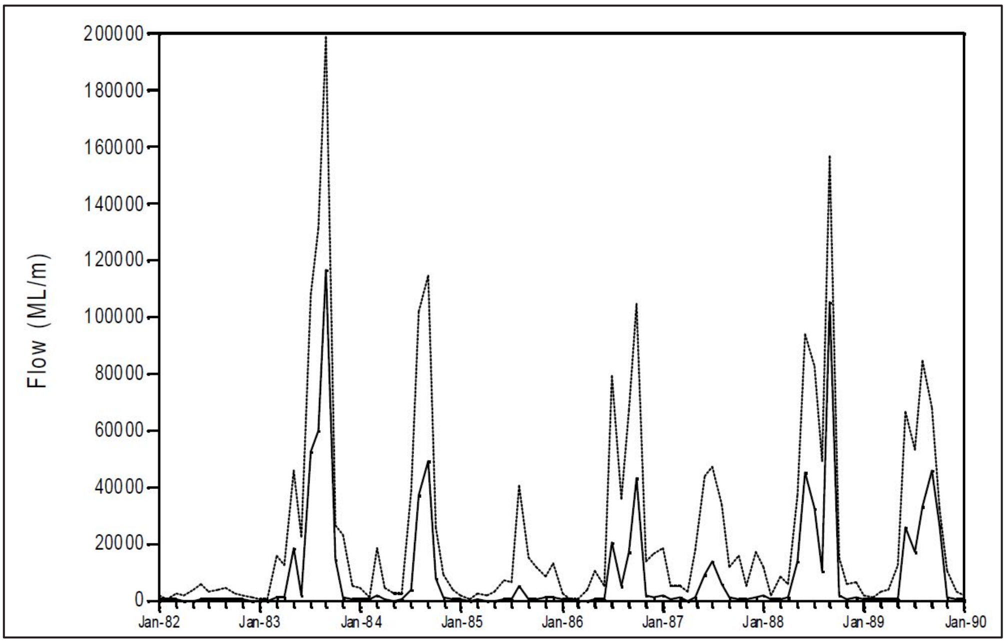

Figure 4-3: Comparison of natural (dotted line) and current (solid line) flows for the Wimmera River at Dimboola (SKM, 2005)

The impact of the inefficient stock and domestic channel system on water security and supplies for consumptive users and the environment was unsustainable. Therefore, a series of measures were undertaken to drastically increase environmental water availability, namely the construction of the Northern Mallee and Wimmera Mallee Pipelines and the purchase of the irrigation entitlement (see Appendix A-5 for more details). The effectiveness of these measures in increasing water availability for the Wimmera River can be seen in the increase in modelled average annual volumes for the Wimmera River (Table 4-1).

Table 4-1: Modelled average annual flows (ML/year) based on different environmental water recovery scenarios (July 1903 – June 2000)

LOCATION	POST NORTHERN MALLEE PIPELINE (1992-2002)	POST WIMMERA MALLEE PIPELINE (2006-2010)	POST IRRIGATION ENTITLEMENT PURCHASE (2012)
Average annual flows in the Wimmera River downstream of MacKenzie River Confluence	102,289 ML/year	147,860 ML/year	169,078 ML/year

Surface water flows in the Wimmera River are controlled by a number of weirs, irrigation diversion points, tributary inflows and distributary outflows. A schematic diagram showing the location of a number of these locations is shown in Figure 4-4.

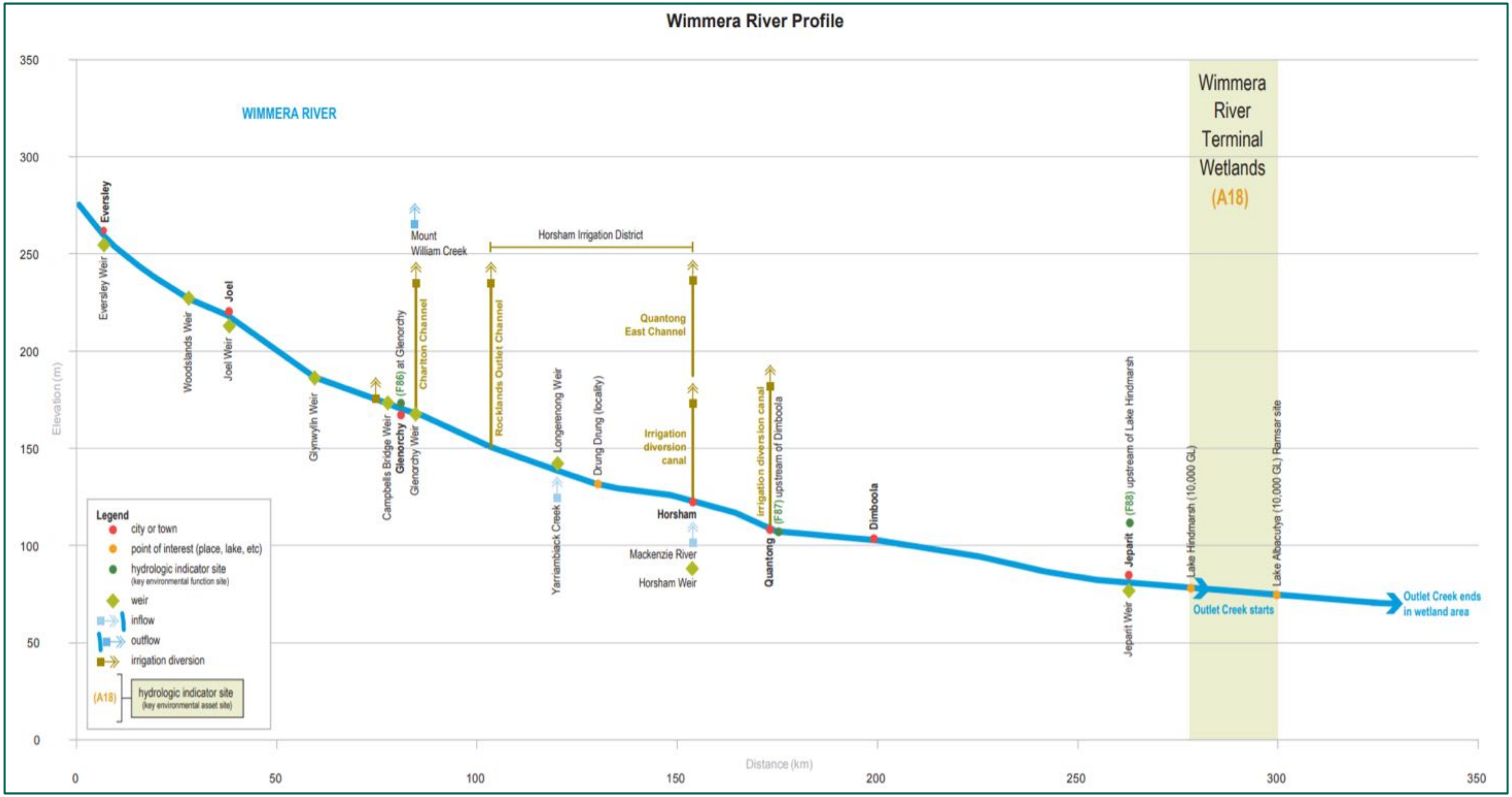

Figure 4-4: Longitudinal profile of the Wimmera River showing inflows and diversions (Source: www.mdba.gov.au)

4.2 GROUNDWATER SURFACE WATER INTERACTION

Within the Wimmera catchment, groundwater surface water interactions take place involving either regional or local groundwater flow systems. Examples of local groundwater flow systems are found adjacent to the Grampians, groundwater infiltrates colluvium deposited from weathered and eroded sediments and can discharge at the base of foot-slopes (Wimmera CMA, 2005) and is of reasonable quality.

Most of the Wimmera River system overlies the regional groundwater flow system within the Parilla Sands which is very saline, ranging from 5,000 mg/L in the south to more than 35,000 mg/L in the north of the Wimmera (Wimmera CMA, 2005). Typically, the groundwater table is well below all waterway channels in the Wimmera River system apart from the main Wimmera River channel. The Wimmera River Environmental Flows Study (Alluvium, 2013) confirmed that the only significant groundwater contributions to surface water in the Wimmera catchment occur in the lower Wimmera River where there is intrusion of hypersaline groundwater into the river channel when it intersects with the water table.

In the lower Wimmera River, groundwater enters pools typically at depths greater than 2m. During low flow conditions, the water quality can become extremely poor and unable to support fish and macroinvertebrates with salinity levels over 50,000 µS/cm (DELWP, 2015). The density difference between the deeper hypersaline water and overlying surface water leads to stratification, which can lead to very low oxygen levels in the deeper parts of the river. As a result, bacterial oxidation of organic matter is impacted by the lack of oxygen, consuming all of the oxygen in the hypersaline layer and leading to bacterial reduction of sulphate which creates toxic hydrogen sulphide as a by-product.

During dry times the lens of less saline water evaporates and there have been fish deaths recorded as the habitable area for fish is lost. In high flows the hypersaline water in these pools can be ‘scoured’ out temporarily (Figure 4-5) as there is mixing and movement of the hypersaline water downstream. Under intermediate flow regimes the hypersaline water is mobilised and can settle in pools further downstream which creates further loss of habitat for large-bodied fish. Locations downstream of Lochiel, especially around Tarranyurk have been observed to have hypersaline groundwater intruding through the sides and base of the river channel which leads to very saline water (> 10,000 µS/cm) during periods of no flow of several weeks or more.

A number of technical investigations have been undertaken to map out these pools and monitor responses to flows of differing magnitudes. AWE (2014) consolidated key findings from these investigations and a risk assessment was undertaken by EPA Victoria to provide information on how environmental water can be used to mitigate risks to water quality posed by these saline pools (EPA, 2008).

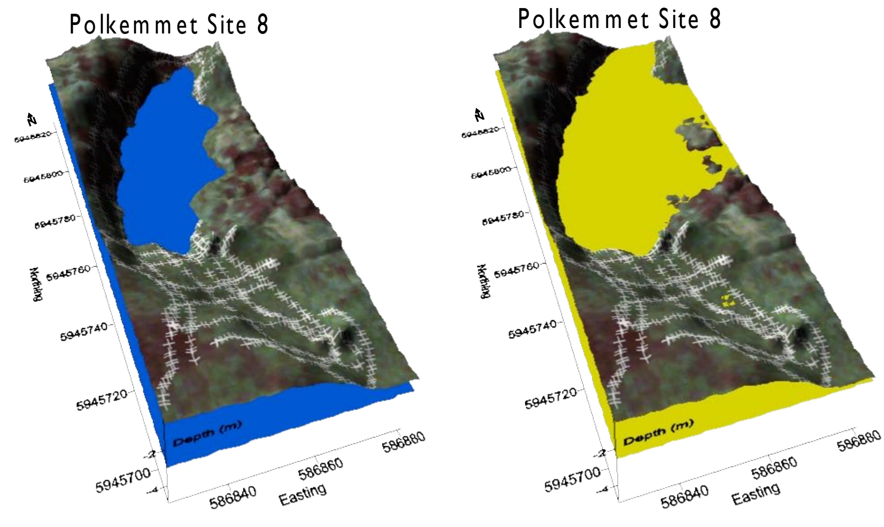

Figure 4-5: 3D model output showing the size of saline pools was slightly reduced (left) during flows in 2004-2005 compared to prior to and after flows (right)

The intrusion of hypersaline groundwater limits the availability of pool habitat for large-bodied fish as well as creating additional water quality issues when higher flows mobilise the hypersaline water, transporting it downstream.

In an attempt to protect five of the deep habitat pools in the Wimmera River, the Wimmera CMA commissioned Streamology in 2021 to outline the environmental (and other) benefits, feasibility and operational requirements of constructing pipelines to deliver water directly from the Wimmera Mallee pipeline to these pools. This study found that a shallow groundwater table and saline groundwater intrusion is a factor that will require ongoing management to mitigate negative impacts on these habitat pools (Streamology 2021). Of the five sites, Tarranyurk is likely to experience the greatest impacts from groundwater intrusion, as this site experiences highly saline groundwater, with several deep pools located within the refuges. The Jeparit site, although residing on top of hypersaline groundwater, is perched higher in the landscape as a wetland system, and is less likely to experience saline groundwater intrusion. Antwerp and Lochiel are observed to reside over saline groundwater (3,500 Mg/L). The analysis of gauge data from Lochiel however did not show a trend in electrical conductivity increasing during times of low flow, however, monitoring of salinity is still recommended to observe changes within the water column during such periods of lower flows.

The Dock Lake FLOWS study found that depth to groundwater measurements from observation bores close to Dock Lake were consistent with regional depth to groundwater mapping for Victoria, which indicates groundwater is less than 5 metres below the ground surface. Dock Lake was conceptualised to have negligible inflow from groundwater due the watertable in the area being sufficiently below ground surface. This was also supported by the fact that Dock Lake does not retain water during low rainfall periods (Jacobs, 2015).

4.3 SYSTEM OPERATIONS

Within the Wimmera River catchment upstream of Reach 2, there are estimated to be 5,939 stock and domestic dams with a total volume of 12,950 ML, which reduces average annual streamflows by approximately 11,000 ML/year (SKM, 2011). Based on current rates of development, the number of farm dams in the Upper Wimmera Catchment in 2030 will be 20% higher than 2005 levels (SKM, 2011), further reducing streamflows. There are also a number of irrigation dams in the foothills of the Pyrenees, supplying a number of vineyards around Landsborough. These factors substantially affect the volumes reaching the regulated sections of the Wimmera River system, especially in summer/autumn and during dry years.

To address these water supply and security challenges, planning is underway to establish a southern Wimmera-northern Pyrenees water pipeline to service 300,000 hectares of land involving parts of Northern Grampians, Pyrenees and Golden Plains shires. If the project proceeds, and depending on annual storage levels and environmental entitlement, water will be readily accessible in the area to meet both environmental as well as stock and domestic supply.

Water harvesting and delivery in the Wimmera River system is very complex with numerous channels, pipelines and waterways used to harvest and transfer water to and from weirs and storages for towns, customers and waterways (Figure 4-6). The Wimmera Mallee headworks system harvests water from two major river systems – the Wimmera and the Glenelg Rivers - and delivers it to towns, stock and domestic customers and the environment over an area of more than 2.6 million hectares.

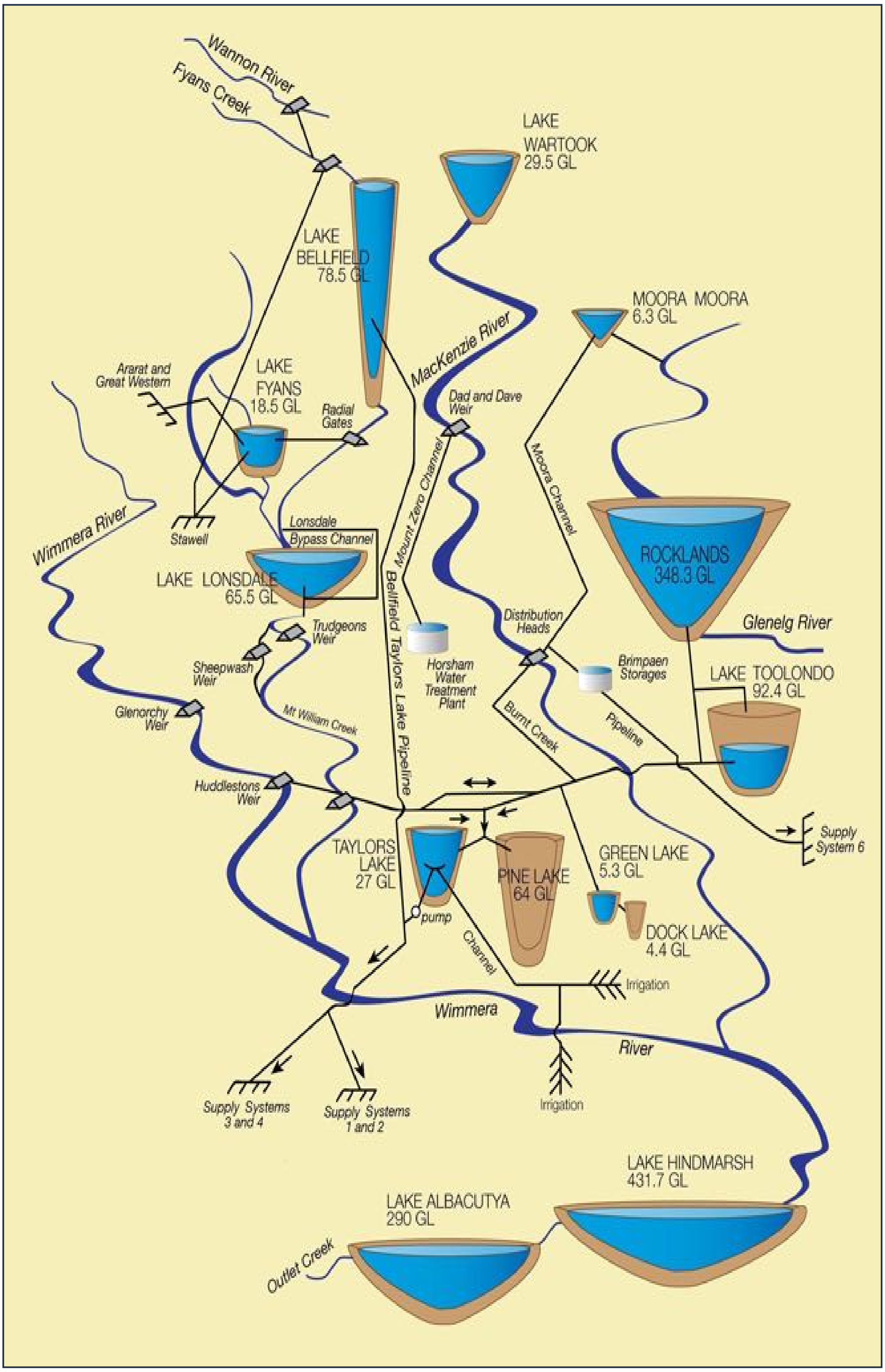

Figure 4-6: Storage and delivery system (Source: GWMWater). (*Note irrigation demands are no longer present and Lakes Albacutya and Hindmarsh are not storages and Pine Lake and Dock Lake are shown as empty in this figure denoting their status as being off-line.)*

Discharge in the Mount William Creek and Wimmera River is measured at a number of established gauging stations (Table 4-2). Water levels are also measured in weirs and storages.

Table 4-2: Victorian Water Measurement Information System flow gauging sites along the Wimmera River

STATION NUMBER	LOCATION AND YEAR ESTABLISHED	NOTES
415203	Mount William Creek @ Lake Lonsdale (tail gauge) (1899)	Measures flow from Lake Lonsdale for the provision of environmental passing flows as well as regulated releases. Also has some flood warning benefit. Compliance point for lower Mt William Creek. Also, site of monthly dissolved oxygen, conductivity and temperature monitoring.
415252	Mount William Creek at Mokepilly (1980)	Measures flows into refuge pool from unregulated flows and environmental water releases from Fyans Outlet Channel.
415206	Wimmera River @ Glynwylln (1902)	
415201	Wimmera River @ Glenorchy Weir Tail Gauge (1910)	Measures unregulated flow from upper catchment and used to determine passing flow volumes for Huddleston's Weir and water harvesting arrangements into the Wimmera Inlet Channel to Taylors Lake. Also, site of continuous turbidity monitoring.
415239	Wimmera River @ Drung Drung (1978)	Water level only – mobile channel bed means accurate volume gauging is not feasible. Can be used as an indicator of flow peaks and their time of travel
415200	Wimmera River @ Horsham (1881)	Long gauging history – over 100 years. An important site for water reporting to the MDBA and is also used to assist the passage of environmental flows through the Horsham weir. Compliance point for Reach 3 of Wimmera River. Also, site of continuous dissolved oxygen, conductivity and temperature monitoring
415261	Wimmera River @ Quantong (1993)	Water level only – flood warning gauge used to assess flow peaks and time of travel.
415256	Wimmera River @ upstream of Dimboola (1986)	Gauge used to assess flow volumes and time of travel. Also, site of continuous dissolved oxygen, conductivity and temperature monitoring
415246	Wimmera River @ Lochiel Railway Bridge (1987)	Gauge used to assess flow volumes and time of travel. Compliance point for Reach 4 of Wimmera River. Also, site of continuous dissolved oxygen, conductivity and temperature monitoring.
415247	Wimmera River @ Tarranyurk (1987)	Water level only - mobile channel bed means volume gauging is not undertaken. Also, site of continuous dissolved oxygen, conductivity and temperature monitoring.
415241	Yarriambiack Creek at Murtoa - Wimmera Highway (1978)	Water level only – flood warning gauge. No regulated environmental releases can be made to the creek.

The current gauging network provides useful information on unregulated and passing flows, which informs regulated environmental water delivery. The streamflow gauges at the downstream ends of reaches are also important compliance points to determine the extent to which volumes requested from delivery points are of sufficient volume and duration to attain ecological objectives. Gauges downstream of Horsham and Dimboola also assist in town weir management through providing information on rates of flow through the weirs. In the last decade improved telemetry has greatly increased the timeliness of information from the gauging network. Flood warning gauges provide continuous height data to the Bureau of Meteorology website and continuous information around flow and water quality is available for other gauges via an online data hosting service and the Victorian Government Water Measurement Information System[4].

[4] https://data.water.vic.gov.au

Gauging site upgrades

Although the current stream gauge network is an important tool for effective environmental water management there are opportunities for it to be enhanced. The following gauging stations (415239 – Drung Drung, 415261 – Quantong and 415247 – Tarranyurk) currently only record water level. These need to be upgraded to measure flow rates, with planning for the Tarranyurk gauge upgrade currently underway. There is no water level monitoring in Dock Lake or the Wimmera River terminal lakes such as Lake Hindmarsh or Lake Albacutya and there is no streamflow gauging station on Outlet Creek.

4.4 WATER MANAGEMENT AND DELIVERY

At its peak the Wimmera headworks and channel system supplied approximately 20,000 dams via 16,000 km of open earthen channel (Wimmera Mallee Pipeline Project Planning Group, 2003) which caused significant issues for waterways and consumptive water users due to inefficiencies and system losses (see Section 4.1 and Figure 4-6). The completion of two major infrastructure projects – the Northern Mallee Pipeline and Wimmera Mallee Pipeline – has resulted in improved reliability of supply for consumptive users with the majority of water savings achieved through the infrastructure upgrades returned to the Wimmera and Glenelg Rivers as environmental flows. The full volume of entitlements within the system is 52,690 ML, with Coliban and Wannon Water having relatively small entitlements (300 ML and 2,120 ML respectively) and the remainder is held by GWMWater. Within GMWWater's entitlement, 2,590 ML is dedicated to maintaining water supply within lakes used for recreational purposes, 2,960 ML is used to compensate for distribution losses in the pipeline systems and a further 3,300 ML makes up the Glenelg Compensation Flow. The Glenelg Compensation Flow is an entitlement for flows that are provided to the lower Glenelg River from Rocklands Reservoir to meet stock and domestic needs but also provides benefits for the environment. Beyond the environmental entitlements described in Table 3-2, there is a 1,000 ML environmental entitlement for off-stream wetlands supplied by the Wimmera Mallee Pipeline. This entitlement is held by the VEWH and is addressed in separate EWMPs.

Prior to the completion of the Wimmera Mallee Pipeline consumptive entitlements totalled 174,050 ML, mostly to cover distribution losses within the channel system and the volume of environmental entitlements within the system was 32,240 ML. The historic reliability of entitlements prior to the construction of the Wimmera Mallee Pipeline is shown in Figure 4-7.

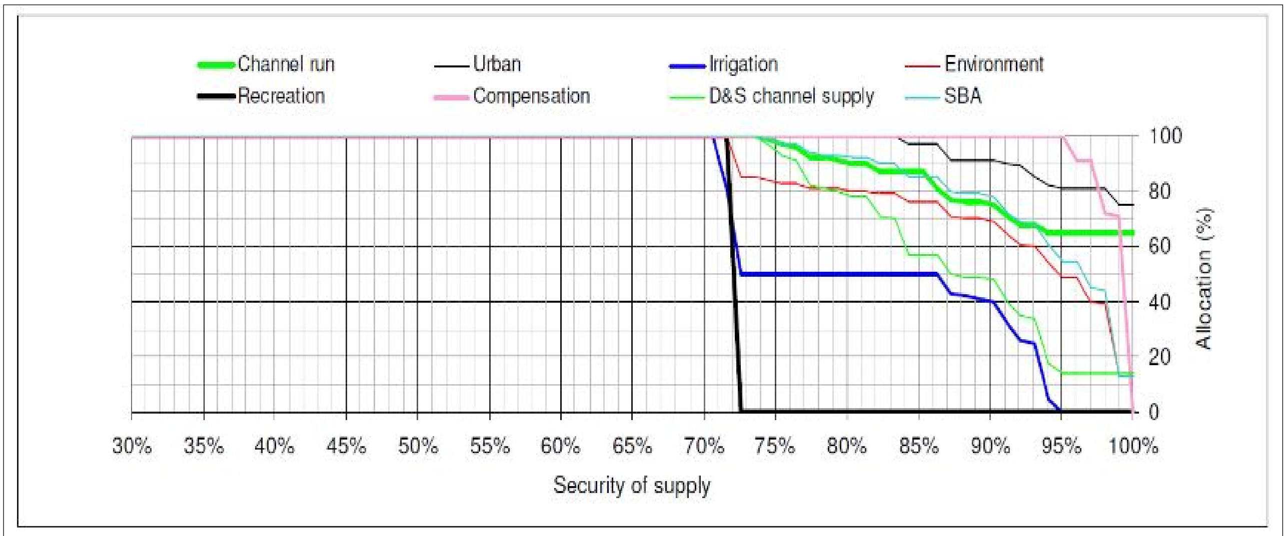

Figure 4-7: Modelled reliability profile of entitlements prior to the construction of the Wimmera Mallee Pipeline (1903-2003) (Source: DSE, 2004)

The completion of the Wimmera Mallee Pipeline significantly increased the reliability of supply. Regulated entitlements apart from the CEWO's environmental entitlement derived from the purchase of the irrigation entitlement have a modelled reliability of 92.6% of years with full allocation based on inflows from 1891-2012 (encompassing the Federation and Millennium Droughts). The CEWO's entitlement has a modelled reliability of 90.1% of years with full allocation (SKM, 2013), however it is important to keep in mind that this is modelled data and has likely overestimated reliability.

An assessment for both Wimmera System and wetland allocations (personal comms VEWH, 2024) on the modelling has been found to be overestimated. In terms of the actual history of the VEWH's environmental entitlement in the system, the rivers have averaged about a 72% allocation between 2010-11 and 2023-24 (based on allocation to date in 2023-24), which is much lower than the allocation modelled (refer Table 4-3 below).

The CEWO allocations have been shown to be less reliable since completion of the pipeline, with suitable conditions for allocations being met only two times, once in 2016 and again in 2022. Accordingly, this modelled reliability should be updated and reviewed over a longer time period (for the last 25 years) based on actual reliability.

Table 4-3: Annual allocations as per the VEWH's environmental entitlement for the Wimmera River (e-mail correspondence VEWH, 2024)

	RIVERS		WETLANDS	
Year	**Allocation Received (ML)**	**Allocation Received (%)**	**Allocation Received (ML)**	**Allocation Received (%)**
2010-11	40,560	100%	1,000	100%
2011-12	40,560	100%	1,000	100%
2012-13	33,268	82%	279	28%
2013-14	32,970	81%	250	25%
2014-15	19,509	48%		0%
2015-16	6,490	16%		0%
2016-17	40,560	100%	1,000	100%
2017-18	32,854	81%	250	25%
2018-19	22,308	55%		0%
2019-20	17,035	42%		0%
2020-21	23,119	57%		0%
2021-22	25,553	63%	60	6%
2022-23	40,560	100%	1,000	100%
2023-24	35,287	87%	490	49%
Average	**29,331**	**72%**	**381**	**38%**

Since the completion of the pipeline, there has been a dramatic reduction in inflows as shown in the graph below (Figure 4-8).

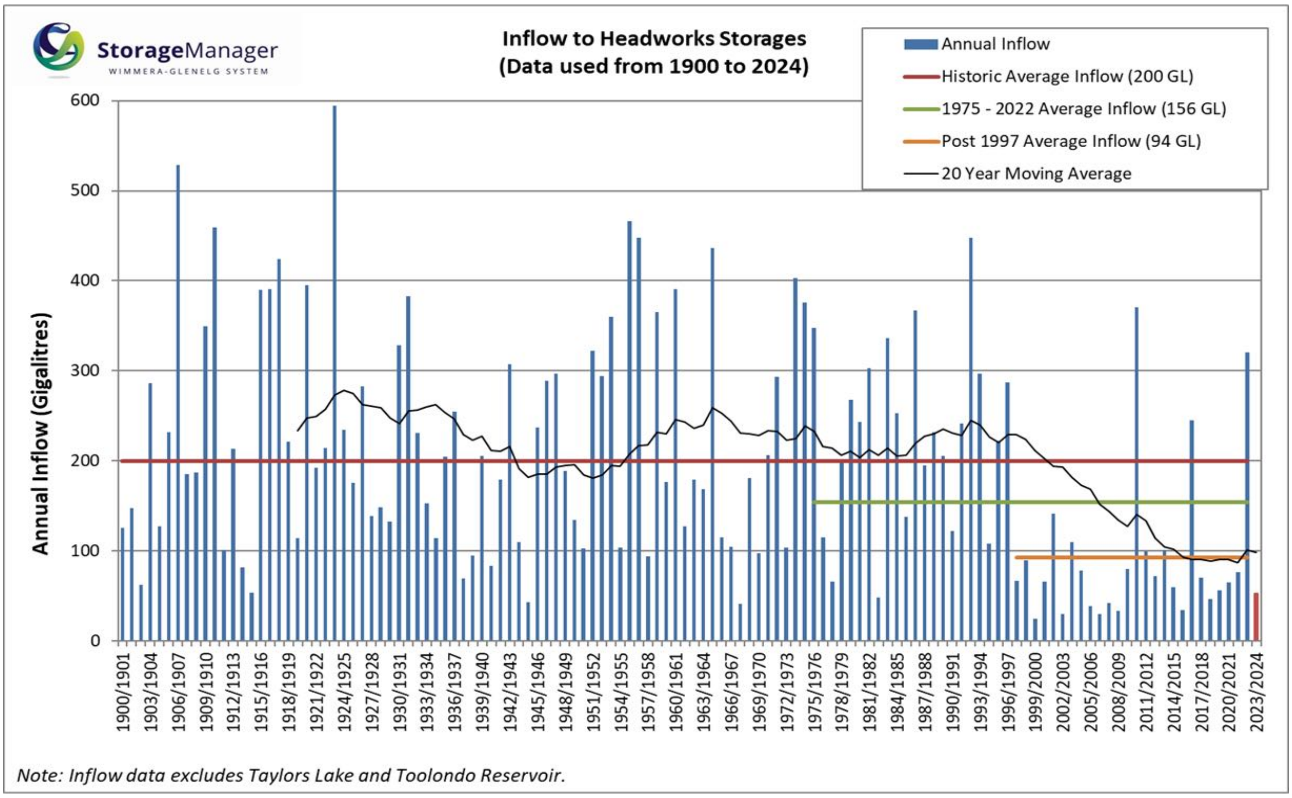

Figure 4-8: Inflow to Headworks Storages 1950 to 2024 (Source: Storage Manager Wimmera Glenelg System, 2024)

As indicated in Figure 4-9, large rain events between 2011, 2016 and 2022 over the past 14-year period have increased inflows and allowed for carryover when dry.

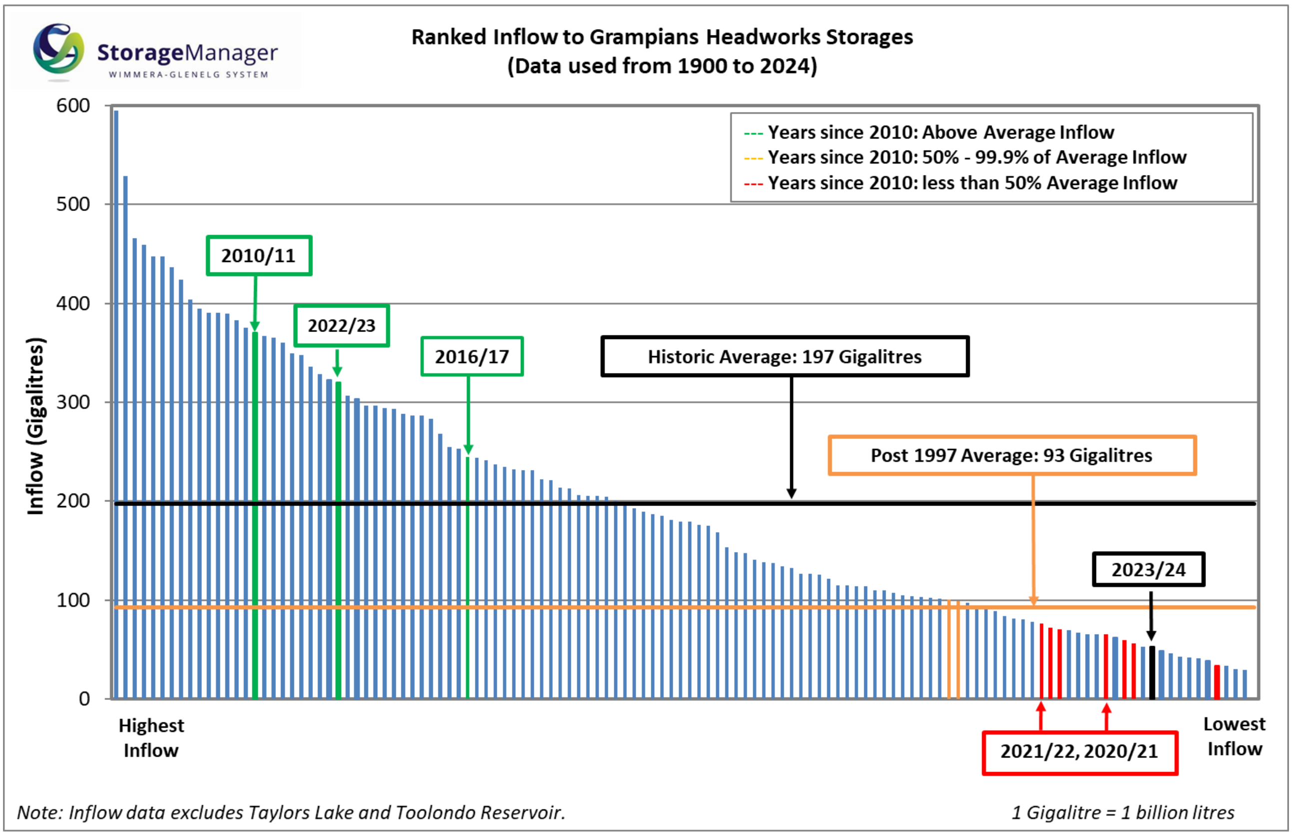

Figure 4-9: Ranked Inflow to Grampians Headworks Storages 1900 to 2024 (Source: Storage Manager Wimmera Glenelg System, 2024)

Climate change modelling indicates that rainfall is expected to decrease in future, particularly in winter/spring and these dry conditions will lead to substantial reductions in reliability of entitlements, which will in turn severely affect availability of water for the environment, particularly for the terminal lakes.

The complexity in system operation, as well as demands such as fixed location supply (towns, pipeline), variable location supply (environment), and managing water quality and system efficiency, necessitates flexibility in system operation and environmental water delivery. Given the scale and complexity of the water supply system, water management and system delivery arrangements are described in several sub-sections.

MOUNT WILLIAM CREEK

The Mt William Creek catchment is comparatively large, straddling the north-eastern edge of the Grampians as well as the western side of the Black Range (near Stawell) and provides inflows to Lake Lonsdale near Hall's Gap. Lake Lonsdale no longer has a regular role in supplying consumptive water although occasionally it may be used to supply water to Taylor's Lake when it is near full as water quality can be comparatively better. Its main purpose is to supply environmental water to the lower Mt William Creek and subsequently the Wimmera River. The fluctuating levels of Lake Lonsdale means that it is a very ecologically productive lake, supporting a thriving fishery and many waterbirds when it contains water. Upstream of Lake Lonsdale a refuge pool on Mt William Creek at Mokepilly several hundred metres long can receive environmental water that is outfalled from Lake Fyans Outlet Channel into an unnamed creek that flows into this pool. Watering of this refuge pool has taken place in autumn following exceptionally dry years (2014, 2015, 2018, 2023).

Lake Lonsdale was naturally a series of large wetlands and now is a shallow storage (up to 4 m deep) with a relatively large surface area (up to 26 km2) and therefore has very high rates of evaporation. This means that with a series of dry years, volumes diminish, and the lake may contain little to no water. An outlet structure in Lake Lonsdale wall is used to release water into the lower Mt William Creek (Figure 4-10) including for the provision of regulated environmental water releases and passing flows. Due to wall engineering safety issues 20 ML/day is the minimum amount the outlet can release. The outlet also has a maximum limit of 300 ML/day due to the size of the outlet pipes and the impact of flooding on downstream landholders. The lower Mt William Creek has been modified in places to improve its utility as a water transfer channel, being deepened and straightened just downstream of Lake Lonsdale to Trudgeon's Weir (Figure 4-10). Historically this weir was used to divert flow into Sheepwash Creek (an anabranch of the Mt William Creek). Sheepwash Weir on Sheepwash Creek was then used to divert flow along the Main Central Channel to Glenorchy (also known as the Lonsdale-Glenorchy channel) to the Wimmera River or allow flow to return to Mt William Creek. These weirs and the Main Central Channel were decommissioned in 2013 and removed, however the changes in channel depth and width remain and influence flows along the creek. A low-level dropboard weir is located on the offtake of the Sheepwash Creek from the Mt William Creek immediately upstream of the former site of Trudgeon's Weir which the adjacent landholder operates occasionally (i.e. during floods and to divert volumes for stock watering along Sheepwash Creek).


Figure 4-10: Lake Lonsdale outlet (left) and the site of the former Trudgeon's Weir (right)

At Dadswell's Bridge, a small weir is owned and managed by the community to retain water for aesthetic purposes and, to a lesser extent, for stock and domestic use (Alluvium, 2015). However, since 2010, the locality has been supplied with stock and domestic water by the Wimmera Mallee Pipeline. Further north, the creek becomes anabranching, however, there have been modifications to preferentially divert flows to the eastern anabranch so flow can be diverted into the Wimmera Inlet Channel near Huddleston's Weir to Taylor's Lake. Environmental water releases outfall from Mount William Creek via Big Pipe into the Wimmera River (Figure 4-11) although the invert of the pipe is above the base of the Wimmera Inlet Channel so there are some losses incurred as a result. Currently only high flows (above regulated release volumes) can be delivered along the western branch (Alluvium, 2015). This course also enters the Wimmera Inlet Channel and the Mt William escape on the downstream side of the channel and can be operated to enable flows to continue down the creek to the Wimmera River (Figure 4-11). Key features influencing flows along the lower Mount William Creek can be seen in the schematic in Figure 4-12.

Figure 4-11: Mount William Escape (left) and Big Pipe (right)

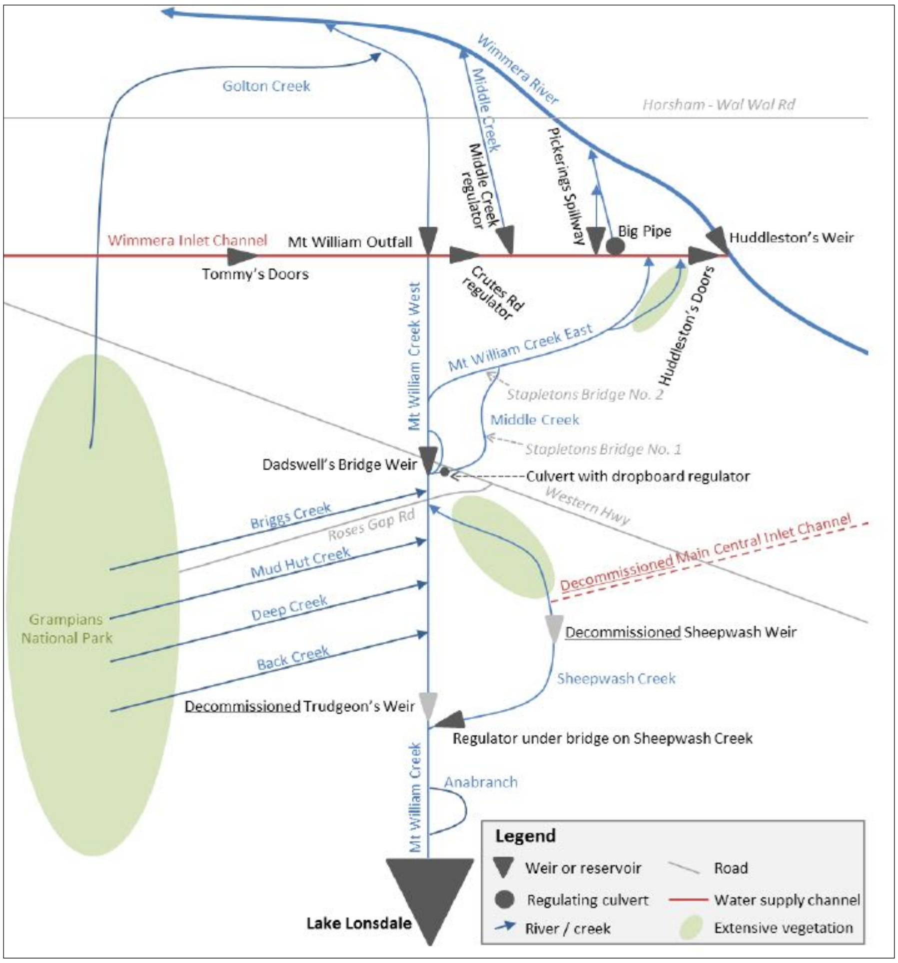

Figure 4-12: Schematic of key features on the lower Mount William Creek and part of the Wimmera River near Dadswell's Bridge (Alluvium, 2015)

WIMMERA RIVER

The Wimmera River's initial diversion point is Huddleston's Weir (Figure 4-13). Passing flow rules govern the extent to which Wimmera River flow can be diverted into the Wimmera Inlet Channel to supply Taylor's Lake. The passing flow rules prescribed for Huddleston's Weir within the Environmental Entitlement are quite complex and vary based on a proportion of upstream flows and are restricted based on the level of allocations. GWMWater only cautiously harvests water from the Wimmera River due to concerns around water quality impacts on Taylor's Lake, particularly salinity and turbidity. Therefore, under certain conditions all flows may continue down the Wimmera River past Huddleston's Weir. This provides a sharp contrast with arrangements prior to the construction of the Wimmera Mallee Pipeline, when Huddleston's Weir was effectively harvesting all low-medium flows (up to 1,600 ML/d). Now the Wimmera Mallee Pipeline is complete, it is usual during wet periods for the Storage Manager to focus on maximising water quality rather than just water quantity. This means that if poorer quality water (high salinity, high turbidity) is flowing from the upper Wimmera River, GWMWater would typically choose to allow all of it to pass down the Wimmera River rather than harvest volumes allowed under passing flow provisions. Additionally, flow can be provided to the Wimmera River from Lake Lonsdale via Mt William Creek or from Taylor's Lake via the Taylor's Lake Outlet Channel outfall (Figure 4-14).

Figure 4-13: Huddleston's Weir (left) and the adjacent gates on the Wimmera Inlet Channel (right)

There are three town weirs (Horsham, Dimboola, Jeparit) along the Wimmera River which have existed in various forms and locations for over a century (Van Veldhuisen, 2001). Whilst they were originally built to offset the reduced flows due to the construction of Lake Lonsdale, the water captured in these weir pools is used for stock and domestic supply as well as watering ovals and gardens and for recreational purposes. In 2006, flume gates were installed across sections of each weir by Wimmera CMA to improve the ability of councils to manage the passage of flows through weir pools (Figure 4-15). Dimboola Weir was substantially upgraded to include a spillway following severe damage during the January 2011 floods. It should be noted that given the lack of endemic diadromous fish species and risks around Common Carp (Cyprinus carpio) movement and cost, fish passage is not a requirement at these and other weirs on the Wimmera River (SKM, 2006). The Wimmera and Glenelg Rivers Environmental Entitlement (Schedule 6) contains provisions regarding the supply of environmental water to other water bodies, namely the Horsham, Dimboola and Jeparit Weir pools. Recommended conditions for this have been developed as part of the EWMP development process although they have not been formally included in the environmental entitlement.

Figure 4-14: Taylor's Lake Outlet Channel Outfall (left)

Figure 4-15: Jeparit Weir (left) and the Dimboola Weir (right)

As mentioned in Section 3 above, in years when rainfall is well above average the Wimmera River provides substantial inflows to a series of terminal lakes, the first of which is Lake Hindmarsh, Victoria's largest freshwater lake (378 GL and 13,483 Ha) and a listed wetland of national significance. When there are consecutive years of high rainfall Lake Hindmarsh may fill and then spill into Outlet Creek which flows into Lake Albacutya, a Ramsar-listed wetland (230 GL and 5,745 Ha). In extremely rare events Lake Albacutya can fill and overflow into a series of smaller lakes (e.g. Lake Agnes, Lake Brimin) before entering the true terminal lake of the Wimmera River – the Wirrengren Plain in Wyperfeld National Park. Upstream regulation has severely reduced the frequency and duration of inundation events. The last time Lake Hindmarsh was full, and water was entering Lake Albacutya was in 2011.

Dock Lake.

The construction of the Wimmera-Mallee Pipeline and the purchase of the irrigation entitlement by the Commonwealth Environmental Water Holder (CEWH) have meant that Dock Lake is not needed to manage water resources. A review of the system operating rules has led to changes regarding Green Lake, with channel pickup now available to supplement natural catchment inflows and regulated supplies from Grampians Wimmera Mallee Water's (GWMWater) consumptive allocation. Based on estimates from historic inflows, Green Lake is now expected to be filled 70% of the time. As Dock Lake can only be filled from Green Lake, the increased filling of Green Lake increases the opportunity for water to be directed into Dock Lake if that water is likely to meet ecological or social objectives.

Currently, up to approximately 100 ML/day of water can be transferred from Green Lake to Dock Lake via a channel/pipeline and related infrastructure. This infrastructure is currently not fully operational and would require repair/de-silting (Figure 4-16) for transfers of this magnitude to occur. A small channel (capacity less than 5 ML/day) was constructed in 2013/2014 to allow water to outfall from Dock Lake to Burnt Creek when the lake contains significant volumes (Figure 4-16). The comparatively high salinity of water retained in Dock

Lake is, however, a potential risk to the ecological values of Burnt Creek should water be passed through this structure.


Figure 4-16: Regulator structure at the inflow pipe from Green Lake to Dock Lake (left) and regulator on the outfall channel from Dock Lake to Burnt Creek (right) (Source: Jacobs, 2015)

YARRIAMBIACK CREEK

Yarriambiack Creek offtake is about 200 metres downstream of the Taylor's Lake outlet to the Wimmera River and diverts a varying proportion of the Wimmera River's flow into Yarriambiack Creek (See Figure 4-18). Initially modified in the 1850's to increase the proportion of flow entering the Yarriambiack Creek, weirs and regulators were built and rebuilt after floods through to the early 20th century to divert water from the Wimmera River up the Yarriambiack Creek for stock and domestic needs (Van Veldhuisen, 2001) (Figure 4-18). As the Wimmera Mallee stock and domestic channel system expanded during the 1920's and 30's, the creek was no longer required as a water supply however there was strong community interest along Yarriambiack Creek in continuing to divert flows so in 1967 concrete sills were constructed across Yarriambiack Creek as well as across the Wimmera River immediately downstream of the offtake point (Figure 4-19). The intent of this was to apportion a fixed sharing of flow between the Wimmera River and Yarriambiack Creek of 3:1 based on weir length, with the weir across the river being three times wider than that across the creek. In practice however, this can only be the case at one flow rate across the hydrograph – notionally at a flow around 750 ML/d upstream of the offtake based on a modelled flow split relationship that was developed by Water Technology (2009) (Figure 4-17). The accuracy of the model is constrained by limited data for model validation and changing conditions such as the presence/ absence of vegetation and condition of the concrete sill, which are a major factor at low flows (< 500 ML/d). It is estimated that when high flows are occurring in the Wimmera River, 30% of the flow is transferred to the Yarriambiack Creek.

Weirs at Jung, Warracknabeal, Brim and Beulah retain water in weir pools for recreational use and aesthetics. The weirs at Brim, Beulah and Warracknabeal are regulated by varying combinations of dropboards and undershot gates and the weir pools are supplied with recreation water allocations via the Wimmera Mallee Pipeline. A Regional Recreation Water Users Group has been established by GWMWater to assist with decision making regarding the use of the recreation water allocations for these weir pools as well as other water bodies across the region that share the entitlement. The Jung Weir is a fixed crest weir with no ability to regulate flows, it is completely reliant on flows along the Yarriambiack Creek for supply. It is the most downstream weir and is not used for waterskiing and boating like the other weirs. Information about the Warracknabeal and Brim Weirs derived from Alluvium (2014). Beulah weir pool is covered in a specific EWMP developed by the Mallee CMA.

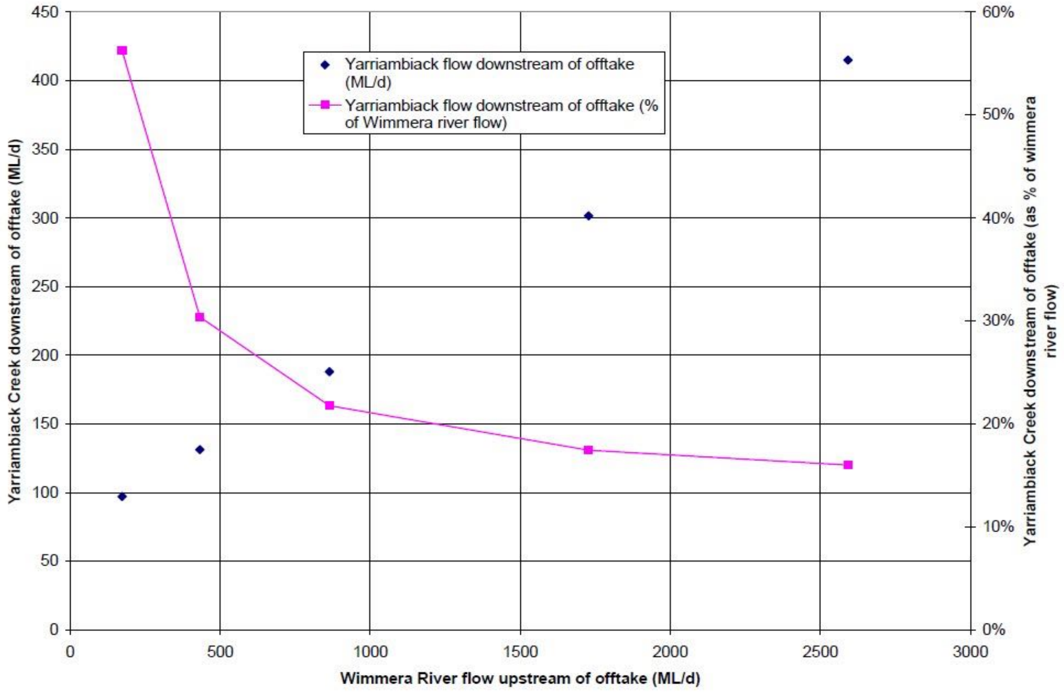

Figure 4-17: Modelled flow split between Yarriambiack Creek and the Wimmera River at low to bankfull flows (3000 ML/d) (Water Technology, 2009).

Figure 4-18: Example features that influence flows down Yarriambiack Creek such as the Yarriambiack Creek Offtake Regulator (left) and Brim Weir (right).

Figure 4-19: Concrete sill on the Wimmera River (left) and Yarriambiack Creek (right) that split all but flood flows between the two waterways.

Yarriambiack Creek, like the Wimmera River ends in a series of terminal lakes, in this case located near Hopetoun in the southern Mallee. Lake Corrong is the most notable terminal lake, being about 600 Ha in area (Ecological Associates, 2006). Lake Lascelles is much smaller (about 20 Ha) and has been modified in the late 19th century to act as a water storage through raising an embankment between Lake Corrong and Lake Lascelles, removing the ability for it to receive inflows from the Yarriambiack Creek (Ecological Associates, 2006). Therefore, it is not considered within this EWMP. Lake Lascelles is a popular recreation lake and supplied from the Wimmera Mallee Pipeline by a recreational entitlement. When Lake Corrong fills, water flows further north to a series of lakes that have been largely cleared for agriculture; Cutche Swamp, Yarrack Swamp, Thistle Lake, Lake Quandong, The Locks and Lake Myall (Ecological Associates, 2006). Like the terminal lakes of the Wimmera River, the inundation regime of these lakes is episodic, with Lake Corrong filling once every ten years on average and flows beyond the lake only happening once in the last 50 years (Ecological Associates, 2006). River regulation prior to the completion of the Wimmera Mallee Pipeline was noted to only impact on one of the lakes' environmental values – breeding of birds dependent on flooded vegetation (Ecological Associates, 2006).

4.5 DELIVERY OF WATER FOR THE ENVIRONMENT

The Wimmera River has one of the longest records of environmental watering in Victoria. In early 1988 water was released down the Wimmera River with the intent of improving the water quality in pools that had become hypersaline (Anderson & Morison, 1989). Since the 1990's infrastructure projects, initially the Northern Mallee Pipeline and later the Wimmera Mallee Pipeline have resulted in water savings that now enable the delivery of environmental water to enhance water quality and provide habitat for fish and platypuses. Despite these improvements, water scarcity still remains a problem for the Wimmera River. The Millennium Drought from 1997 to 2009 severely restricted the allocations available for environmental watering (Figure 4-20)(Figure 4-21). In 2006, and 2009, the Ministerial powers were used to temporarily alter the arrangements in the Environmental Entitlement to boost supplies for consumptive use, to improve water quality in storages and for firefighting which prevented planned environmental water releases (VAGO, 2010).

During this time Wimmera CMA has played a pivotal role in managing flows in the Wimmera River, with its involvement dating back to the establishment of CMAs in the late 1990's.

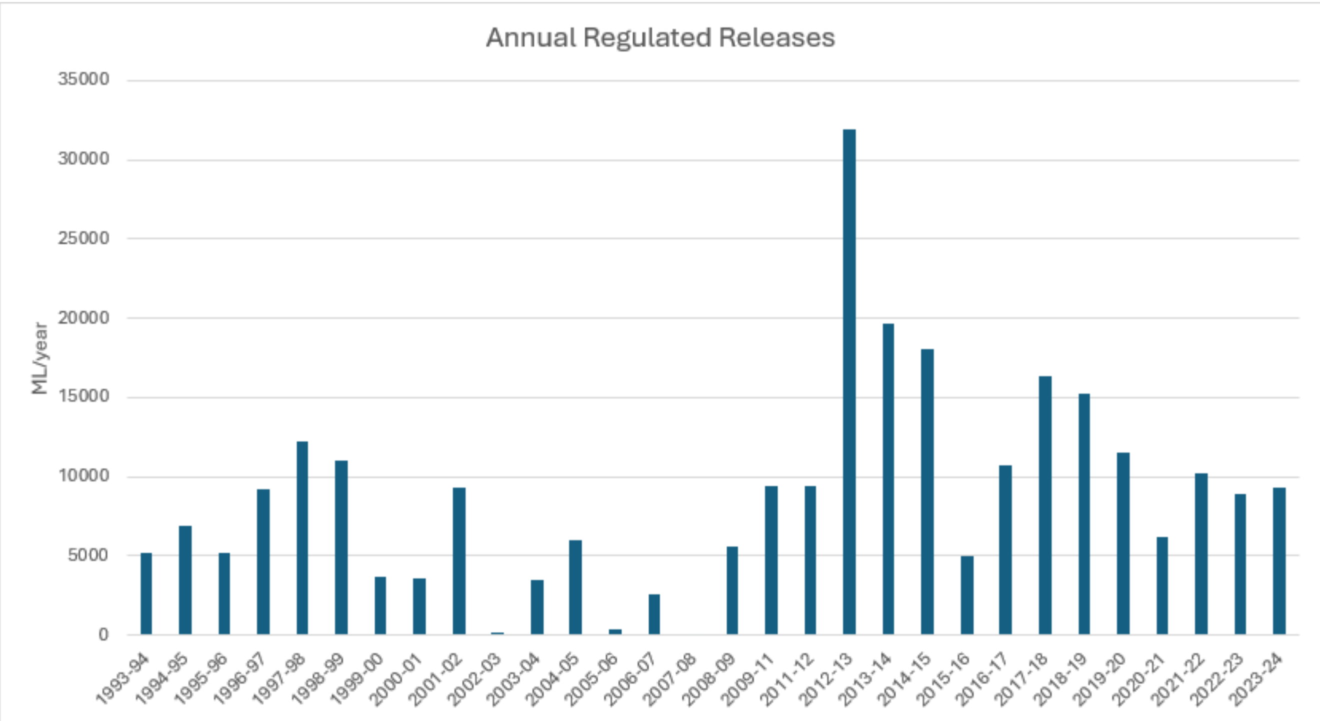

Figure 4-20: Record of environmental water releases for the Wimmera River system from 1993-94 to 2023-24

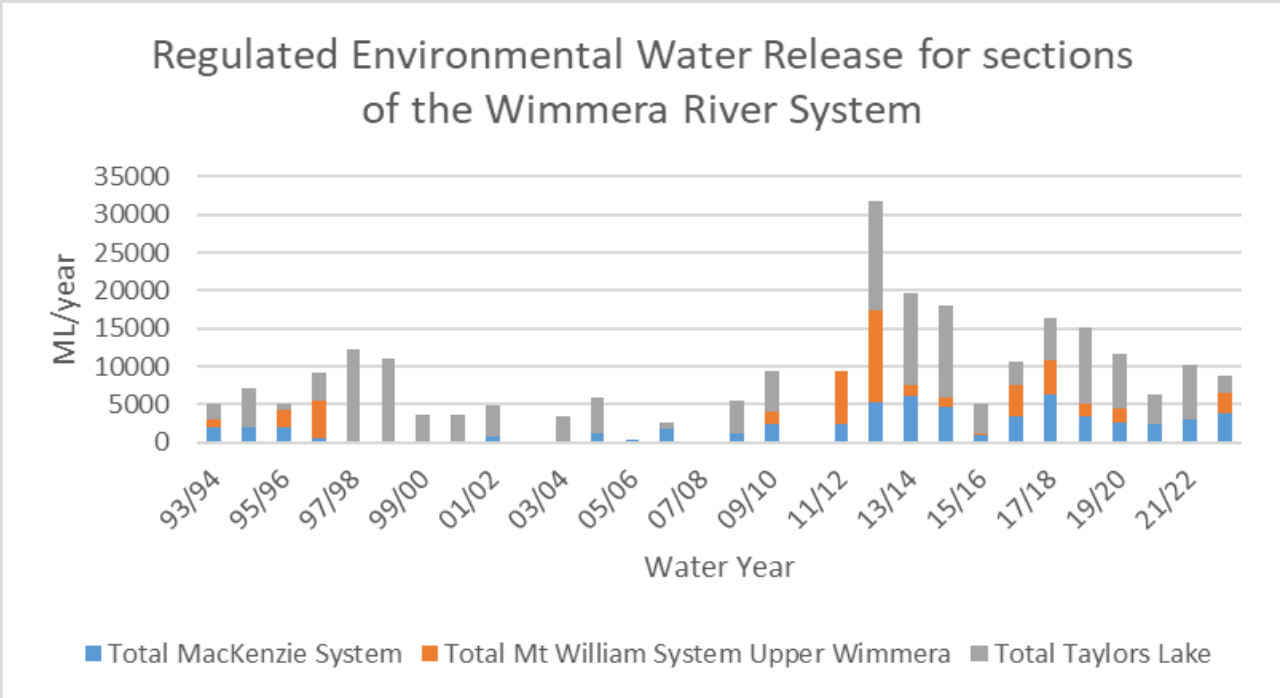

Figure 4-21: Record of environmental water releases for sections of the Wimmera River system from 1993-94 to 2022-23

Figure 4-22 shows the volumes released for environmental watering for the Wimmera River system and the Glenelg River from November 1999 to 2014. It highlights the substantial improvements in environmental water availability for the environment, as well as reduced consumptive demands, since the completion of the Wimmera Mallee Pipeline and wet climatic conditions in 2010 and 2011. There were also wet conditions in 2016 and 2022 (not shown on this graph).

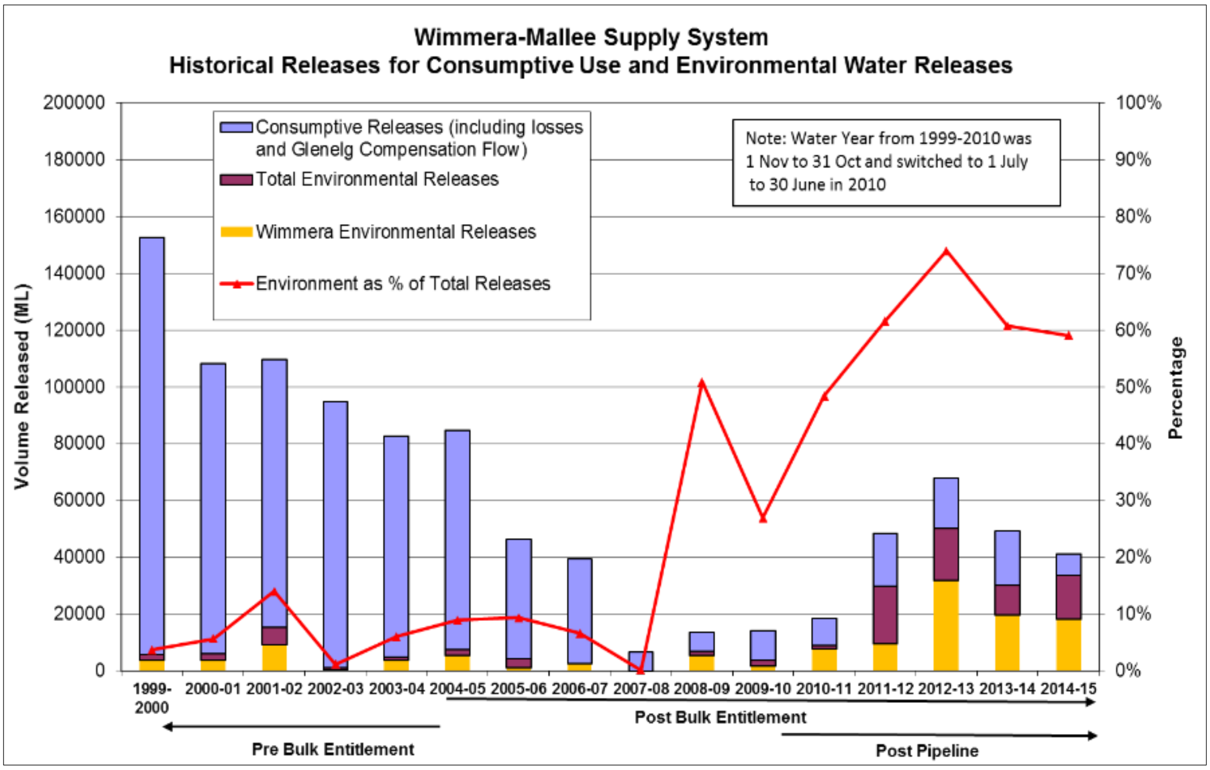

Figure 4-22: Volumes released per water year from November 1999 – December 2014 from the Wimmera-Mallee Supply System

Figure 4-23 shows the volumes reaching the Wimmera River system as regulated releases and passing flows since November 2005. Passing flows are a condition on water harvesting (Table 3-2), designed to ensure a proportion of inflows are allowed to continue downstream and comprises the majority of environmental water made available from savings from the Wimmera Mallee Pipeline. This further highlights the increase in environmental water available after 2010. From 2012 to 2015 conditions have been drier than average and this is reflected in the fact that regulated releases have been greater than passing flows. After a series of dry years, regulated allocations diminish, leading to substantially reduced volumes of all sources of environmental water. This was the case for the 2015-16 water year with only a 1% allocation available by September 2015 for high reliability entitlements. Opening allocations were also very low in the 2018-19 and 2019-20 water years due to similar circumstances. In 2022/23 the allocation reached 100% for all entitlements, and in 2023/24 the allocation reached 87%.

Although substantial water savings have been generated by the construction of the Northern Mallee and Wimmera Mallee Pipelines (Section 3.1) and through purchase of irrigation entitlements, dry conditions will still lead to impacts on the environmental values of these waterways (Section 6).

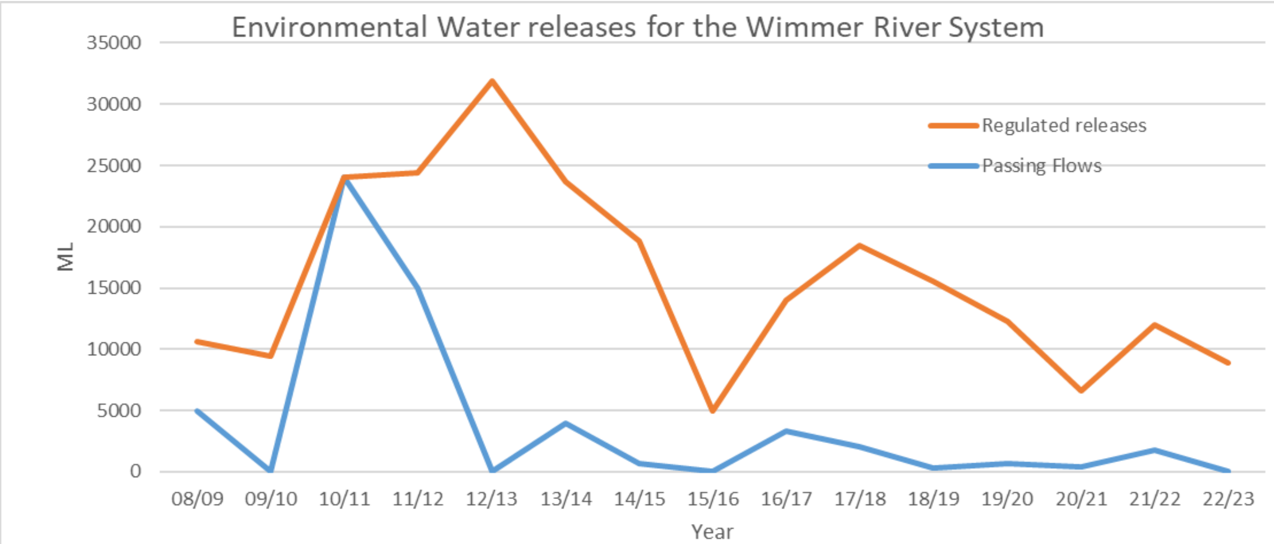

Figure 4-23: Volumes released/passed to the Wimmera River system under the Wimmera Glenelg Flora and Fauna Bulk Entitlement/Environmental Entitlement to maintain/improve environmental values from November 2005 to June 2023. Please note passing flows only commenced from 2008/09.

Experience has shown that long-term planning for environmental water delivery in the Wimmera River system is an inherently challenging task and strongly influenced by prevailing climatic conditions. Droughts mean that even the minimum flow requirements are unable to be met in all reaches and the focus shifts to protecting key refuge sites. Floods mean that only limited regulated releases are required due to the large volumes provided by unregulated streamflows. During average-wet conditions the focus is on building resilience in waterway ecosystems to protect them from flood and drought conditions.

Despite the substantial volumes of water recovered for the environment, shortfalls in environmental water are expected be quite frequent into the future. The shortfall between supply and demand is likely to be biggest when successive dry seasons lead to drought as seen in Figure 4-24. Using historical flow data, Alluvium (2013) highlights there are frequent shortfalls in water availability at most sites. Maximising the volume available for environmental watering as well as its effective and efficient use will be critical in obtaining the greatest outcomes possible. This will be increasingly the case with climate change forecasts indicating substantially reduced rainfall, in particular in winter and spring (Timbal, et al., 2015).

Robust and flexible planning processes are needed if the best ecological outcomes are to be achieved with the water available. This was initially achieved through the development of the Environmental Operating Strategy for the management of the Wimmera-Glenelg Environmental Water Reserve (EOS) (GHCMA &

WCMA, 2004), which outlined the principles and processes to be followed when developing Annual Watering Plans for the Wimmera and Glenelg River systems.

Since 2010, there have been substantial changes in environmental water reserve management given the creation of the Victorian and Commonwealth Environmental Water Holders, the completion of the Wimmera Mallee Pipeline and the purchase of the entitlement from the Wimmera Irrigators' Association for the environment. However, many of the core elements of the EOS are still relevant, such as shared planning processes between the Wimmera and Glenelg catchments to optimise the best regional environmental outcomes. This has been enhanced through the development of the Wimmera and Glenelg Rivers Environmental Entitlement: Environmental water sharing rules (VEWH, 2014).

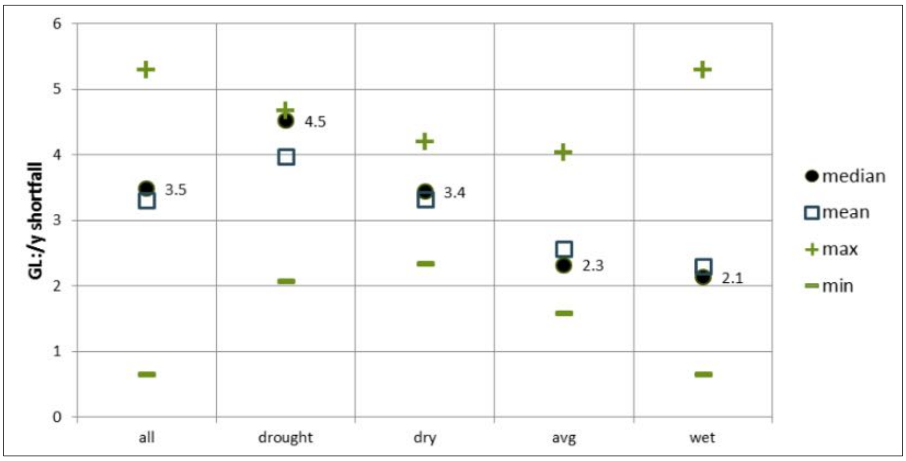

Figure 4-24: Shortfalls in environmental water to Reach 4 of the Wimmera River under different historic climatic conditions (Alluvium, 2013)

Given the frequency and severity of shortfalls in environmental water, a risk-based approach has been developed to prioritise watering components within reaches. This was initially established specifically for macroinvertebrates through an Ecological Risk Assessment of the Lower Wimmera River (EPA, 2008), using a Bayesian network with streamflows, water quality and habitat data to predict the condition of the macroinvertebrate community.

Another tool to inform decision making around environmental water management is described in Prioritisation of Environmental Water Releases in the Wimmera, Glenelg and Avon-Richardson River Systems (SKM, 2010). This tool uses the flow components required for various ecological objectives (fish, vegetation, macroinvertebrates and geomorphology) and determines risk levels associated with shortfalls in compliance based on ecological response curves. Risk levels were calculated over a multi-year time series and flow components that were a higher priority for delivery (subject to water availability and capacity constraints) were identified based on the higher risk rating.

Annual water planning processes will endeavour to minimise the risks to various ecological assets. However, provision of bankfull or overbank flows for certain outcomes will largely be contingent on unregulated streamflows. Similarly, the provision of freshes and baseflows will be provided when regulated allocations are sufficient.

It should be noted that environmental water deliveries are underpinned by a continuous improvement approach. Given compliance points for priority reaches are often some distance downstream, a higher flow rate is required to cover in-stream losses through seepage, evaporation and diversion experienced between the delivery point and the compliance point. Ongoing monitoring of flow rates at stream gauges enables environmental flows to be increased or decreased to efficiently meet compliance (Figure 4-25). In some cases, it will be a matter of supplementing unregulated and/or passing flows or "piggy-backing" environmental water releases on top to meet recommended thresholds in terms of volumes and durations. In time the datasets will be refined to enable effective and efficient environmental water delivery through better understanding in-stream losses and timing of flows along various waterways under different conditions.

In addition, the construction of a pipeline to the lower Wimmera refuge pools will allow the impacts of future extreme dry periods on the values of these refuge areas to be mitigated, and support faster recovery of species throughout the system. This will involve the establishment of branch connections from the Wimmera Mallee Pipeline to four priority refuge areas between Dimboola and Jeparit to enable the delivery of water during drought periods. Development of a Drought Refuge Management Plan (Alluvium, 2018) has guided the project activities and preferred supply option.

The focus of refuge management is on protecting habitat for Freshwater Catfish, Australian smelt and Flathead gudgeon, in four priority refuge areas at Lochiel, Arkona, Antwerp and Tarranyurk. Delivery of water will consider water quality and flow triggers; however, these are still to be confirmed. Salinity is also an important issue due to groundwater intrusions in the Lower Wimmera River and stratification of deep pools.

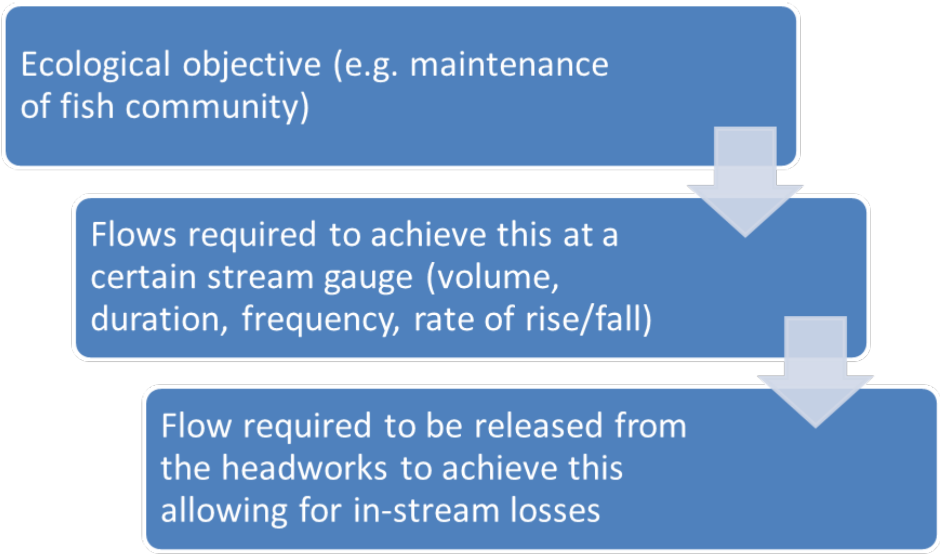

Figure 4-25: Process of implementing environmental watering activities based on various ecological objectives

Figure 4-26: Wimmera River at Wundersitz Crossing (left), Wimmera River at Longerenong Weir (right).

5 Water-dependent values

The Wimmera River was noted as a high value waterway in the WWS, meaning that it has at least one high environmental, social or economic value. The concept of high value waterways comes from the Victorian Waterway Management Strategy where certain characteristics such as the presence of threatened species, a popular recreational fishing location or water storage would mean that a waterway possessed high environmental, social and economic values respectively.

The Wimmera River, Yarriambiack Creek, Lake Hindmarsh and Lake Albacutya had such an abundance of high values for social and environmental attributes that they were deemed to be priority waterways for management activities in the WWS. Priority waterways are a subset of high value waterways where feasible and effective management activities (such as weed control or environmental water management) can be undertaken to improve or maintain their condition.

5.1 ENVIRONMENTAL VALUES

A number of waterways and wetlands within the Wimmera River System have been listed under legislation and other formal instruments (Table 5-1). The Wimmera River from Polkemmet (near Horsham) to the Wirrengren Plain is a Heritage River under the *Victorian Heritage Rivers Act 1992* due to its significant nature conservation, recreation, scenic or cultural heritage attributes and is also included in the Directory of Nationally Important Wetlands. Lake Albacutya is wetland of international significance listed under the Ramsar Convention. Lake Hindmarsh and the section of the Wimmera River that is classified as a Heritage River is also listed on the Directory of Nationally Important Wetlands.

The environmental values for which Lake Hindmarsh was recognised as a nationally significant wetland (Department of Environment, 2015) are:

- It is a good example of a wetland type occurring within a biogeographic region in Australia
- Plays an important ecological or hydrological role in the natural functioning of a major wetland complex
- Important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail
- It is of outstanding historical or cultural significance.

For Lake Albacutya the environmental criteria for its listing as a nationally significant wetland are the same as the first three listed for Lake Hindmarsh above as well as fact that the lake supports 1% or more of the national populations of any native plant or animal taxa.

The criteria for which Lake Albacutya is Ramsar-listed are similar and are listed following (Cibilic & White, 2010):

- Contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region
- Supports vulnerable, endangered, or critically endangered species or threatened ecological communities
- Supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region
- Regularly supports 20,000 or more waterbirds
- Regularly supports 1% of the individuals in a population of one species or sub-species of waterbird

The Wimmera River supports a number of flora and fauna species that are listed as threatened at either the National or State level (Table 5-2, Table 5-3, Table 5-4 and Table 5-7). Lake Hindmarsh and Lake Albacutya also support a number of migratory bird species included in international agreements (Table 5-4).

Table 5-1: Threatened Species Lists developed under legislation, agreements or conventions that apply to the Wimmera River System

THREATENED SPECIES LIST	JURISDICTION	RIVERS/ CREEKS	LAKES
Japan Australia Migratory Birds Agreement (JAMBA)	International		
China Australia Migratory Birds Agreement (CAMBA)	International		
Republic of Korea Australia Migratory Birds Agreement (ROKAMBA)	International		
Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)	International		
Convention on Wetlands of International Importance, especially as Waterfowl Habitat (Ramsar Convention)	International		
Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act)	National		
Directory of Nationally Important Wetlands	National		
Flora and Fauna Guarantee Act 1988 (FFG Act)	State		
DEECA Advisory Lists (revoked in 2021)	State		
Heritage Rivers Act 1992	State		

SIGNIFICANT FAUNA

The following section outlines the various flow dependent fauna species that have been observed in and around the Wimmera River and terminal lakes, in particular current listed threatened species under the EPBC Act (DCCEEW, 2023) and FFG Act (DEECA, 2023). A complete list of fauna species is in Appendix A-1, whilst waterway dependent threatened species are listed in the following sections.

The Wimmera River sustains three threatened fish species although they have all been introduced to the region from elsewhere in Australia (SKM, 2006) (Table 5-2). Murray Cod (*Maccullochella peelii*) and Silver Perch (*Bidyanus bidyanus*) are stocked and are believed to not be self-sustaining. Murray Cod are now only stocked in Taylor's Lake and so may occasionally enter the Wimmera River when water is released into the river. Freshwater Catfish (*Tandanus tandanus*) is found in the Wimmera River and Yarriambiack Creek and is self-sustaining. Mount William Creek contains the threatened Western Swamp Cray (*Gramastacus insolitus*).

Golden Perch (*Macquaria ambigua*) is found in the Wimmera River, previously listed as 'near threatened' on the Advisory List of Threatened Vertebrate Fauna of Victoria (DSE, 2013). However, this only applies to natural populations and Golden Perch is not endemic to the Wimmera River System and is not self-sustaining. Golden Perch were also not included as threatened in the latest Flora and Fauna Guarantee Act 1988 Threatened List (DEECA, 2023)

River Blackfish (*Gadopsis marmoratus*) found in Mount William Creek are believed to be part of a genetically distinct subspecies confined to the Wimmera and Glenelg systems (Hammer et al., 2014) but has no formal status with regards to being threatened.

Table 5-2: Fish Species in the Wimmera River of conservation significance

SPECIES NAME	COMMON NAME	EPBC ACT[5] STATUS	FFG ACT[6] STATUS	REACHES APPLICABLE
Bidyanus bidyanus	**Silver Perch**	Critically endangered	Endangered	Wimmera 2-4
Gramastacus insolitus	**Western Swamp Crayfish**		Endangered	Mt William Creek
Maccullochella peelii peelii	**Murray Cod**	Vulnerable	Endangered	Wimmera 2-4
Tandanus tandanus	**Freshwater Catfish**		Endangered	Wimmera 2-4

The Wimmera River contains large-bodied non-endemic species namely Golden Perch, Freshwater Catfish, Silver Perch and rarely Murray Cod. Discussion around exotic fish species distribution in the Wimmera River System is contained in Section 5.3 under Water Related Threats.

Mount William Creek contains the non-endemic Common Galaxias (*Galaxias maculatus*) and is located in parts of the creek located in and near the Grampians. The creek is also home to populations of other small-bodied native fish including Australian Smelt, Southern Pygmy Perch, Flathead Gudgeon.

Macroinvertebrate communities in the Wimmera River system are highly variable. In the lower Wimmera River, there are fewer species than in the headwater streams of the Wimmera River and they are more tolerant of poor water quality (WEC, 2012). When conditions are wet and there are good streamflows then the macroinvertebrate community demonstrates a very good level of resilience as can be seen from Macroinvertebrate Biotic Index (MBI) scores across the Wimmera River System (Figure 5-1). However, during dry conditions, such as those experienced during the Millennium Drought, poor water quality and a lack of habitat leads to much lower MBI scores (WEC, 2009).

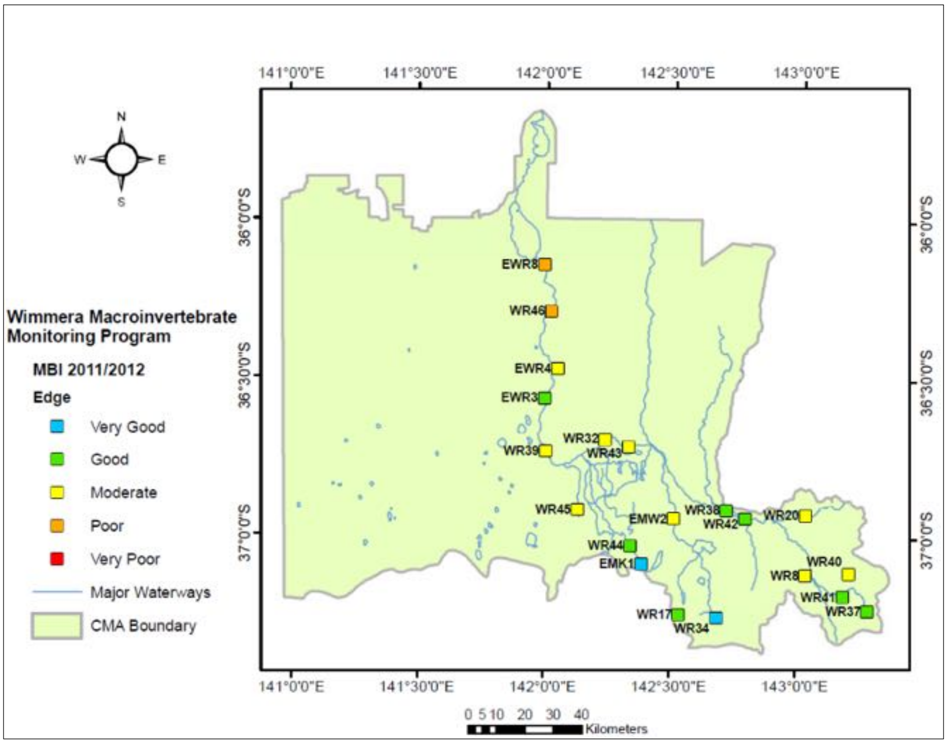

Figure 5-1: MBI classifications for the Wimmera River System (and other waterways) 2011/12 (Source: WEC, 2012)

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5 EPBC: *Environment and Biodiversity Conservation Act*

6 FFG: *Flora and Fauna Guarantee Act*

Other water-dependent species of conservation significance occurring in the Wimmera River, Mount William Creek and terminal lakes include a number of frog and reptile species including Growling Grass Frog (*Litoria raniformis*) and Eastern Long-Necked Turtle (*Chelodina longicollis*).

Although not listed as a threatened species, Platypus is highly vulnerable in the Wimmera with the only confirmed population being in the MacKenzie River. Isolated sightings indicate that a population of platypus may be present in the Wimmera River, although it must be in extremely low numbers as recent surveys have failed to locate or capture any (Ecology Australia, 2023). Amphibians and reptiles of conservation significance in the Wimmera River System are listed in Table 5-3. Platypus have also been recorded in Mount William Creek with the most recent record in 1993.

Table 5-3: Amphibians, mammals and reptiles in the Wimmera River system of conservation significance

SPECIES NAME	COMMON NAME	EPBC ACT[7] STATUS	FFG ACT[8] STATUS	REACHES APPLICABLE
Litoria raniformis	**Growling Grass Frog**	Vulnerable	Vulnerable	Wimmera 2-4
Pseudophryne bibronii	**Brown Toadlet**		Endangered	Mt William Creek
Ornithorhynchus anatinus	**Platypus**		Vulnerable	Mt William Creek

The Wimmera River system hosts an abundance of bird species, partly due to migratory waterbirds and waders in terminal lakes when they are inundated. For example, Lake Albacutya has supported over 20,000 waterbirds when flooded and 13 migratory species, many of which are listed under international treaties (Cibilic & White, 2010). Non-waterbirds take advantage of the conditions provided by environmental water releases with a greater diversity of bush birds observed where flows are taking place (Wimmera CMA, 2012). Waterbirds of conservation significance that occur in the Wimmera River system are listed in Table 5-4.

Table 5-4: Waterbird species in the Wimmera River System of conservation significance

SPECIES NAME	COMMON NAME	EPBC ACT[9] STATUS	FFG ACT[10] STATUS	REACHES APPLICABLE
Botaurus poiciloptilus	**Australasian Bittern**	Endangered	Critically Endangered	Dock, Yarriambiack, Hindmarsh
Anas rhynchotis	**Australasian Shoveler**		Vulnerable	Hindmarsh, Albacutya, Wyperfeld Sth, Dock
Oxyura australis	**Blue-billed Duck**		Vulnerable	Hindmarsh, Albacutya, Wyperfeld Sth, Dock
Hydroprogne caspiaJ	**Caspian Tern**		Vulnerable	Hindmarsh, Albacutya
Tringa nebularia	**Common Greenshank**		Endangered	Hindmarsh, Albacutya, Dock
Actitis hypoleuocosBCJR	**Common Sandpiper**		Endangered	Hindmarsh
Calidris ferruginea	**Curlew Sandpiper**		Critically Endangered	Hindmarsh, Albacutya, Wyperfeld South, Dock
Ardea alba modesta	**Eastern Great Egret**		Vulnerable	Hindmarsh, Albacutya, Wyperfeld South, Dock

7 EPBC: *Environment and Biodiversity Conservation Act*
8 FFG: *Flora and Fauna Guarantee Act*
9 EPBC: *Environment and Biodiversity Conservation Act*
10 FFG: *Flora and Fauna Guarantee Act*

SPECIES NAME	COMMON NAME	EPBC ACT[9] STATUS	FFG ACT[10] STATUS	REACHES APPLICABLE
Stictonetta naevosa	**Freckled Duck**		Endangered	Hindmarsh, Albacutya, Dock
Pluvialis squatarola	**Grey Plover**		Vulnerable	Hindmarsh
Geolochelidon nilotica Macrotarsa	**Gull-billed Tern**		Endangered	Albacutya
Aythya australis	**Hardhead**		Vulnerable	Hindmarsh, Albacutya, Wyperfeld Sth, Dock
Tringa stagnatilis	**Marsh Sandpiper**		Endangered	Hindmarsh, Albacutya
Anseranas semipalmata	**Magpie Goose**		Vulnerable	Dock
Biziura lobate	**Musk Duck**		Vulnerable	Hindmarsh, Albacutya, Dock
Ardea intermedia plumifera	**Plumed Egret**		Critically Endangered	Wyperfeld Sth
Arenaria interpres	**Ruddy Turnstone**		Endangered	Hindmarsh, Albacutya
Haliaeetus leucogaster	**White-bellied Sea Eagle**		Endangered	Hindmarsh, Wyperfeld Sth, Wyperfeld Nth, Dock

FLORA

The Wimmera Bulk Entitlement Conversion Environmental Flows Study (SKM, 2003) noted that 135 threatened flora species occur in the Wimmera River catchment, and of these 24 species were considered reliant on waterways for their survival. Dyer and Roberts (2006) reviewed these species and concluded only four were possibly flow-dependent, the others not being found in the Wimmera River system, rather associated with nearby salt lakes. A comprehensive list of flora species located in or adjacent to waterways considered in this EWMP is presented in Appendix A-3. They have been recorded in riparian and wetland areas through the Victorian Biodiversity Atlas as well as vegetation monitoring undertaken for the Victorian Environmental Flows Monitoring and Assessment Program (VEFMAP).

VEGETATION COMMUNITIES

Because the Wimmera River flows from the edge of the Grampians to the southern Mallee, it supports a wide variety of vegetation communities. Due to widespread clearing for agriculture, many of these vegetation communities are now spatially restricted compared to their pre-European settlement distribution and extent. Much of the Wimmera River is dominated by an overstorey of River Red Gums (Eucalyptus camaldulensis). The Lake Albacutya provenance of River Red Gum is renowned globally for its salt-tolerance. However Black Box (*Eucalyptus largiflorens*) is the dominant overstorey species for the northern section of the Yarriambiack Creek (downstream of Warracknabeal) and for the parts of the Wimmera River where salinity has killed the larger River Red Gums. Table 5-5 and Table 5-6 list the riparian and wetland Ecological Vegetation Classes (EVCs), their conservation status and the relevant reaches/lakes where they are found.

Submerged vegetation (e.g. *Triglochin, Vallisneria, Potamogeton*) and emergent vegetation (e.g. *Typha, Phragmites, Eleocharis*) are also a notable feature of the Wimmera River. They provide a nursery for small-bodied native fish like Southern Pygmy Perch (B. McInnes, Wimmera CMA pers. comm) and habitat for birds like Australian Reed-Warblers (*Acrocephalus australis*) (Wimmera CMA, 2012). They are also a valuable sink for nutrients (namely nitrogen and phosphorus) which in turn reduces their availability for blue-green algae blooms (Roberts, Grace, Sherwood, Lind, & Nash, 2006).

The update of the environmental water requirements of the Wimmera River terminal lakes (Jacobs, 2019) found that the main ecological zones for the terminal lakes that retain wetland characteristics are:

1. Lake-bed vegetation characterised by a near-uniform expanse of EVC107 Lake Bed Herbland in the wettest depressions and EVC741 Salt Paperbark Woodland/Samphire Shrubland Mosaic in the drier depressions.
2. A fringing woodland zone of EVC813 Intermittent Swampy Woodland with a dominant canopy of River Red Gum or in drier areas EVC103 Riverine Chenopod Woodland with a dominant canopy of Black Box.
3. Terrestrial mallee woodland comprising either cleared agricultural land around Lakes Hindmarsh and Albacutya or a complex mosaic of terrestrial vegetation in protected areas such as in Wyperfeld National Park.
4. The bioregional conservation status of EVCs associated with the Wimmera River and its floodplain and the terminal lakes have been included in Table 5-5 and Table 5-6 respectively. A description of the EVCs is provided in Appendix A-2.

Table 5-5: Ecological Vegetation Classes associated with the Wimmera River and its floodplain.

EVC NO.	ECOLOGICAL VEGETATION CLASS NAME	BIOREGION(S)	BIOREGIONAL CONSERVATION STATUS
103	**Riverine Chenopod Woodland**	Wimmera	Endangered
641	**Riparian Woodland**	Wimmera	Vulnerable
		Lowan Mallee	
		Murray Mallee	
813	**Intermittent Swampy Woodland**	Murray Mallee	Vulnerable
822	**Intermittent Swampy Woodland/ Riverine Grassy Woodland Complex**	Lowan Mallee	Vulnerable
		Murray Mallee	
823	**Lignum Swampy Woodland**	Wimmera	Vulnerable
		Murray Mallee	
56	**Floodplain Riparian Woodland**	Wimmera	Endangered
658	**Riverine Grassy Woodland/ Sedgy Riverine Forest/ Aquatic Herbland Mosaic**	Wimmera	Vulnerable
659	**Plains Riparian Shrubby Woodland**	Wimmera	Vulnerable
3	**Sand Ridge Woodland/ Damp Sands Herb-rich Woodland Mosaic**	Wimmera	Endangered

Table 5-6: Ecological Vegetation Classes associated with the terminal lakes of the Wimmera River.

EVC NO.	ECOLOGICAL VEGETATION CLASS NAME	BIOREGION(S)	BIOREGIONAL CONSERVATION STATUS	TERMINAL LAKE*		
				Hindmarsh	Albacutya	Others
829	**Chenopod Grassland**	Murray Mallee	Depleted			
89	**Dunefield Heathland**	Murray Mallee	Least Concern			
88	**Healthy Mallee**	Murray Mallee	Least Concern			
813	**Intermittent Swampy Woodland**	Murray Mallee	Vulnerable			
822	**Intermittent Swampy Woodland/ Riverine Grassy Woodland Complex**	Murray Mallee Lowan Mallee	Vulnerable			
107	**Lake Bed Herbland**	Murray Mallee	Depleted			
91	**Loamy Sands Mallee**	Murray Mallee	Least Concern			
981	**Parilla Mallee**	Murray Mallee	Endangered			
95	**Red Swale Mallee**	Murray Mallee	Least Concern			
96	**Ridged Plains Mallee**	Murray Mallee	Endangered			
103	**Riverine Chenopod Woodland**	Murray Mallee	Depleted			
741	**Salt Paperbark Woodland/Samphire Shrubland Mosaic**	Murray Mallee	Vulnerable			
93	**Sandstone Ridge Shrubland**	Murray Mallee	Least Concern			
98	**Semi-arid Chenopod Woodland**	Murray Mallee	Vulnerable			
97	**Semi-arid Woodland**	Murray Mallee	Vulnerable			
90	**Tea-tree Scrub**	Murray Mallee	Least Concern			
824	**Woorinen Mallee**	Murray Mallee	Least Concern			

* Please note that grey shading indicates EVC presence at the terminal lakes.

Threatened species found in and adjacent to the waterways and lakes of the Wimmera River that are reliant on flows or inundation to maintain condition and/or recruitment are included in Table 5-7.

Table 5-7: Threatened flow dependent flora species in the Wimmera River and associated status

SPECIES NAME	COMMON NAME	EPBC ACT[11] STATUS	FFG ACT[12] STATUS	REACHES APPLICABLE
Acacia trineura	**Three-nerve Wattle**		Critically Endangered	Wimmera 4 and terminal lakes
Allocasuarina luehmannii	**Buloke**		Critically Endangered	Wimmera 2, 3, 4 and terminal lakes
Jasminum didymium	**Desert Jasmine**		Endangered	Terminal lakes
Pterostylis cheraphila	**Floodplain Rustyhood**		Endangered	Wimmera 4

[11] EPBC: *Environment and Biodiversity Conservation Act*
[12] FFG: *Flora and Fauna Guarantee Act*

ECOSYSTEM FUNCTION

'Ecosystem function' is the term used to define the biological, geochemical and physical processes and components that take place or occur within an ecosystem. Ecosystem functions relate to the structural components of an ecosystem (e.g. vegetation, water, soil, atmosphere and biota) and how they interact with each other, within ecosystems and across ecosystems (Maynard, James, & Davidson, 2012). Ecosystem functions critical to support primary water dependent environmental values of the Wimmera River system include, but are not limited to:

- Food Web Support - a critical function is the conversion of matter to energy by primary producers for uptake by biota. Structural components include substrate surfaces (e.g. large woody habitat and rocks) for biofilms, and plant matter. Interactions between primary producers and consumers such as zooplankton and macroinvertebrates break down the carbon and nutrients required for higher order consumers.
- Reproduction – recruitment of new individuals is important for all of the river system's biota and the maintenance of local and regional populations. Flows and inundation can act as cues for fish to spawn through changing water temperatures and habitat availability (e.g. inundating fringing vegetation) (Lintermans, 2007). It also prompts the reproduction of vegetation, for example Wimmera Bottlebrush has shown a strong recruitment response to flows (Marriott, 2006).
- Movement/Dispersal – movement of individuals throughout various waterway habitats to take advantage of different resources is linked to the food web support. By providing flows of differing volumes, different areas of the river are accessible for foraging by fish, waterbirds, other aquatic fauna and propagules. Variability in lake levels is also an important mechanism to disperse species and provide a range of habitats. Flow and connectivity also facilitate the dispersal of different species up and down the Wimmera River which is especially important following dry spells to allow recolonisation.
- Landscape Contribution – the Wimmera River and terminal lakes are crucial to the overall biodiversity of the broader Murray Darling Basin and south-east Australia as a whole. The terminal lakes are crucial breeding sites for a variety of waterbirds as well as species such as the Wimmera Bottlebrush that have a limited distribution.

A summary of how this EWMP will address various ecosystem functions is given in Table 5-8. This table also shows which ecosystem functions are being specifically addressed in this EWMP by using the ecosystem functions structure suggested in the Basin Plan (Australian Government, 2012).

Table 5-8: Ecosystem functions provided within the Wimmera River and terminal lakes

CRITERIA		MEETS CRITERION	EXPLANATION
1.	**The ecosystem function supports the creation and maintenance of vital habitats and populations**		
	Assessment indicator: An ecosystem function requires environmental watering to sustain it if it provides vital habitat including:		
	(a) A refugium for native water-dependent biota during dry periods and drought; or	✓	The Wimmera River has deep pools (including weir pools) which provide refuge for aquatic fauna (notably Freshwater Catfish, Golden and Silver Perch) during seasonal dry phases and extended droughts. Providing low flows during seasonally dry and very dry conditions will maintain this refuge habitat and ensure its water quality (salinity) remains within the tolerance range of the dependent fauna.
	(b) Pathways for the dispersal, migration and movement of native water dependent biota; or	✓	Flows enable some species (e.g. platypus) to disperse and genetic mixing of some species (e.g. Mountain Galaxias and Southern Pygmy Perch).
	(c) A diversity of important feeding, breeding and nursery sites for native water-dependent biota; or	✓	The Wimmera River System contains one of four self-sustaining Freshwater Catfish population in Victoria (DSE, 2005) with suitable habitat for nesting sites. Stretches of the Burnt and Mt William Creeks as well as the MacKenzie River are key locations for the breeding of Southern Pygmy Perch and Mountain Galaxias. There has been evidence of platypus breeding in the MacKenzie River (cesar, 2014).
	(d) A diversity of aquatic environments including pools, riffle and run environments; or	✓	The Wimmera River is characterised by the deep pools, particularly near Dimboola. These pools have runs in between to provide a diversity of habitat. This morphology is similar for the lower Burnt and Mt William Creeks as well as parts of the MacKenzie River. The reaches of the MacKenzie River and Mt William Creek located near the Grampians contain more of a rocky substrate and so have riffles as well.
	(e) A vital habitat this is essential for preventing the decline of native water-dependent biota.	✓	Experience during the drought has shown that without environmental water releases, native fish species are at a very high risk of being lost from the region, riparian vegetation rapidly declines, macroinvertebrate communities become depauperate and other species like platypus and rakali are vulnerable to becoming regionally extinct. Environmental watering has enabled these impacts to be minimised and facilitated recovery.
2.	**The ecosystem function supports the transportation and dilution of nutrients, organic matter and sediment**		
	Assessment indicator: An ecosystem function requires environmental watering to sustain it if it provides for the transportation and dilution of nutrients, organic matter and sediment, including:		
	(a) Pathways for the dispersal and movement of organic and inorganic sediment, delivery to downstream reaches and the ocean, and to and from the floodplain; or	✓	The Wimmera River flows into a series of terminal lakes, some of which are of national and international importance. Inputs of organic and inorganic sediment are vital for the establishment and maintenance of food webs that support an abundance of birds, fish and other aquatic species when the lakes contain water.

CRITERIA		MEETS CRITERION	EXPLANATION
	(b) The dilution of carbon and nutrients from the floodplain to the river systems.	✓	Experience from the floods of 2010 and 2011 showed that environmental water releases were critical for managing the issues of blackwater and eutrophication created by large quantities of carbon and nutrients washing off floodplains into waterways.
3.	**The ecosystem function provides connections across floodplains, adjacent wetlands and billabongs (lateral connections)**		
	Assessment indicator: An ecosystem function required environmental watering to sustain it if it provides connections across floodplains, adjacent wetlands and billabongs, including:		
	(a) For dispersal and re-colonisation of native water-dependent communities; or	✓	Monitoring has shown the re-establishment of platypus in reaches of the MacKenzie River following the provision of environmental flows. One of the objectives within the Wimmera River environmental flows study is the provision of habitat and conditions to enable re-colonisation of platypus from the MacKenzie River to the Wimmera River.
	(b) For migration to fulfil requirements of life history stages; or	✗	No endemic species of fish require migration to complete life history stages.
	(c) For in-stream primary production	✓	Freshening flows along all regulated waterways are required in order to try and mobilise sediment and biofilms on woody habitat and interstitial spaces (Alluvium, 2013).
4.	**The ecosystem function provides connections across floodplains, adjacent wetlands and billabongs (lateral connections)**		
	Assessment indicator: An ecosystem function required environmental watering to sustain it if it provides connections across floodplains, adjacent wetlands and billabongs, including:		
	(a) Lateral connections for foraging, migration and re-colonisation of native water dependent species and communities; or	✓	The Wimmera River and MacKenzie Rivers as well as Mt William Creek have high-flow channels that are engaged by large fresh and bankfull flows to provide additional habitat. Furthermore, many of the biota that inhabit the Wimmera River enter the terminal lakes when they contain water in order to establish food webs.
	(b) Lateral connections for off-stream primary production	✓	Inputs from flows are critical for primary production in high-flow channels

5.2 SHARED BENEFITS

TRADITIONAL OWNER CULTURAL

The significance of the Wimmera River and terminal lakes to the local indigenous community is substantial. There is an indigenous creation story about a fleeing kangaroo named Purra leaving waterholes in the Wimmera River where it jumped (Pouliot, 2012), and Lake Albacutya is where Purra ate some bitter quandongs. The name Albacutya is derived from the word ‘Nalbagadja’ which means ‘place of the bitter quandongs’.

> *“We have a huge connection to the Wimmera River; it is a creation story path and has a very special place in our hearts. It is a major part of who we are as a people.”*
>
> Aunty Nancy Harrison – Wotjobaluk Elder (Pouliot, 2012)

In December 2005 the Federal Court recognised the Wotjobaluk, Jaadwa, Jadawajali, Wergaia and Jupagalk people’s non-exclusive title rights for much of the lower Wimmera River, downstream of the Yarriambiack Creek offtake. These native title rights provide the right to hunt, fish, gather and camp for personal, domestic and non-commercial purposes, under traditional rights and customs. Consultation with the Barengi Gadjin Land Council who represent the traditional owners with respect to cultural heritage indicates a strong emphasis should be placed on the fact that flows used to regularly travel much further than Lakes Hindmarsh and Albacutya, reaching lakes beyond.

Abundant scar trees, shell middens, burial sites and artefact scatters bear testimony to the profound connection between local Aboriginal people and the Wimmera River. Whilst some cultural sites have been catalogued on the Victorian Aboriginal Heritage Register, many more exist along the length of the Wimmera River. Aboriginal Water Assessments and cultural heritage surveys undertaken on the Wimmera River and terminal lakes since 2017 continue to illustrate the profound connections of traditional owners to these waterways.

European cultural heritage values associated with the Wimmera River include old bridges, weirs and Ebenezer Mission near Antwerp which was established in 1859 by Moravian missionaries. Many local Aboriginal people lived at the mission where a school was established, and they hunted and fished in and around the Wimmera River as well as working in a garden irrigated by water from the river.

The region’s Waterway Strategy (Wimmera CMA, 2014) contains a number of priorities for actions to maintain and enhance cultural values including looking at opportunities around watering Ranch Billabong and Datchak Creek, anabranches of Reach 4 of the Wimmera River that have very strong cultural values. SKM (2008) determined that flows in excess of 3,000 ML/d will enter Datchak Creek. Ranch Billabong is filled during overbank flows (in excess of 6,000 ML/d).

Maximising cultural benefits and Aboriginal community outcomes from managing water in the environment in the lower Wimmera River (RMCG, 2020) reviewed environmental water actions like the watering of Ranch Billabong. This also included other initiatives such as the River Yarns Aboriginal Waterway Assessments of the lower Wimmera River. It documented the positive outcomes associated with these actions as well as providing recommendations to enhance them further. Recommendations included clearer links to objectives related to cultural benefits and Aboriginal community outcomes, as well as improved monitoring, evaluation and reporting to show if and how these objectives are being achieved.

The Ranch Billabong near Dimboola continues to be an example of being able to enhance Aboriginal cultural and environmental values with environmental water. The site is managed by BGLC on behalf of the Wotjobaluk people and listed as a significant place in their Country Plan, Growing What is Good (BGLC, 2017). The billabong is currently connected to the Wimmera River channel by a road culvert constructed by Hindmarsh Shire Council (Walker 2017). The culvert is very high up on the riverbank would only be able to receive flows when the Wimmera River is in flood. The Wimmera CMA has worked with BGLC to complete a permanent option to transfer water into the billabong in June 2024. The Country Plan lists as priority goals restoring a natural flooding regime to the billabong system and restoring indigenous plant and animal habitats, with particularly attention to controlling priority weeds (BGLC, 2017).

Table 5-9: provides an overview of the shared benefits for cultural outcomes from environmental watering at 'The Ranch' in Dimboola.

Table 5-9: Traditional Owner Values and Uses (WCMA, 2023)

RIVER/ WETLAND	VALUES/ USES/ OBJECTIVES/ OPPORTUNITIES	ALIGNMENT WITH POTENTIAL WATERING ACTIONS
Ranch Billabong	This site is managed by BGLC, and the enhanced condition of the billabong will support the site's use for gatherings and other events. It will also tie in with other onground works to improve the billabong's accessibility and condition. It will support contemporary cultural events, such as the Wotjobaluk Cultural Festival by improving water quality and amenity at this site during this event. Water will support the health of a culturally significant site and some valued species, such as Old Man Weed/Sneezeweed.	There is an explicit priority watering action to supply water to the Ranch Billabong. Water quality monitoring will continue to determine flows into the site and assess requirements for watering actions to meet native fish reintroduction. Ongoing vegetation improvements on the fringe and bank of the billabong to improve the overall habitat features at the site.
Other waterways	All waterways are important to Wotjobaluk people with heritage values existing with the environment.	Maintaining continuous flows with the current Seasonal proposals is seen to align with BGLC requirements. Ongoing fish monitoring and any future proposed carp removal is seen to be a proactive management step.

RECREATION

Water in the Wimmera landscape provides social and recreational values and many of these values (e.g. fishing) directly rely on environmental flow regimes. State policy encourages consideration of social values when undertaking environmental water planning (DEPI, 2013).

Horsham, Dimboola and Jeparit have town weir pools on the Wimmera River and Jung, Warracknabeal, Brim and Beulah have weir pools on the Yarriambiack Creek. There are walking tracks, picnic and barbeque facilities as well as campgrounds adjacent to most of these, and they are a magnet for locals and tourists alike. Water skiing takes place at all weir pools apart from Jeparit when water levels are sufficient. At Jeparit, water skiing takes place downstream of the weir, near Lake Hindmarsh.

Fishing is very popular pastime, especially at weir pools. Golden and Silver Perch is stocked throughout the Wimmera River and Golden Perch is stocked in the Brim, Beulah and Warracknabeal weir pools. Freshwater Catfish is also a popular angling species in the Wimmera River and Yarriambiack Creek, being the only location in Victoria that they can be legally kept.

Fishing competitions are huge drawcards, bringing competitors from much of Western Victoria and generating substantial revenue for community groups and local businesses. The Dimboola Rowing Regatta is an annual highlight and crews come from as far away as Melbourne and Mildura to compete. Regattas have taken place at Horsham Weir Pool and water-skiing competitions take place at a number of weir pools. Fishing is also popular in the Mount William Creek.

Lakes Albacutya and Hindmarsh are also valued by the community when they contain water for water skiing and excellent fishing in particular Redfin (*Perca fluviatalis*) and yabbies (*Cherax destructor*). They are also extremely popular tourist and camping venues.

The Wimmera CMA actively supports community events and where possible supporting them with environmental water releases where this aligns with environmental objectives and environmental outcomes are not compromised. The benefits for the community along the Wimmera River system since the return of regular flows in 2010 have been enormous through increased recreation opportunities and tourism as well as the wellbeing that comes through having water in a waterway and the life it brings.

There is also strong alignment with DECCA's Our Catchments, Our Communities program with community values from environmental water being enhanced by improved facilities at Horsham and Dimboola Weir pools (new tracks/shelters/rowing pontoons/fish habitat/erosion control/canoe launches). Other waterways (Mt William Creek) are valued for angling opportunities but not to the same degree as the Wimmera River. Dadswell's Bridge has a walking track featuring the Mt William Creek. Dock Lake is also a renowned bird watching site when it contains water.

ECONOMIC VALUES

A number of reaches in the Wimmera River comprise a vital part of the Wimmera Mallee Headworks system as described previously in Section 3.3, which is underpins the economic prosperity of the region supplying water for domestic, industrial, agricultural and recreational use.

There are a large number of stock and domestic licences along these waterways as well as a number of irrigation licences on the Wimmera River (Table 5-10). Stock and domestic water is now largely provided by the Wimmera Mallee Pipeline and irrigation is limited due to issues around poor water quality (high salinity) and limited reliability of supply. There are community concerns around the impact of large numbers of stock and domestic diverters taking water during droughts and in clustered locations in residential areas such as the Wimmera River at Dimboola.

Table 5-10: Licenced diversion details for the Wimmera River

WATERWAY	NUMBER OF LICENCES (TYPE	TOTAL VOLUME (ML)
Wimmera River Reach 2	1 (Domestic and Stock)	2.2
Wimmera River Reach 3	14 (Domestic and Stock)	30.8
	5 (Irrigation)	314.9
Wimmera River Reach 4	7 (Domestic)	15.4
	84 (Domestic and Stock)	189.2
	31 (Irrigation)	895.9
Lower Mt William Creek	12 (Domestic and Stock)	26.4
	2 (Irrigation)	32.3
Yarriambiack Creek	7 (Domestic and Stock)	15.4

A wide variety of shared benefits will be provided by environmental watering actions, and Table 5-11 outlines the expected social, recreational and economic shared benefits to be derived from environmental water delivery.

A key shared benefit from environmental water delivery is from recreational use. A key annual study undertaken on the social and economic value of recreational and environmental water for the Wimmera Southern Mallee has estimated the total regional economic contribution from the 27 selected recreational water facilities in the Wimmera Southern Mallee is $24.89 million (Street Ryan, 2021).

Table 5-11: Expected social, recreational and economic shared benefits to be derived from environmental water delivery (WCMA, 2023).

RIVER/ WETLAND	BENEFICIARY	CONNECTION TO THE RIVER	VALUES/ USES/ OBJECTIVES/ OPPORTUNITIES	ALIGNMENT WITH POTENTIAL WATERING ACTIONS
Wimmera River only	Rowers/ Canoers	Recreation plays an important social and economic role. Wellbeing associated with recreational use of the river complements the annual economic contribution to regional communities.	Horsham and Dimboola Weir Pools are the locations of rowing clubs, and an annual regatta is at Dimboola. Training events and school trips using canoes are an annual occurrence at these weir pools.	Provision of environmental water to maintain pool levels and water quality for multiple reasons will also assist the maintenance of weir pool water levels. (Year round baseflows/freshes)
	Walkers/		Tracks along the Wimmera River at Horsham, Dimboola and Jeparit are very popular and support events like the Wimmera River Parkrun.	Provision of environmental water to maintain pool levels and water quality for multiple reasons will also assist the aesthetics and appeal of these tracks.
	Runners/ Cyclists		Dimboola Weir Pool has a waterski club that regularly uses the river for recreation and organises biannual competitions. Horsham Weir Pool is also used for water-ski demonstrations at occasions like the annual Kannamaroo Festival.	Provision of environmental water to maintain pool levels and water quality for multiple reasons will also assist the maintenance of weir pool water levels (including tailoring flows around events that align with environmental outcomes). (Year round baseflows/freshes)
	Water-skiers		The appeal of the Wimmera River in terms of being a destination for visitors for holidays or events such as fishing competitions is enormous, see Street Ryan (2021).	Provision of environmental water to maintain pool levels and water quality for multiple reasons will support these events (including tailoring flows around events that align with environmental outcomes). (Year round baseflows and freshes)
All waterways (except Ranch Billabong and Dock Lake)	Landholders with Stock and Domestic and/or Irrigation licenses	Landholders have a close connection to the river, and interest in maintaining its health. Water quality improvements associated with increased flow can be important to landholders who are reliant on the river to meet their stock and domestic needs.	There are several landholders as well as councils along these waterways who extract water for various purposes such as watering gardens/ovals (subject to licence conditions).	Environmental water deliveries help maintain water quality and levels.
	Anglers	Recreation plays an important social and economic role in the catchment. Wellbeing associated with recreational use of the river complements the annual economic contribution to regional communities.	The Wimmera River is a highly valued destination for anglers looking to catch native (and exotic) fish species. Other waterways are not as highly valued but still provide opportunities. The fishing competitions that are held on the Wimmera River bring a number of people to the area that contribute to the socio-economic levels in the surrounding communities.	Provision of environmental water to maintain fish communities will enhance angling opportunities. (Summer/autumn baseflows and freshes and winter/spring baseflows/freshes)
	Birdwatchers	Recreation plays an important social and economic role in the catchment.	The lake is renowned for the waterbird response when it contains water and the lake reached 94% capacity in late November 2022.	Current water levels will allow waterbirds to utilise the site. Any large unregulated flows may enter if 2023/24 flows are above average.

5.3 CURRENT ECOLOGICAL CONDITION

The Wimmera River system has been modified by a number of factors in the last 200 years which has affected its condition and led to ongoing threats that need addressing to prevent additional declines. Flows within the system are impacted by the presence of dams, weirs and channels. Water quality has declined due to increased nutrient and sediment inputs from eroding tributaries. Waterways intersecting with saline groundwater has also led to salinity issues. Exotic flora and fauna have also invaded the system with annual grasses and pest fish species like Common Carp and Eastern Gambusia in particular becoming the dominant species in many parts of the system during the Millennium Drought.

The protection of riparian areas through their designation as Crown land within parks, reserves or frontage has led to riparian and wetland areas retaining many of their environmental values.

The condition of the Wimmera River and terminal lakes and the threats it faces vary depending on climatic circumstances with flood, drought and fire all having major impacts. The following sections provides an outline of the environmental values that these waterways provide and the threats that they currently face.

CURRENT CONDITION

A number of programs have assessed the condition of waterways in the Wimmera River and terminal lakes over the last 15 years as part of Murray Darling Basin or statewide programs or as part or more local catchment condition monitoring. Their results tell a consistent narrative about current values and trends.

Sustainable Rivers Audit

The Sustainable Rivers Audit (SRA) was undertaken by the Murray Darling Basin Authority at the Murray Darling Basin scale. It determined the condition of 23 river valleys based on fish, macroinvertebrates, vegetation, physical form and hydrology by comparing them to reference (pre-European) condition. The first SRA was for 2004-2007 and was based on only fish, macroinvertebrates and hydrology. The second SRA was for 2008-2010 and also included physical form and vegetation. According to the MDBA the results of the two iterations are not directly comparable (ISRAG, 2011). The Wimmera valley assessed for the SRA is larger than the area considered in this EWMP, but it is generally reflective of conditions at the time. The SRA was primarily undertaken during drought conditions and before water savings from the Wimmera Mallee Pipeline were made available for the environment. These factors would have combined to affect some of the results although the metrics are referential and so would have had allowances for impacts brought about dry conditions. The results are summarised in Table 5-12 with more detail available in the Sustainable Rivers Audit Group report (ISRAG 2008 and 2011). It should be noted that SRA results were stratified by elevation zones and only the results for the ‘lowland’ section of the Wimmera Valley are included here as the ‘upland’ section is not within the spatial scope of the Wimmera River and terminal lakes EWMP.

Table 5-12: Summary of SRA results for the Wimmera Valley with scores out of 100 in brackets (ISRAG, 2008) (ISRAG, 2011)

INDEX	FIRST SRA	SECOND SRA
Fish	Lowland: Very Poor (23)	Lowland: Very Poor (33)
Macroinvertebrates	Lowland: Poor (44)	Lowland: Moderate (69)
Vegetation	NA	Lowland: Poor (49)
Physical Form	NA	Lowland: Good (91)
Hydrology	Lowland: Poor – Very Poor	Lowland: Moderate
SRA overall rating	Very Poor	Poor

Index of Stream Condition (ISC)

The ISC is an assessment of stream condition across Victoria. Scores and classifications are provided for reaches of several kilometres up to about 50 kilometres long for rivers and creeks based on five sub-indices (hydrology, physical form, water quality, streamside zone, aquatic life) (Table 5-13). The ISC has been undertaken on three occasions (1999, 2004 and 2010) and the methods applied for collecting data have varied significantly each time and so the results are not directly applicable and so trends in condition cannot be inferred.

The reaches of the Wimmera River covered in this EWMP have many of the attributes of a healthy waterway, problems associated with weeds and erosion are comparatively minor when compared to other waterways across the state. The riparian area is largely continuous with some especially high value sections in Crown reserves like the Little Desert National Park and Barabool State Forest. Unfortunately, the lack of flows has been a major factor in the modest condition scores, affecting the hydrology, water quality and aquatic life scores (Table 5-13). Water quality is also affected by other impacts such as dryland salinity and sediment disturbance due to processes such as erosion and carp feeding (Wimmera CMA, 2002).

Table 5-13: ISC results for the Wimmera River reaches subject to this EWMP

ISC REACH	FLOWS REACH	PHYSICAL FORM			STREAM-SIDE ZONE			HYDROLOGY			WATER QUALITY			AQUATIC LIFE			TOTAL			CONDITION		
		Year																				
		99	**04**	**10**	**99**	**04**	**10**	**99**	**04**	**10**	**99**	**04**	**10**	**99**	**04**	**10**	**99**	**04**	**10**	**99**	**04**	**10**
2	**4**	4	5	9	4	6	6	2	0	7	-	-	3	8	-	2	19		22	**VP**	**P**	**P**
3	**4**	5	5	9	7	5	7	2	0	7	6	6	4	9	8	4	25	18	27	**P**	**M**	**M**
4	**4**	4	4	9	4	7	7	2	1	7	-	-	2	9	6	6	22	18	26	**P**	**M**	**M**
5	**4**	5	6	9	5	6	6	2	1	7	-	-	-	-	6	5	18	20	31	**VP**	**M**	**M**
6	**4**	5	6	9	5	-	7	2	1	7	8	8	3	8	6	6	23	21	28	**P**	**M**	**M**
7	**2,3**	6	6	8	6	6	6	2	1	7	-	-	5	9	9	5	23	22	28	**P**	**M**	**M**
8	**2,3**	5	6	7	8	6	7	5	4	7	-	-	-	9	8	6	30	27	33	**M**	**M**	**M**

*VP: Very Poor, P: Poor, M: Moderate.

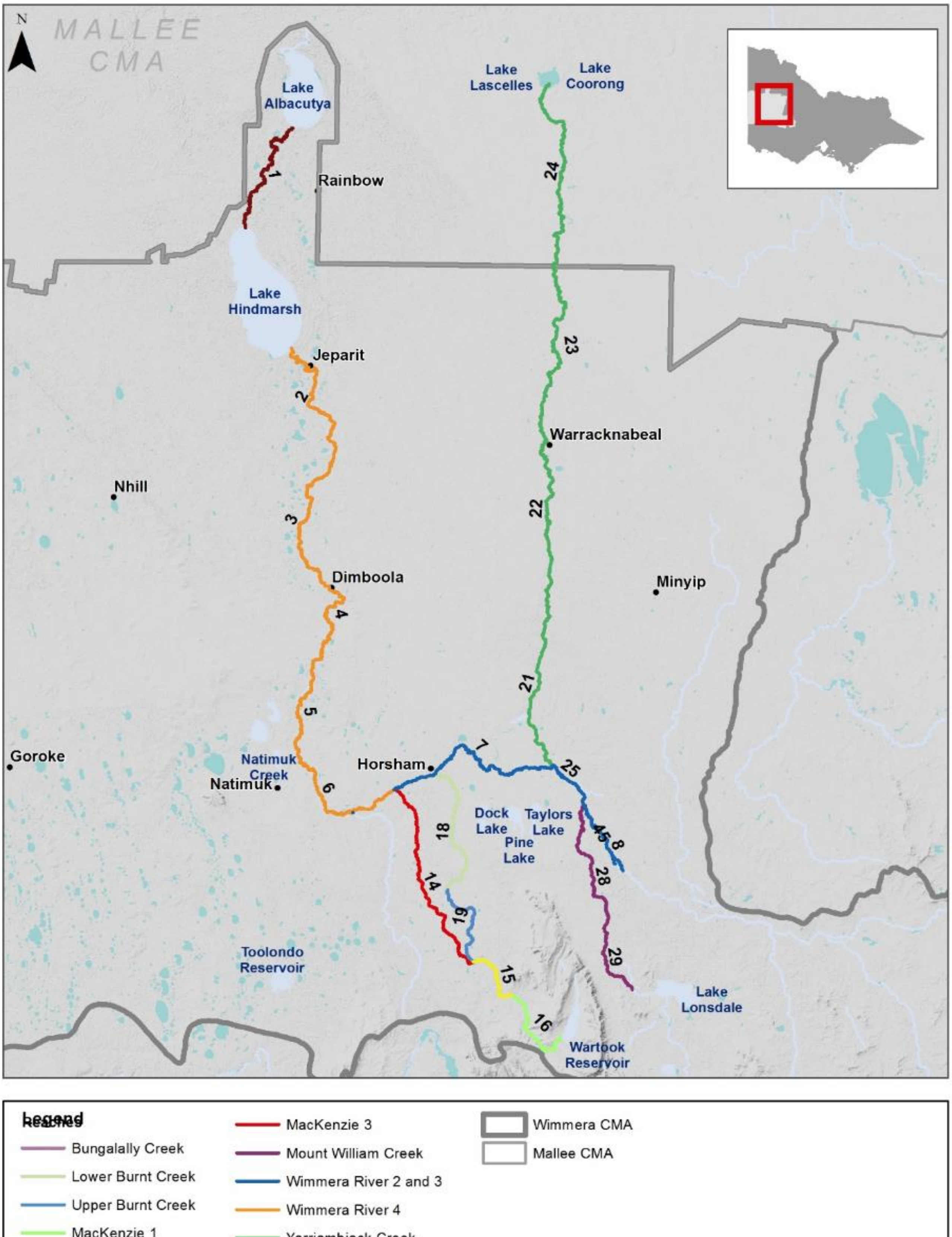

Figure 5-2: ISC reaches within the Wimmera River system (Source: WCMA)

The lower Mt William Creek has historically been impacted by limited flows when the stock and domestic channel system was in operation, being the third most flow-stressed waterway in Victoria (SKM, 2005). This accounts for its low Hydrology scores (Table 5-14). Streamside zone scores (which focuses on riparian vegetation) are generally high, due to the fact that much of the creek is located on Crown land.

Table 5-14: ISC Results for the Mt William Creek reaches covered in this EWMP

ISC REACH	FLOWS REACH	PHYSICAL FORM			STREAM-SIDE ZONE			HYDROLOGY			WATER QUALITY			AQUATIC LIFE			TOTAL			CONDITION		
		Year																				
		99	**04**	**10**	**99**	**04**	**10**	**99**	**04**	**10**	**99**	**04**	**10**	**99**	**04**	**10**	**99**	**04**	**10**	**99**	**04**	**10**
28	**L**	5	6	7	6	6	7	2	0	1	-	-	-	9	-	6	23	15	21	**M**	**P**	**P**
29	**U**	5	6	7	7	6	9	2	0	1	8	-	5	9	8	6	25	21	22	**P**	**M**	**P**
30	**U**	3	4	5	5	7	7	10	4	3	-	-	4	8	-	5	27	23	21	**P**	**M**	**P**

*P: Poor, M: Moderate.

The riparian zone of the Yarriambiack Creek is largely intact although narrow and degraded in some places although there has been a lot of work undertaken by landholders to improve this through fencing and revegetation works. There are virtually no issues with erosion given the low gradient of the creek (Table 5-15). Hydrology scores are low due to the assessment indicating that the seasonality of flows have changed (e.g. higher flows in summer than would be the case) which could be attributed to modifications at the offtake.

Table 5-15: ISC Results for the Yarriambiack Creek reach covered in this EWMP

ISC REACH	FLOWS REACH	PHYSICAL FORM			STREAM-SIDE ZONE			HYDROLOGY			WATER QUALITY			AQUATIC LIFE			TOTAL			CONDITION		
		Year																				
		99	**04**	**10**	**99**	**04**	**10**	**99**	**04**	**10**	**99**	**04**	**10**	**99**	**04**	**10**	**99**	**04**	**10**	**99**	**04**	**10**
21		6	6	8	5	5	7	10	4	3		-	-	9	-	-	34	24	26	**M**	**M**	**M**
22		5	6	7	7	5	7	10	4	3	-	-	5	9	-	-	35	24	24	**G**	**M**	**M**
23		4	6	7	7	6	7	10	-	3	-	-	-	8	-	-	32	NA	19	**M**	**NA**	**VP**
24		5	6	3	7	6	6	10	-	3	-	-	-	8	-	-	34	NA	18	**M**	**NA**	**VP**

* VP: Very Poor, P: Poor, M: Moderate, G: Good, NA: Insufficient data.

Outlet Creek has not flowed since ISC assessments were initially undertaken in 1999 (the Aquatic Life and Hydrology scores have been extrapolated from an upstream reach). Outlet Creek is protected as part of the Wimmera River Heritage Area and its riparian areas remain in good condition giving moderate scores for Streamside Zone (Table 5-16).

Table 5-16: ISC Results for Outlet Creek

ISC REACH	FLOWS REACH	PHYSICAL FORM			STREAM-SIDE ZONE			HYDROLOGY			WATER QUALITY			AQUATIC LIFE			TOTAL			CONDITION		
		Year																				
		99	04	10	99	04	10	99	04	10	99	04	10	99	04	10	99	04	10	99	04	10
1	**N/A**	7	7	8	7	7	6	10	-	-	-	-	-	8	-	-	-	-	-	M	NA	NA

* M: Moderate, NA: Insufficient data.

Index of Wetland Condition

IWC assessments have taken place using a standard method (DELWP, 2018) at a relatively small number of wetlands across the Wimmera in 2009-10. This included the terminal lakes of the Wimmera River, most notably Lake Hindmarsh and Lake Albacutya but also several smaller lakes beyond Lake Albacutya (Figure 3-2). Their condition rating was affected by the presence of upstream regulating structures affecting their Hydrology scores. All of the lakes apart from Lake Hindmarsh were dry and there was no evidence of increasing salinity and nutrients which led to good scores for the Water Properties sub-index. However, this was not the case for Lake Hindmarsh and water quality was comparatively poor, affecting the sub-index score (Table 5-17).

Table 5-17: IWC results for Lake Hindmarsh and Lake Albacutya and other several smaller lakes potentially influenced by the Wimmera River

WETLAND	CATCHMENT	PHYSICAL FORM	HYDROLOGY	WATER PROPERTIES	SOILS	BIOTA	OVERALL	CONDITION
Lake Hindmarsh	18	20	0	5	20	14	5	Moderate
Lake Albacutya	10	20	0	20	20	5	5	Moderate
Lake Brimin	18	20	0	17	20	10	6	Moderate
Lignum Plain	20	20	0	17	20	12	6	Moderate
Lake Agnes	20	20	0	20	20	11	7	Good

Note: All scores apart from the Overall score are out of 20.

Hydrological Assessments

In 2008, a report by CSIRO looked at water availability of major river basins across the Murray Darling Basin as well as the modelled impacts of future climate change. It highlighted that the Wimmera Basin has the highest proportion of surface water use to availability in the Murray Darling Basin (CSIRO, 2008) (Figure 5-3). This in turn led to substantial reductions in streamflows reaching the end of the system.

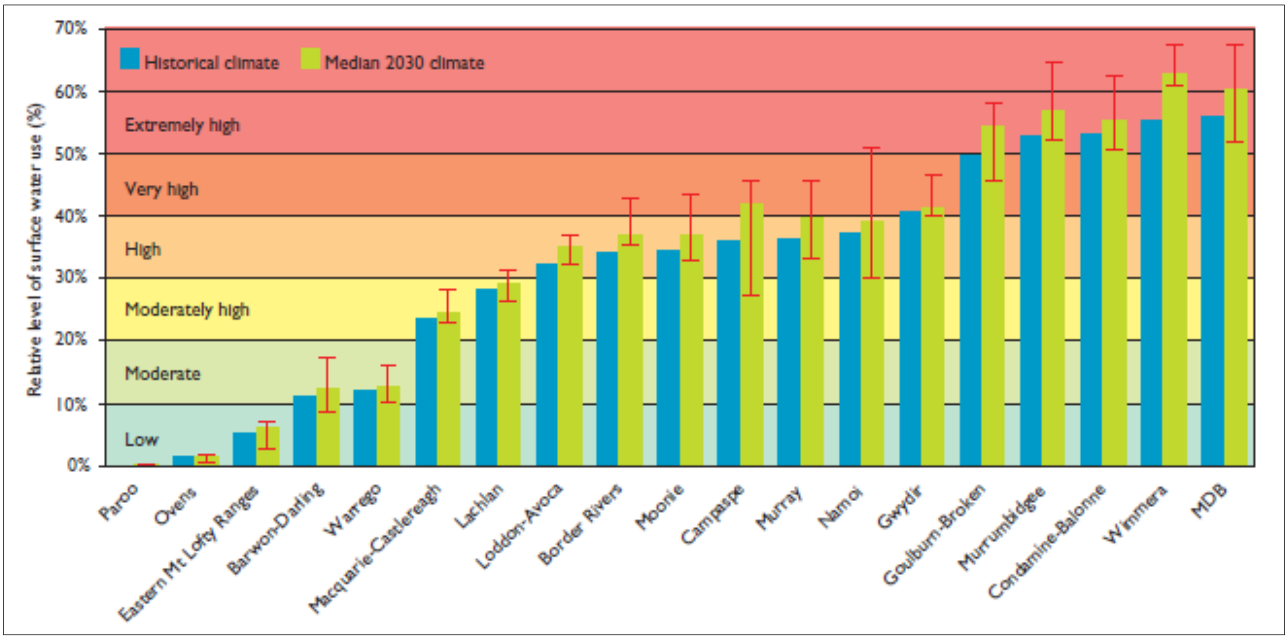

Figure 5-3: Relative level of surface water use for major basins across the Murray-Darling Basin under historic conditions and 2030 median climate change projections (with uncertainty range) (CSIRO, 2008)

The Flow Stress Ranking Project also classified the impact of water resource management on several waterways in the Wimmera River System and compared them to others across Victoria. These results have been discussed in Section 3.1.

Regional Fish Monitoring

Regional fish monitoring has been taking place since 2006 when SKM developed a methodology that involved determining the condition of parts of the Wimmera CMA region using a sampling method similar to that used in SRA assessments (SKM, 2006). The Wimmera River catchment was broken up into a number of ‘Waterway Health Management Units’ (WHMUs) for strategic planning purposes. The intention was that each WHMU that experienced regular streamflows would be sampled every three years. However, drought conditions meant the number of sites where monitoring could take place was limited, resulting in considerable variation in the frequency some WHMUs were sampled. Reductions in funding mean that regional fish monitoring is no longer undertaken annually and happens at a much-reduced scale (i.e. and average of less than one WHMU rather than three sampled a year). There is value in continuing this program to assist with catchment condition reporting and monitoring the impacts of environmental water releases although WHMUs are no longer used for planning purposes.

Figure 5-4 shows the locations of fish monitoring sites within the area covered by this EWMP, Table 5-18 shows (Wimmera CMA, 2024) and Table 5-19 shows a summary of data following analysis of results from 2005-2010 (SKM, 2010). The condition of the fish population in each WHMU is classified based on the proportion of native species compared to exotic in terms of abundance, diversity and biomass. Using these monitoring sites, and to assist in recovery of aquatic biodiversity and to guide strategic management, environmental flow regimes, cost-effective investment and recovery of native fish in the Wimmera region, the CMA commissioned a Native Fish Management Plan to be developed for the Wimmera Region (ARI, 2022).

Since 2009, VEFMAP fish monitoring has taken place at 12 sites along the Reach 3 and 4 of the Wimmera River capturing the fish condition during drought conditions, and also after more consistent environmental flow releases from 2010-11 onwards.

The latest results from VEFMAP Stage 6 (ARI, 2020) can be found here.

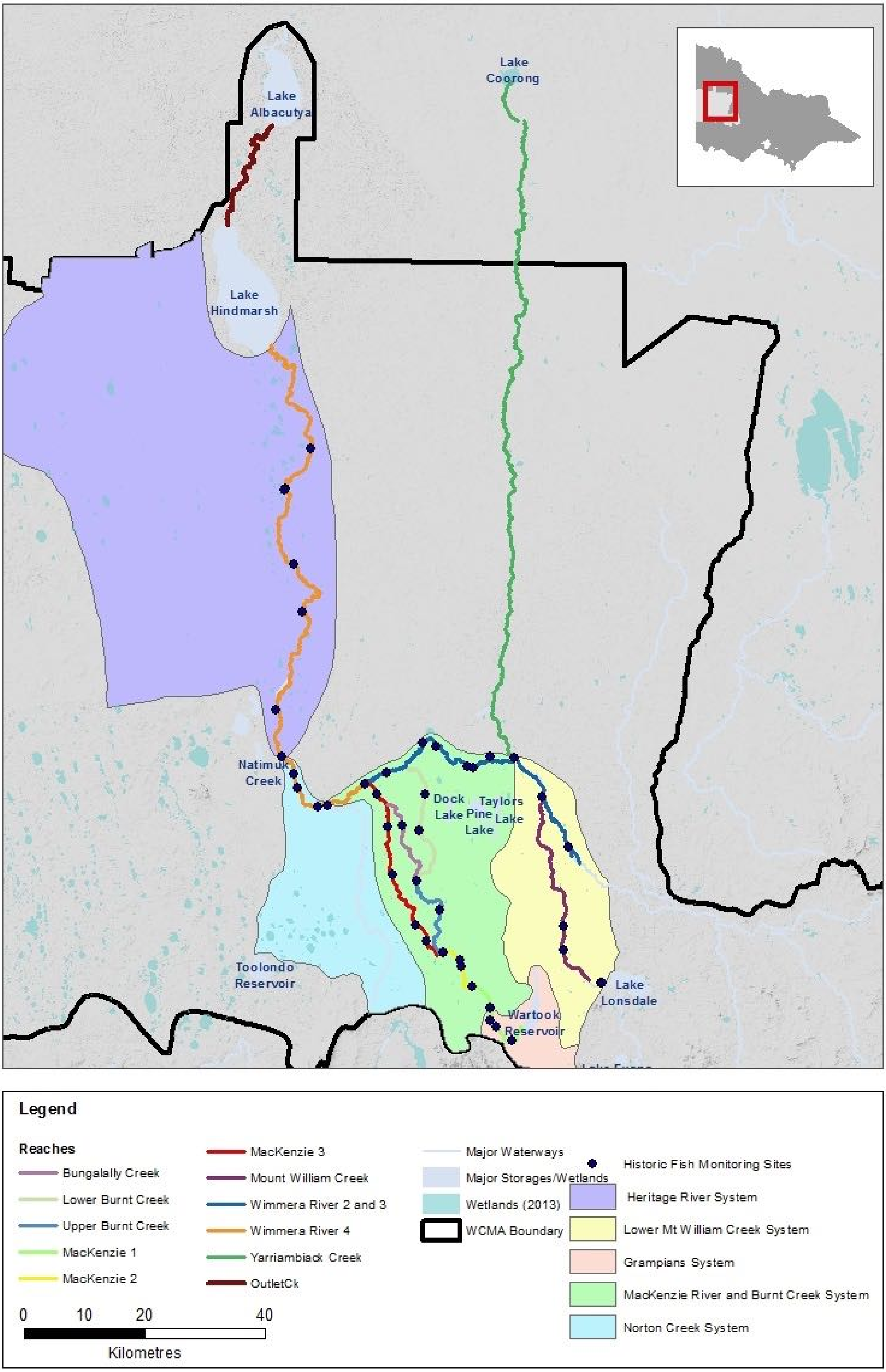

Figure 5-4: Regional fish monitoring sites within the Wimmera River system (SKM, 2010)* –

**Note this map from 2010 does not include data from Yarriambiack Creek.*

Table 5-18: Fish monitoring data (abundance) for WHMUs included in this EWMP (Source: Wimmera CMA, 2024)

LOCATION	SUM OF TOTAL FISH ABUNDANCE	SUM OF NATIVE	SUM OF EXOTIC	SUM OF NATIVE NOT ENDEMIC TO THE WIMMERA
Glenlofty Creek	**315**	**315**	**0**	**0**
2011	315	315	0	0
Glenpatrick Creek	**103**	**103**	**0**	**0**
2011	103	103	0	0
Mt Cole Creek	**838**	**838**	**0**	**0**
2011	123	123	0	0
2020				
2021				
2023	715	715	0	0
Mt William Creek	**2159**	**1288**	**871**	**0**
2006	407	263	144	0
2008	500	308	192	0
2012	829	778	51	
2015	605	395	210	0
2019	81	49	32	0
2020	363	76	287	0
2023	203	197	6	0
Wimmera River	**6143**	**3742**	**2334**	**67**
2011	993	202	777	14
2011	608	585	20	3
2012	670	163	485	22
2014	1348	1033	304	11
2015	118	67	51	0
2016	1852	1406	443	3
2020	229	51	174	4
2021	37	32	0	5
2022	40	39	0	1
2023	248	164	80	4
Yarriambiack Creek	**232**	**43**	**187**	**2**
2020	232	43	187	2
Norton Creek	**43**	**8**	**35**	**0**
2020	43	8	35	0
Grand Total	**9833**	**6337**	**3427**	**69**

Table 5-19: Fish monitoring data (species numbers) for WHMUs included in this EWMP (SKM, 2010)

WHMU	LOWER MT WILLIAM CK (INC. REACH 2 WIMMERA RIVER		MACKENZIE AND BURNT LOWER (INC. REACH 3 WIMMERA RIVER)			NORTON CREEK (INC. REACH 4 WIMMERA RIVER)				HERITAGE RIVER (INC. REACH 4 WIMMERA RIVER)			
Year	2006	2008	2008	2009	2010	2006	2008	2009	2010	2005	2007	2009	2010
#Native Species	4	5	4	5	4	4	3	2	3	6	2	2	4
#Exotic Species	5	5	4	4	4	3	4	1	4	4	3	1	4
Total Species	9	10	8	9	8	7	7	3	7	10	5	3	8
Condition	Fair	Fair	Poor	Poor	Poor	Fair	Poor	Poor/ HD	Poor	Fair	Poor	HD*	Poor

*HD: Highly Degraded

Figure 5-5: Fish monitoring in the lower Wimmera River at Big Bend

Regional Macroinvertebrate Monitoring

Macroinvertebrate monitoring was undertaken from 2005-2012 like the regional fish monitoring project, to detect trends in catchment condition. Although additional sites were included periodically to determine the impact of environmental water releases on macroinvertebrates. Like the regional fish monitoring program, it covered the shift in conditions from drought to floods. It used Rapid Biological Assessment (RBA) techniques and, in a number of years was able to complement RBA data collected by EPA as part of their statewide monitoring program. The extent and frequency of macroinvertebrate monitoring both locally and across the state has decreased significantly due to reduced funding, and there has been no macroinvertebrate monitoring since 2012. Figure 5-6 illustrates the distribution of macroinvertebrate monitoring sites in the area covered by this EWMP. The number of times a site was monitored depended on Wimmera CMA and EPA resourcing as well as whether or not the site held surface water.

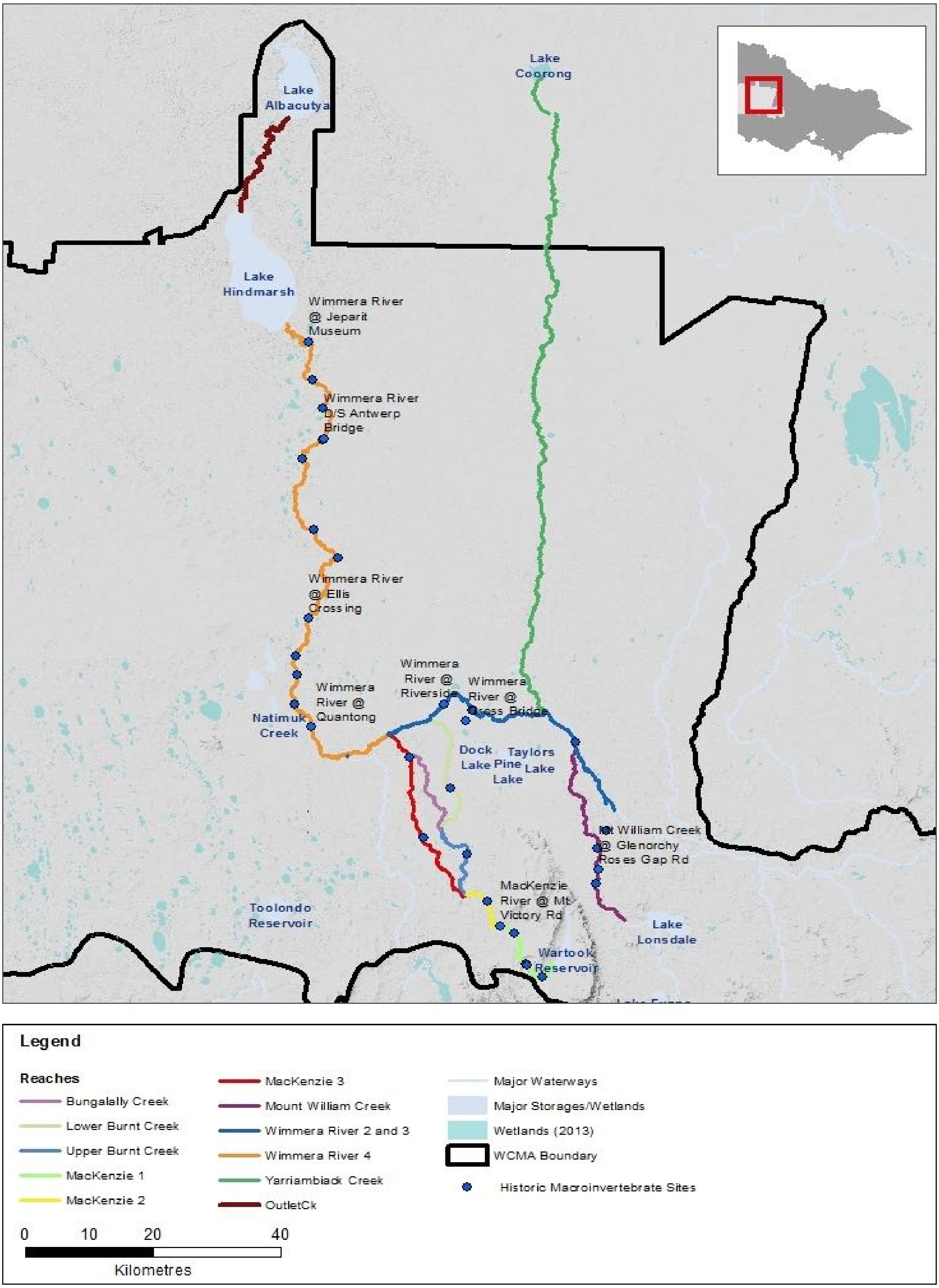

Figure 5-6: Macroinvertebrate monitoring sites within the area covered by this EWMP

Macroinvertebrate monitoring has provided very useful insight into the decline in waterway condition during drought (e.g. EPA (2008)) as well as their recovery following wetter years in 2010 and 2011 (e.g. WEC (2012)).

Figure 5-7 highlights the dramatic increase in number of taxa for Reach 4 of the Wimmera River as flows have been more regular and enduring. The improvement at this site was the most drastic across the region given the depauperate macroinvertebrate community monitored during the drought. However, it was still only classified as being in 'poor' condition based on the Macroinvertebrate Biotic Index (MBI). MBI classifications for the latest regional macroinvertebrate sampling program are in Table 5-20 indicating that conditions of macroinvertebrate communities are highly variable across the Wimmera River sites although there was improvement due to increased flows following drought conditions.

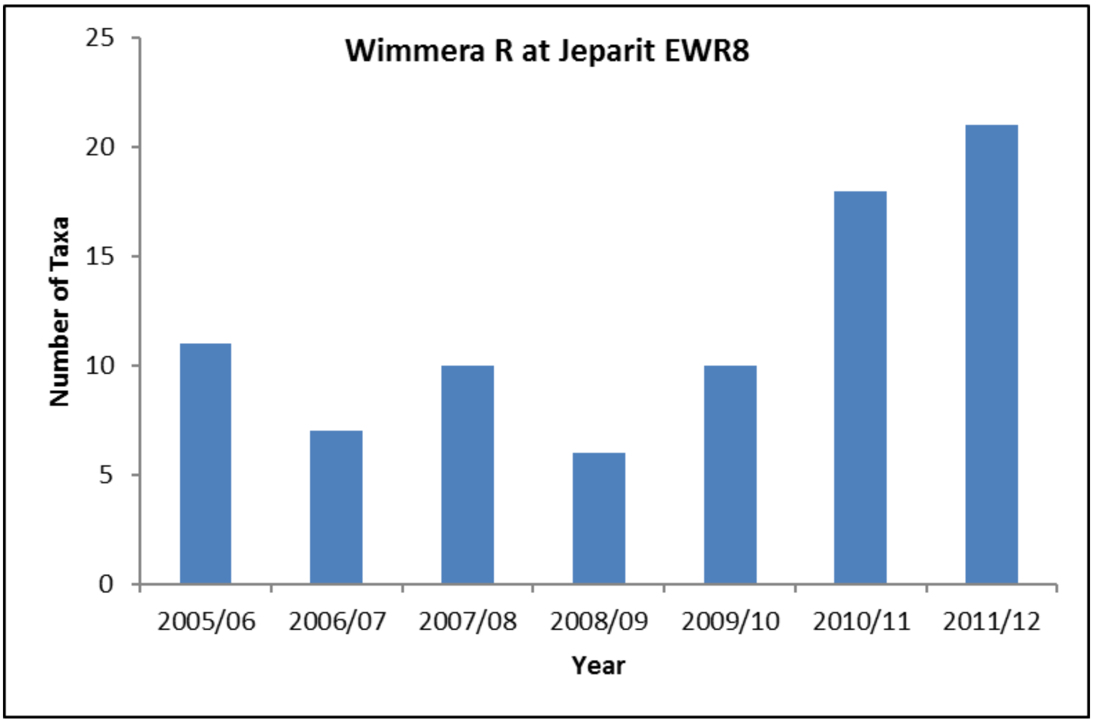

Figure 5-7: Graph showing the positive response of macroinvertebrates to wetter conditions in 2010 and 2011 at the Wimmera River at Jeparit (source: WEC (2012))

Table 5-20: MBI scores and ratings 2011/12 and 2008/09 – locations shown in Figure 5-6 (Source: WEC (2012 & 2009))

REACH	SITE NAME	MBI SCORE AND RATING 2011/12		MBI SCORE AND RATING 2008/09	
Reach 3 Wimmera River	Riverside	7	Moderate	5	Moderate
	Gross' Bridge	5	Moderate	NA	NA
Reach 4 Wimmera River	Ellis Crossing	8	Good	1	Very Poor
	Jeparit Museum	4	Poor	1	Very Poor
	Quantong	5	Moderate	5	Moderate
	Downstream Antwerp Bridge	4	Poor	1	Very Poor

Vegetation monitoring

Under the Victorian Environmental Flows Monitoring and Assessment Program (VEFMAP), vegetation is monitored for responses to environmental flows released from impoundments on eight major streams across Victoria. The Wimmera CMA established vegetation monitoring at five sites, and monitoring at 10 sites for the health of river red gums (*Eucalyptus camaldulensis*). The five sites included one on the MacKenzie River and four on the Wimmera River (at Gross Bridge, Polkemmet, Big Bend and Wundersitz). River red gum monitoring sites were all on the Wimmera River.

In 2023 Ecology Australia was commissioned to conduct the fifth round of vegetation and tree health monitoring. At each of the five vegetation sites quadrat data were collected at 1 metre intervals on 15 transects spanning the streams, with vegetation in a total of 1,407 quadrats being recorded.

Generally, the vegetation was found to be in a highly degraded state (Ecology Australia, 2023), largely attributed to the high exotic annual and perennial grass cover at each site. Additionally, a large proportion of flora species recorded were exotic. A substantial increase in recruitment of woody species since the last monitoring period was also evident, likely attributable to the recent high rainfall and widespread flood events that had occurred over the last two spring/summer periods 2022/23. A total of seven threatened flora species were identified within quadrats, including two which had not previously been recorded within the study area; pale-flower crane's-bill *Geranium sp*. and Mallee annual-bluebell *Wahlenbergia tumidifructa*.

In total 281 river red-gum trees were also scored for health (on a 1-5 scale) at the 10 sites. Thirty percent of the trees were deemed to be in good health, while 47% were found to be dead, with most recorded as long-dead, presumably from the Millennium Drought. Only two trees had died since the previous monitoring period in 2014. Results from this round of vegetation monitoring have also shown that the percentage of dead branches recorded has either stayed stable or decreased since 2014. When compared with monitoring data from 2009, the percentage of dead branches has fluctuated substantially. Similarly, the amount of epicormic growth recorded across surveys since 2009 have also varied considerably.

While these indicators suggest tree canopy health has fluctuated, a reduction in the percentage of trees recorded with moderate health and a concurrent increase in healthy trees suggest overall tree health has improved. It is also suggested that improvement is most likely due to increased water availability following the end of the Millennium Drought and subsequent recent wetter years and flood events (Ecology Australia, 2023). However, without accurate data on the amount of water available to the trees at the study sites or data on how tree condition has changed following environmental water delivery, it was not possible to attribute these changes to environmental water delivery or naturally occurring weather events.

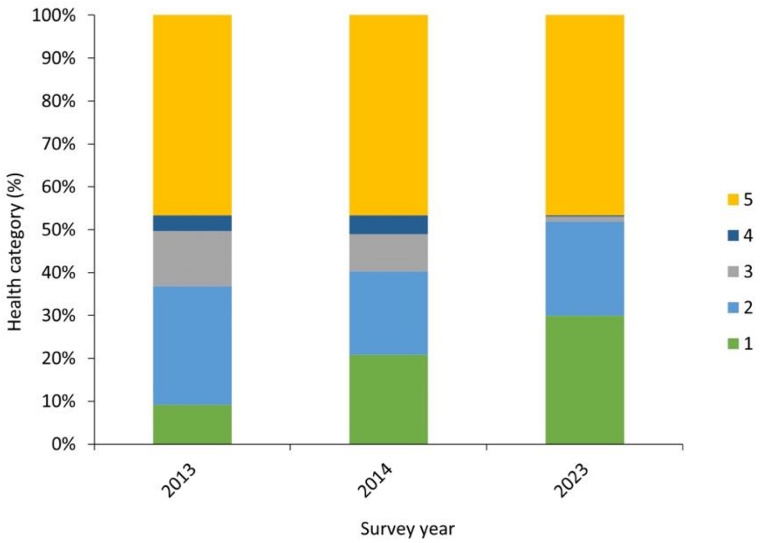

Figure 5-8: Percentage of trees assessed falling within each health score category (1 = good – 5 = dead across monitoring years[13], river red gum canopy health monitoring transects (Source: Ecology Australia, 2023)

[13] Health category score data was not collected in years 2007 – 2010.

Figure 5-9: Wimmera River at Dimboola, July 2023

Large Woody Debris

Much of the Wimmera River contains good physical habitat values. Historically, de-snagging took place on the reach of the Wimmera River upstream of Horsham to Longerenong. In town weir pools large woody debris was once removed as it posed a safety risk for various boating activities. However typically now it is moved to be close to and parallel with the bank to provide habitat values whilst also minimising risks to recreational users of these waterways.

Whilst there has been some historic tree clearing in riparian areas in much of the Wimmera River, they remain largely intact and over time fringing River Red Gums will fall into the waterway to provide additional habitat. This was particularly noticeable in 2009-10 when water returned to much of the Wimmera River and streambanks were wetted up, which triggered the fall of a number of large trees into the river.

The 2010 Index of Stream Condition (ISC) assessment indicated that large woody habitat was depleted in the Wimmera River system with average scores of 1 out of 5 for the Wimmera River and Yarriambiack Creek. However, Wimmera CMA believes that the assumptions used in calculating reference large woody debris quantities to benchmark against in the Wimmera means the scores are lower than should be the case. That being said some areas such as the Wimmera River downstream of Jeparit Weir are very depauperate when it comes to woody habitat.

Synthesis

The information presented around the current condition of the Wimmera River, Mount William Creek and terminal lakes, illustrates the increasing impacts of threats like water extraction, poor water quality and exotic flora and fauna towards the end of the Wimmera River. Native fish and vegetation assemblages become increasingly dominated by exotic species moving from the MacKenzie River and Mt William Creeks towards the Wimmera River. Issues such as a lack of flow and poor water quality manifest themselves strongly in

Reach 4 of the Wimmera River which in turn also affects macroinvertebrate diversity. However, the terminal lakes remain remarkably resilient despite the severe impact upstream river regulation and ongoing dry conditions have had on their hydrological regime.

WATER DEPENDENT THREATS

Exotic species

Exotic species are a major threat to native flora and fauna in the Wimmera River, Mount William Creek and terminal lakes including Dock Lake. Redfin are voracious predators of small-bodied native fish as well as frogs and tadpoles with monitoring showing that Southern Pygmy Perch were not found in remnant pools containing Redfin (SKM, 2007). They also carry the epizootic haematopoiestic necrosis virus (EHNV) which can be transferred to native species like Obscure Galaxias (SKM, 2007). Eastern Gambusia (*Gambusia holbrooki*) are widespread throughout the Wimmera River System and have been noted to predate on macroinvertebrate and frog eggs as well as out-competing small-bodied native fish for habitat and resources. Their aggressive behaviour such as fin-nipping and biting means other species such as Southern Pygmy Perch and Australian Smelt cannot co-exist with Gambusia.

Common Carp, along with Tench (*Tinca tinca*) and Goldfish are found throughout much of the Wimmera River. These species impact on the Wimmera River through their feeding behaviour of ingesting sediment and filtering out food which in turn prevents the growth of instream vegetation through disturbance and the increased turbidity reduces light penetration and nutrient mobilisation (SKM, 2007). Carp constitutes most of the biomass of fish in the Wimmera River (SKM, 2010) and fish kills and mass aggregations of carp have taken place during dry conditions. There was the capture of a single Roach in 2018 as part of the Angler Report Card fish surveys.

With respect to exotic or overabundant native aquatic and riparian vegetation, there are no species such as Willows (*Salix spp.*) or Azolla (*Azolla spp.*) currently within or along the Wimmera River that would be advantaged by environmental flows, threatening environmental values. Although there can be large beds of Azolla in the Burnt Creek in Horsham, the main risk to overabundant growth of azolla is the scouring effects of floods favouring recolonization by annual species who take advantage of the disturbance (SMEC, 2011) rather than environmental flow releases. Stormwater collection dams in newer housing established around Horsham can be impacted by Azolla, which has also impacted the Lower Burnt Creek when releases occur from the dams.

Recreation

The Wimmera River and terminal lakes are very popular for recreational activities. Fishing is managed by the Victorian Fisheries Authority (VFA) who undertake regulation and stocking to maintain and enhance fish populations as well as other activities specified in the Wimmera Fishery Management Plan (DPI, 2009) such as raising awareness of responsible conduct with respect to fishing. This is intended to reduce the threat around overfishing as well as damage to riparian areas by anglers. This will be supported by the Wimmera Native Fish Management Plan (ARI, 2022).

Water-skiing is only allowed in the terminal lakes and weir pools under conditions established by waterway managers declared by the Minister for Ports. For the Wimmera River this is typically regulated by local councils although DEECA is the waterway manager for Lake Albacutya. Wimmera CMA works with councils to ensure that water skiing is regulated to minimise impacts on riverbanks and riparian vegetation.

WATER QUALITY

Water quality is highly variable within the Wimmera River and terminal lakes depending on the water source and flow regime. Wimmera Waterway Monitoring Assessment Project 2007-2008 (Ecowise Environmental, 2008) involved a detailed analysis of the comprehensive physico-chemical water quality monitoring program that involved monthly sampling at a number of sites across the catchment from 2003-2008. The program included a number of sites within the Wimmera River and recommendations for a more strategic monitoring program. The implementation of this monitoring since 2008 provides an ongoing valuable water quality dataset the complements water quality monitoring at a number of streamflow gauging stations (Table 4-2).

Mt William Creek straddles agricultural land in the east and national park in the west and so its water quality is highly variable depending on the prevailing source of runoff. During dry to average conditions, the rocky escarpments of the Grampians is the source of most runoff entering the creek. Whilst streamflows under these conditions are generally insufficient to travel the entire length of the upper Mt William Creek into Lake Lonsdale, there can be flows along the lower Mt William Creek and water quality is comparatively good (low salinity and turbidity).

During wet conditions, when Lake Lonsdale receives significant inflows from the entire upper Mt William Creek catchment (thousands of megalitres), it is subsequently used to provide environmental water releases. Water quality is poorer than when runoff was just from the Grampians (for example salinities up to 3000 μS/cm although more typically 500 μS/cm to 2000 μS/cm) although temperature is not an issue due to it being a very shallow storage. The Mt William Creek is also prone to long cease to flow periods which in turn leads to diminishing water quality, in particular elevated salinity levels. Lake Lonsdale is also predisposed to Blue Green Algae blooms with the lake regularly tested for algal blooms given its shallow water levels, high nutrient levels and lack of throughflow. The lower Mt William Creek has also been noted to experience elevated counts of Blue Green Algae when there has been blooms in Lake Lonsdale.

Flows from the upper Wimmera River tend to be of a very poor quality water, rarely meeting the Environment Reference Standards (ERS) for all parameters except pH. There are pronounced salinity impacts in tributaries flowing into the upper Wimmera River with salinities of typically 2000 μS/cm - 8000 μS/cm during low or no flow conditions. Therefore, when wet conditions occur the salinity impacts are spread further down the river although they are diluted in higher flows. Environmental water releases from Lake Lonsdale via the Mt William Creek tend to also be reasonably saline. However environmental water releases from Taylor’s Lake are of higher quality with salinity levels under 1000 μS/cm and low turbidity. Therefore, water quality levels are highest during periods when there are ongoing environmental water releases from Taylor’s Lake rather than during unregulated/passing flows.

The Wimmera River is also susceptible to Blue Green Algal blooms with blooms monitored in Taylors Lake, Horsham Weir Pool and Dimboola Weir Pool.

Victorian Water Quality Trends 1991-2010 (DEPI, 2013) provides detailed results and analysis for water quality parameters including salinity, turbidity, pH, dissolved oxygen and nutrients several sites on the Wimmera River including at Horsham.

No information on water quality was available for the update of the terminal lakes environmental water recommendations (Jacobs, 2019), however salinity impacts on the lake bed and fringing vegetation were considered to be potentially limiting factors in improved condition of these values.

Dock Lake has historically experienced very high salinity making it unsuitable for irrigation supply. When the flows study was undertaken in 2015 it had been dry for 15 years, which raised a number of issues for water quality if environmental watering or natural inundation was to occur:

1. Large amounts of vegetation built up on the bed of the lake would decompose following rewetting resulting in bacterial activity and consumption of oxygen. This could result in anoxic conditions and cause animal kills and under the worst conditions the development of noxious tastes and odours.
2. Excessive algal growth fuelled by the regeneration of nutrients previously tied up in dead plant material.
3. Excessive salinity requiring monitoring during filling and throughout the inundation period.

5.4 TRAJECTORY OF CHANGE

What was experienced during the past 20 years provides a valuable insight into what would happen should environmental water not be provided to the Wimmera River and terminal lakes into the future. The impacts would be further exacerbated under climate change scenarios which indicate that winter/spring rainfall (and subsequent runoff into waterways) will be much reduced.

Without environmental water most reaches would only flow in years when rainfall was well above average which would lead to drastic declines in the condition of many of the values including the likely loss of fish communities from many of these waterways. Lowland fish communities would be restricted to unregulated tributaries of the Wimmera River System as well as deep remnant pools that could retain sufficient water to endure a sequence of years with no flow.

Macroinvertebrate populations and riparian vegetation condition would decline, and channels would be colonised or even blocked by River Red Gum saplings and emergent macrophytes such as Typha and Phragmites.

Cultural values would be impacted by the death and/or decline of scar trees in riparian areas. Townships would suffer from the loss of amenity and recreation opportunities and fish deaths and algal blooms would be more prevalent. During the drought, odours from the hypersaline water in the Wimmera River next to Jeparit affected quality of life for the town's residents. Without environmental watering, incidents such as these would occur more frequently.

Occasionally floods would still make their way along these waterways, providing a brief period of respite for fish and other water-dependent vertebrate species and triggering various ecological processes (Section 4.4). However, the lack of baseflows and freshes following these flood events would limit the success of recruitment events for fish and aquatic vegetation.

6 Managing water-related threats

A qualitative risk assessment has been undertaken to assign the level of long-term risk to achieving the ecological objectives for the Wimmera River system as well as risks related to the delivery of environmental water through the implementation of this EWMP. The relationship between likelihood (probability of occurrence) and the severity (severity of impact) provides the basis for evaluating the level of risk (Table 6-1). This risk matrix (as well as the definitions as to consequences) are taken from Victorian Environmental Watering Partnership Risk Management Framework (RMCG, 2014).

Table 6-1: Risk matrix (derived from RMCG (2014))

		Consequences				
		Extreme	Major	Moderate	Minor	Negligible
Likelihood	Almost Certain	Extreme	Extreme	High	Moderate	Low
	Likely	Extreme	Extreme	High	Moderate	Low
	Possible	Extreme	High	Moderate	Moderate	Low
	Unlikely	Extreme	High	Moderate	Low	Low
	Rare	High	Moderate	Low	Low	Low

Management measures are recommended and the residual risk, assuming the measures have been successfully completed, is recalculated using the same matrix. It should be noted that risk management for the delivery of environmental water is undertaken on an annual basis through the development of the Wimmera River and terminal lakes Seasonal Watering Proposal developed by the Wimmera CMA in accordance with the guidelines provided by the Victorian Environmental Water Holder.

Table 6-2: Risk assessment and management measures for the Wimmera River, Yarriambiack and Mt William Creek, Dock Lake and terminal lakes system

THREAT	OUTCOME	RELEVANT OBJECTIVE	REACH(ES)	LIKELIHOOD	CONSEQUENCES	RISK	MANAGEMENT MEASURES	FEASIBILITY	RESIDUAL RISK
Threats to achieving ecological objectives									
1. Artificial instream structures (e.g. town weirs)	Water quality declines (salinity and dissolved oxygen) that impacts on fish, macroinvertebrate communities (fish deaths, loss of habitat) due to reduced flows if town weirs do not effectively pass flows	Water quality, fish, macroinvertebrates, aquatic and riparian vegetation	Wimmera 3 & 4	Possible	Major	High	Implement recommendations regarding weir management from Alluvium (2014)	Moderate	Moderate
	Impacts on ecological processes such as recolonisation, habitat utilisation and dispersal	Fish, platypus, aquatic and riparian vegetation	All	Almost certain	Moderate	High	Use fishways effectively, provide high flows that drown out structures	Medium	Moderate
	Water quality declines as hypersaline water is trapped at the base of town weirs, especially if they are mobilised when weir boards are removed.	Water quality	Wimmera 4	Likely	Minor	Moderate	Upgrade weirs subject to funding	Low	Low
2. Saline groundwater intrusion	Water quality declines due to ongoing intrusion of hypersaline water into deep pools (Longerenong to Antwerp) and channel banks (downstream of Antwerp). Water quality declines reduce conditions suitable for a diversity of fish, macroinvertebrates and aquatic vegetation. The proximity of the groundwater to the surface also impacts on established floodplain vegetation through intersecting with roots.	Water quality, fish, macroinvertebrates, aquatic, riparian and floodplain vegetation	Wimmera 4	Almost certain	Extreme	Extreme	Implement actions prescribed in Wimmera River Saline Pools Project (AWE, 2014) around investigating regional groundwater influences	Low	Extreme
3. Recreational fishing	Freshwater Catfish and River Blackfish population declines through unsustainable levels of take	Fish	Wimmera 3 & 4 (Catfish), Lwr Mt William (Blackfish)	Unlikely	Major	High	Continue to work with anglers to highlight the risks to fish population.	High	Low
							Enforce angling regulations.	High	
4. Grazing pressures	Unrestricted grazing leads to impacts such as the consumption of aquatic, floodplain and riparian vegetation in particular grasses, herbs and juvenile woody vegetation. This in turn leads to reductions in habitat and water quality (increased erosion) affecting fish and macroinvertebrate populations.	Water quality, fish, macroinvertebrates, aquatic, floodplain and riparian vegetation	All (in isolated sections)	Almost certain	Moderate	High	Implement management activities in Victorian Waterway Management Strategy and WWS around improving management of riparian areas through such actions as ensuring licence conditions are being complied with.	High	Moderate
5. Carp/Goldfish/ Tench	The 'mumbling' feeding behaviour of Carp impacts on vegetation through disturbance of seeds/seedlings as well increasing turbidity which limits light penetration for photosynthesis.	Water quality, fish, macro-invertebrates, aquatic vegetation	All	Almost certain	Extreme	Extreme	Implement management activities in WWS intended to prevent the dispersal of carp as well as increase understanding of their movement and behaviour in the Wimmera River. Support initiatives such as the Koi Herpes Virus and Daughterless Carp gene technology.	Low	Extreme

THREAT	OUTCOME	RELEVANT OBJECTIVE	REACH(ES)	LIKELIHOOD	CONSEQUENCES	RISK	MANAGEMENT MEASURES	FEASIBILITY	RESIDUAL RISK
6. Redfin/ Gambusia	Redfin impact on native fish communities through being voracious predators of small-bodied native fish as well as young large-bodied species. They also carry a disease that impacts on native species. Gambusia also impact on small-bodied native fish populations through aggressive behaviour (fin-nipping) and predating on fish and frog eggs.	Fish	All	Almost certain	Major	Extreme	Encourage a catch and take approach from anglers with respect to Redfin. Little can be done to mitigate the threat of these species.	Low	Extreme
7. Foxes	Foxes impact on Platypus, Rakali and Eastern Long-Necked Turtle populations through predation.	Platypus	All	Likely	Minor	Moderate	Implementing fox control actions as part of the Wimmera Invasive Plant and Animal Management Strategy (Wimmera CMA, 2010) (WIPAMS).	Moderate	Moderate
8. Weeds	Riparian and floodplain vegetation outcomes are threatened by invasive plant species such as Bridal Creeper, Boneseed, Blackberry, Perennial Veldt Grass and Cape Tulip through outcompeting and smothering native species.	Riparian and floodplain vegetation	All	Almost certain	Extreme	Extreme	Implement invasive plant management activities outlined in the WWS.	Low	Extreme
9. Rabbits	Rabbits impact on riparian and floodplain vegetation through consuming herbs, grasses and seedlings of woody species. They have been known to have prevented recruitment of species when at high densities including Cypress-Pine at Lake Albacutya.	Riparian and floodplain vegetation	All	Almost certain	Moderate	High	Implement invasive plant and animal management activities outlined in the WWS and WIPAMS.	High	Moderate
Threat related to the delivery of environmental water									
10. Mobilising hypersaline pools	Environmental water releases can mobilise hypersaline water and potentially without sufficient flows it will not be diluted and impact on downstream water quality and ecological values.	Water quality, fish, aquatic and riparian vegetation	Wimmera 4	Possible	Moderate	Moderate	Implement actions prescribed in Wimmera River Saline Pools Project (AWE, 2014) as well as undertake further analysis of flow thresholds understood to mobilise saline pools.	Moderate	Low
11. Releasing poor quality water	In a couple of cases environmental water being released is poorer quality than tributary inflows or environmental water released from another location. This in turn impacts on water quality outcomes through increased salinity and turbidity which affects aquatic vegetation, fish and macroinvertebrate communities.	Water quality, fish, aquatic and riparian vegetation	Lwr Mt William	Possible	Minor	Moderate	Investigate the impact of releases on ecological objectives.	High	Moderate
12. Growth of nuisance grass species	Rapid growth of plants as the lake dries and in the subsequent dry phase may pose a fire risk. Blown Grass is known to be present around Dock Lake and build ups of dead material have in the past been responsible for damaging fires.	All	Dock Lake	Possible	Moderate	Moderate	Develop Fire Management Plan in consultation with the relevant stakeholders.	High	Low
13. Aging and degrading infrastructure	Could cause interruptions to planned water releases.	All	All	Possible	Moderate	Moderate	Develop and implement an water asset management and maintenance plan with water management partners	High	Low

7 Management goals, objectives and targets

7.1 MANAGEMENT GOALS

The Wimmera Waterway Strategy 2014-2022 lists a number of long-term (20+ year) goals for the region's waterways. They were developed with community, partner and stakeholder feedback to inform the preparation of the Wimmera Waterway Strategy and these provide context for this EWMP. They are:

- Maintaining and improving the values and condition of waterways that have formally recognised significance (*WWS-G1*)
- Improve connectivity and condition along priority wetland systems and riparian corridors (*WWS-G2*)
- Improve water quality in priority areas for; water supply, environmental condition and recreation (*WWS-G3*)
- Waterways with high social, cultural and economic values are maintained in a state that continues to support those values in line with climatic conditions (*WWS-G4*).

The recently developed Wimmera RCS 2021 – 2027 also outlines a series of outcomes relevant to management of water for the environment:

20-year water theme outcomes (20Y-WO)

- The knowledge and experience of First Nations people is informing water planning, management and delivery in the Wimmera (*RCS-20Y-WO1*).
- The Wimmera Heritage River's values are maintained or improved (*RCS-20Y-WO2*).
- The connectivity and condition of native vegetation along riparian corridors are improved (*RCS-20Y-WO3*).
- Water quality is improved at important areas for water supply, environmental and recreational values (*RCS-20Y-WO4*).
- Rivers and streams with high environmental, social, cultural and economic values are improving their value despite climate change (*RCS-20Y-WO5*).

Six-year water theme outcomes (6Y-WO)

- Ongoing collaboration and two-way learning in river and stream planning and management by supporting and strengthening partnerships with First Nations people (*RCS-6Y-WO1*).
- Recreational participation numbers on the Barringgi Gadyin (Wimmera River) are increasing (*RCS_6Y-WO2*).
- More river and stream reaches have improved management of and access for recreation (*RCS-6Y-WO3*).
- Healthier rivers and streams enable more on Country activities for First Nations people (*RCS-6Y-WO4*).
- Blue green algal blooms and fish deaths are prevented where possible in the Barringgi Gadyin (Wimmera River) (*RCS-6Y-WO5*).
- No new pest plants and animals are established beyond small, localised populations (*RCS-6Y-WO6*).
- More rivers and stream reaches have less stock access (*RCS-6Y-WO7*).
- More reaches have improved riparian width and connectivity (*RCS-6Y-WO8*).
- More river reaches are permanently protected through management agreements (*RCS-6Y-WO9*).
- Drought refuges are protected and retain water during drought (*RCS-6Y-WO10*).
- Net rates of streamflow interception are stabilising (*RCS-6Y-WO11*).
- Native fish and platypus are increasing their abundance and distribution (*RCS-6Y-WO12*).

- Native fish numbers are greater than carp numbers in most fish surveys and fishing competitions (*RCS-6Y-WO13*).

The management goal for the Wimmera River and terminal lakes EWMP aligns with these outcomes.

> *"Environmental water will maintain and enhance the condition of the Wimmera River and terminal lakes to support its formally recognised status, its role in providing connectivity for flora, fauna, carbon and nutrients as well as maintaining its strong environmental values. This includes diverse, abundant and resilient native fish and vegetation communities, geomorphic diversity, sustainable platypus population and mitigated impacts of poor water quality."*

Environmental watering of the regulated reaches of the Wimmera River and terminal lakes will be a critical plank in achieving this goal as well as being an important part of the 50-year visions of the Wimmera RCS (2021-2027) and the 2013 Victorian Waterway Management Strategy that are listed as follows:

> *"A healthy Wimmera catchment where a resilient landscape supports a sustainable and profitable community. (Wimmera CMA, 2021)."*
>
> *"Victoria's rivers, estuaries and wetlands are healthy and well-managed; supporting environmental, social, cultural and economic values that are able to be enjoyed by all communities (DEPI, 2013)."*

Specific ecological objectives that underpin the achievement of these long-term goals and visions are outlined in Section 6.1.

7.2 ENVIRONMENTAL OBJECTIVES AND TARGETS

WIMMERA RIVER AND MOUNT WILLIAM CREEK

In 2002, ecological objectives were developed by an expert panel in consultation with Wimmera CMA staff for the Wimmera River in the Stressed Rivers Project – Environmental Flow Study Wimmera River System (SKM, 2002). In 2003, this was expanded to other regulated reaches in the Wimmera Bulk Entitlement Conversion Environmental Flows Study (SKM, 2003). Following this the Mt William Creek above Lake Lonsdale was considered in the Environmental Flow Recommendations for Mt William Creek (SKM, 2003). These studies in 2002 and 2003 were some of the first environmental flow studies undertaken in Victoria.

Since then, there have been advances in the methodology for determining environmental flow requirements and in understanding the ecological condition (e.g. through monitoring projects) of rivers in Victoria. These advances warranted a comprehensive review and updating of these objectives and the required flow regimes. This was undertaken in the Wimmera River Environmental Flows Study (Alluvium, 2013).

Instead of the ecological objectives being solely determined by scientists and waterway managers, FLOWS Edition 2 (DEPI, 2013) recommends the involvement of a Project Advisory Group involving community and agency representatives in terms of providing a level of endorsement of the ecological objectives. In this case, instead of a new group being established, the objectives developed by Alluvium and Wimmera CMA staff were endorsed by the Wimmera CMA's Rivers and Streams Advisory Committee which comprises community and agency representatives (Section 1.3).

The review investigated the available monitoring data (e.g. in terms of plant, fish and macroinvertebrate species and platypus distribution as well as geomorphology and water quality data) to determine where certain objectives are feasible. The objectives have been refined to ensure that they are feasible and measurable and are listed in Table 7-1.

Table 7-1: Ecological objectives for the Wimmera River and Mount William Creek

Ecological Value	Long-Term Overarching Ecological Objective	Target Ecological Objective	RCS Outcomes WWS Goals	Rationale
Native fish	1. Improve the abundance, movement and species richness of native fish species.	Freshwater Catfish (Wimmera River reaches 2, 3, 4)	WWS-G2 WWS-G4 RCS-20Y-WO4 RCS-20Y-WO5 RCS-6Y-WO5 RCS-6Y-WO10 RCS-6Y-WO12 RCS-6Y-WO13	Freshwater Catfish are a threatened native fish species with very limited fragmented populations across Victoria, the Wimmera River contains one of the last self-sustaining populations. Several key species have restricted distribution in Mount William Creek and have been lost from reach 2 of the Wimmera River due to lack of flow, poor water quality and competition with exotic species – it is expected that the provision of environmental flows will enable recolonization of reach 2 and will maintain populations in Mount William Creek. Recreational fishing species are valued by the community.
Vegetation	2. Maintain the species richness and extent of in-channel aquatic vegetation, improve the abundance of aquatic vegetation 3. Improve the condition of riparian EVCs.	Instream and riparian vegetation in Wimmera River reaches 2, 3 and 4 and Mount William Creek	WWS-G2 RCS-20Y-WO3 RCS-20Y-WO5 RCS-6Y-WO4 RCS-6Y-WO8	Healthy and diverse aquatic, riparian and floodplain vegetation is critical for supporting fauna and contributing to carbon and nutrient cycling, maintaining character under Heritage River status and flood mitigation.
Habitat	4. Maintain the quality of geomorphic habitat (maintain channel form, clean substrates, prevent stream bed colonisation) 5. Improve longitudinal connectivity (between river reaches) to facilitate fish movement 6. Maintain refuges for native fish species (prevent loss of channel capacity through sedimentation) 7. Maintain adequate surface water salinity to enable growth and reproduction of aquatic vegetation.	Stream bed and channel of Wimmera River reaches 2, 3 and 4 and Mount William Creek	WWS-G2 WWS-G3 WWS-G4 RCS-20Y-WO4 RCS-20Y-WO5 RCS-6Y-WO4 RCS-6Y-WO5 RCS-6Y-WO8 RCS-6Y-WO10 RCS-6Y-WO12 RCS-6Y-WO13	Excessive sedimentation can fill pool habitat used by key aquatic species and reduces channel capacity increasing flooding issues. Colonisation by terrestrial species such as River Red Gum into the stream channel reduces channel capacity and diminishes recreational values.
Macro-invertebrates	8. Maintain macro-invertebrate diversity	Macro-invertebrates in reaches 2, 3 and 4	WWS-G3 RCS-20Y-WO4 RCS-6Y-WO5 RCS-6Y-WO10	Macroinvertebrates are a critical component of the food web, supporting a variety of aquatic fauna species.
Platypus	9. Improve habitat for Platypus and Rakali	Platypus and Rakali habitat in reaches 2 and 3 and Mount William Creek	WWS-G4 RCS-20Y-WO1 RCS-6Y-WO1 RCS-6Y-WO10	The Wimmera River historically supported a population of platypus, a key native species which is highly vulnerable in the Wimmera, which is now believed to be locally extinct. Habitat improvement will encourage recolonization of a Platypus population to the Wimmera River from the MacKenzie River and subsequent expansion.
Other	10. Maintain habitat for crayfish communities	Crayfish in Mount William Creek	WWS-G4 RCS-20Y-WO1 RCS-6Y-WO1	Mount William Creek supports a population of Western Swamp Crayfish which is a species of conservation significance.

TERMINAL LAKES

The ecological objectives for the terminal lakes of the Wimmera River were developed as part of The Environmental Water Needs of the Wimmera Terminal Lakes (Ecological Associates, 2004) and later updated in the Review of the Wimmera Terminal Lakes Environmental Water Requirements (Jacobs, 2019).

Table 7-2: Summary of ecological values, objectives and rationale for the terminal lakes of the Wimmera River (Jacobs, 2019)

Ecological Value	Long-Term Overarching Ecological Objective	Target Ecological Objective	RCS Outcomes WWS Goals	Rationale
Vegetation	1. Provide conditions suitable for the establishment and maintenance of vegetation in the lake bed zone representative of the wetted and dry phases of an episodically inundated wetland in a semi-arid environment. 2. Provide conditions suitable to maintain vegetation communities in fringing woodland zone	EVC 107 Lake Bed Herbland in lower terminal lakes (i.e. Lake Hindmarsh to Lake Brambruk) and fringing woodland of the lower terminal lakes and Outlet Creek	WWS-G1 WWS-G2 RCS-20Y-WO2 RCS-20Y-WO3 RCS-20Y-WO5 RCS-6Y-WO4	Supporting the persistence of seed banks of aquatic vegetation species will support a transformation to a productive wetland environment when water is present. Fringing vegetation communities including understory species provide aesthetic and amenity value, provide important food and habitat for a range of fauna including frogs, birds, reptiles and mammals.
Waterbirds	3. Support waterbird use of the terminal lakes system through improved access to feeding, roosting and breeding habitat during episodic filling of the lakes and provide extensive wetland habitat to support large populations of waterbirds in the lower terminal lakes in years when widespread natural flooding occurs.	Waterbirds in lower terminal lakes and Outlet Creek	WWS-G2 RCS-20Y-WO2 RCS-20Y-WO5 RCS-6Y-WO4 RCS-6Y-WO10	The terminal lakes provide extensive wetland habitat when widespread flooding occurs, but also can provide valuable waterbird habitat when lower volume inflows occur. This objective helps meet Ramsar criteria for Lake Albacutya – maintaining numbers of waterbirds including Freckled Duck, Banded Stilt and Australian Shoveler.
Woodland birds	4. Provide habitat and refuge for migratory and resident woodland bird species.	Birds utilising fringing woodland habitat including Regent Parrot	WWS-G1 WWS-G2 RCS-20Y-WO2 RCS-20Y-WO3 RCS-20Y-WO5 RCS-6Y-WO10	Inundation of the lakes can increase the condition and extent of fringing woodland vegetation, which provides habitat for woodland birds. The lake bed zone also provides food resources for woodland bird species in the dry phases.
Fish and macro-invertebrates	5. Promote biomass of macroinvertebrate and fish communities sufficient to provide food resources for waterbirds during wet phases.	All macroinvertebrate and fish species (particularly native species) within terminal lakes and Outlet Creek	WWS-G2 WWS-G3 RCS-20Y-WO4 RCS-20Y-WO5 RCS-6Y-WO5 RCS-6Y-WO10 RCS-6Y-WO12 RCS-6Y-WO13	Yabbies and fish (particularly Redfin Perch) have previously been present in the terminal lakes when they were inundated and are highly valued by the local community. Yabbies are likely to re-establish, however the fish community of the lakes would likely to be dominated by Carp.
Frogs and turtles	6. Support the opportunistic colonisation of wetland habitats and Outlet Creek during inundation events by frogs and turtles.	Frog and turtle species in terminal lakes and Outlet Creek including Burrowing Frogs, Marsh Frogs and Eastern Long-necked Turtle.	WWS-G4 RCS-20Y-WO4 RCS-6Y-WO5 RCS-6Y-WO10	Turtles may use inundated habitat at the terminal lakes but are not a high priority ecological objective.

Figure 7-1: Lake Albacutya, April 2009

Figure 7-2: Lake Hindmarsh at Four Mile Beach, November 2022

YARRIAMBIACK CREEK

There is no capacity to deliver regulated flows to Yarriambiack Creek although a proportion of flows in the Wimmera River pass into the Yarriambiack Creek. The environmental water requirements of Yarriambiack Creek and its terminal lakes can only be met by unregulated and passing flows.

Table 7-3: Summary of ecological values, objectives and rationale for Yarriambiack Creek

Ecological value	Long-term overarching ecological objective	RCS Outcomes WWS Goals	Rationale
Vegetation	Protect and restore riparian and floodplain EVCs.	WWS-G2 RCS-20Y-WO3 RCS-6Y-WO6	Healthy and diverse riparian and floodplain vegetation is critical for supporting fauna values and contributing to carbon and nutrient cycling. Important for preventing excessive erosion and also plays a role in flood mitigation.
Geomorphology	Maintain habitat values through prevention of stream-bed colonisation by terrestrial species.	WWS-G4 RCS-20Y-WO5 RCS-6Y-WO6	During periods of no or severely reduced flow species like River Red Gum colonise the base of waterways which in turn affects channel shape and capacity as well as diminishing some recreational values.

DOCK LAKE

The ecological objectives for Dock Lake were developed as part of the Dock Lake FLOWS Study (Jacobs, 2015). There were no specific objectives written for native fish because it was found that inundation was not likely to be for sufficient duration to allow populations to establish. However, it was recognised that fish that are able to colonise Dock Lake from Green Lake during inundation would provide a valuable food resource for birds, and should not be excluded from entering Dock Lake from Green Lake during the filling stage. It was also found that the abundant and widespread Eastern Long-necked Turtle would likely be supported by Dock Lake whenever it is inundated.

Table 7-4: Summary of ecological values, objectives and rationale for Dock Lake (Jacobs, 2015)

Ecological value	Long-term overarching ecological objective	Target ecological objective	RCS Outcomes WWS Goals	Rationale
Vegetation	1. Return to a seasonal or intermittent wetting and drying cycle to encourage the establishment and maintenance of structurally and floristically diverse native vegetation.	Wetland vegetation in Dock Lake	WWS-G4 RCS-20Y-WO5 RSC-6Y-WO8	The low diversity and limited extent of fringing and submerged macrophytes associated with a deep, permanent waterbody may reduce the suitability of the lake for many frog species, which require vegetation for cover and for egg attachment sites. Also, waterbirds establish nests in long grasses surrounded by shallow water. A variable water regime would encourage a greater diversity of vegetation providing habitat and food resources to other biota.
Birds	2. Provide diverse habitat and foraging resources to a suite of birds by varying the water level in the lake over time.	All waterbirds in Dock Lake	WWS-G4 RCS-20Y-WO5 RSC-6Y-WO8	When inundated Dock Lake supports a wide range of birds, including some threatened species. Varying the water level will expose mud flats and create a greater range of micro-habitats to maximise foraging resources for birds to exploit. Shallowly inundated areas are used as nesting sites.
Frogs	3. Encourage the use of Dock Lake by common frog species at times of inundation.	Common frog species in Dock Lake	WWS-G4 RCS-20Y-WO5 RSC-6Y-WO8	Provision of habitat through inundation of Dock Lake will benefit the location population of frogs and will provide an important food resource for birds.
Macroinvertebrates and micro-invertebrates	4. Engage suitable habitats to attract and support an abundant and diverse community.	All species in Dock Lake	WWS-G4 RCS-20Y-WO5 RSC-6Y-WO8	Macroinvertebrates and micro-invertebrates provide an important part of the food web for many taxa including fish, frogs and birds.

8 Environmental water requirements and intended water regime

8.1 WATERING REQUIREMENTS AND INTENDED WATERING REGIMES

FLOW RECOMMENDATIONS FOR THE WIMMERA RIVER AND MOUNT WILLIAM CREEK

The water regimes required for achieving ecological objectives described in Section 7.2 were developed according to the FLOWS method for determining environmental water requirements in Victoria (DEPI, 2013) for the Wimmera River, Mount William Creek and terminal lakes. This approach makes allowance for seasonal conditions (drought to wet conditions) rather than recommending the same flow regime every year regardless of the prevailing climate. For example, during dry or drought conditions the recommended number and volume of freshes will be fewer than during average or wet conditions and cease to flow periods will be longer. Bankfull and overbank flows may only be recommended during average and/or wet periods. Ecological information (e.g. required frequency of recruitment events to maintain a species) still underpins the recommendations around the frequency of various flow components. Details of magnitude, timing, duration and frequency of each flow component for each reach are given in Table 8-1, Table 8-2 and Table 8-3, with the relevant ecological objectives documented. Recommended rates of rise and fall for flows greater than baseflows have also been developed to assist mitigating negative impacts such as riverbank slumping and fish stranding that could occur should flow rates vary too quickly.

These recommendations have been extracted as a subset of priorities to target in the next ten years. However, additional ecological objectives and flow recommendations may be targeted if the opportunity or need arises.

To meet the hydrological requirements of the Wimmera River and terminal lakes EWMP, flow recommendations have been set considering the following factors:

- The preferred timing of watering events
- The recommended duration for watering events
- The tolerable intervals between events (condition tolerances)
- The volume required to provide these events – per event / per season.

These flows studies are used as a guidance for environmental flows under ideal climate scenarios, with annual seasonal proposals developed six months ahead of planned delivery. With the accumulated knowledge of 10 years of environmental watering there is need to ensure future objectives, targets and outcomes are adaptable and outcome driven to meet conditions in the river at the time, rather than as a compliance tool. This could include, for example, watering when certain quality is declining, or delivery of freshes to coincide with known spawning requirements for fish or to meet the water requirements for habitat that promotes movement of regionally specific fauna.

There are a number of challenges that need to be addressed in order to achieve the desired ecological outcomes using water for the environment. These challenges include threats such as exotic species, instream infrastructure and system constraints, and saline groundwater intrusions. The risks associated with these threats are outlined and mitigation actions are prescribed.

- Availability of water for the environment is often less than the water needed to deliver the recommended flows. For example, most of the larger flow components (such as bankfull or overbank) cannot be delivered through regulated releases in most cases. Other factors (such as prohibitive channel losses and risks around inundation of private land) mean most of these releases are also not feasible. As a consequence, overbank flow recommendations will only be met by natural events.

- Infrastructure limits flows with suggested bank flows and overbank flows not achievable. Flows suggested in the studies would cause flooding and there are currently no agreements with landholders for this to occur. Any flows over 500 ML are not feasible under these conditions.
- Climate change and a drying climate also influences the use of the water for the environment. For example, the recent climatic water cycle has a seen a large rain event every six or so years that fills the headwork storages and causes minor to moderate flooding. Whilst this meets the larger flow components of the flow studies, management of the water is needed to occur between these high flow periods to ensure flows still meet the river's ecological requirements.
- If the river or tributaries are meeting optimal ecological requirements, planned flows for the period may be reduced for use in the upcoming season. The amount of water not used at the end of the financial year is carried over, for use in the upcoming season.

Table 8-1: Flow recommendations for Wimmera River and William Creek

FLOW COMPONENT	TIMING	MAGNITUDE	CLIMATIC SCENARIO	FREQUENCY	DURATION	OVERARCHING ENVIRONMENTAL OBJECTIVE	DETAILED ENVIRONMENTAL OBJECTIVE	SOURCE
Cease to flow	Dec-May	0 ML/d	Drought	As infrequently as possible	Less than 90 days in total	1,2,8,9,10	Ensure stress on environmental values is not exacerbated beyond the point of no return. Cease to flow periods should be concluded with fresh lasting at least 7 days duration.	Alluvium (2013)
			Dry					
			Average		Less than 30 days in total			
Baseflow	Any	5 ML/d or natural	All	Continuous	Continuous	1,2,4,5,7,8,9,10	Maintain edge habitats and shallow water habitat availability for macroinvertebrates and endemic fish and near-permanently inundated stream channel for riparian vegetation and prevent excessive instream terrestrial species growth.	
Freshes	Dec-May	20 ML/d	Drought	3 per period	3-7 days	1,4,5,6,7,8,9,10	Prevent water quality decline by flushing pools during low flows.	
			Dry	3 per period	4-7 days			
	Dec-May	30 ML/d	Average	3 per period	3-7 days	1,4,5,6,7,8,9,10	Provide variable flow during low flow season for macroinvertebrates (over wood debris to increase biofilm abundance as a food source), fish movement and to maintain water quality and diversity of habitat.	
			Wet	3 per period				
	Jun-Nov	100 ML/d	Drought	1 per period	3 days	1,4,5,6,7,8,9,10	Wet benches, entraining organic debris and promote diversity of habitat. Flush surface sediments from hard substrates to support macroinvertebrates.	
			Dry	3 per period	3 days			
			Average	5 per period	5 days			
			Wet	5 per period	7 days			
	Jun-Nov	500 ML/d	Dry	1 per period	1 day	1,4,5,6,7,8,9,10	Wets highest benches, entraining organic debris and promoting diversity of habitat.	
			Average	2 per period	2 days			
			Wet	3 per period	3 days			
			Wet	2 per period	3 days			
Bankfull*	Any	750 ML/d	Average	Natural	2 days	3,4,8	Inundate riparian vegetation to maintain condition and facilitate recruitment. Entrain organic debris in the channel to support macroinvertebrates. Maintain structural integrity of channel.	
			Wet	Natural	4 days			
Overbank*	Aug-Nov	1,500 ML/d	Wet	Natural	1 day	3,4,8	Inundate floodplain vegetation to maintain condition and facilitate recruitment of adult River Red Gums. Entrain organic debris from the floodplain to support macroinvertebrates. Maintain floodplain geomorphic features.	

***** *Please note that bankfull and overbank flows cannot be met with the release of water for the environment.*

Table 8-2: Environmental flow recommendations for the Wimmera River reaches 2 and 3

FLOW COMPONENT	TIMING	MAGNITUDE	CLIMATIC SCENARIO	FREQUENCY	DURATION	OVERARCHING ENVIRONMENTAL OBJECTIVE	DETAILED ENVIRONMENTAL OBJECTIVE	SOURCE
Cease to flow	Dec-May	0 ML/d	Drought	As infrequently as possible	Less than 21 days in total	1,2,8,9	Limits cease to flow to ensure stress on environmental values is not exacerbated beyond the point of return.	Alluvium (2013)
			Dry					
			Average		Less than 7 days in total			
Baseflow	Dec-May	10 ML/d or natural	All	Continuous	Continuous	1,2,4,5,7,8,9	Maintain edge habitats in deeper pools and runs, and shallow water habitat availability for macroinvertebrates and endemic fish. Maintains near-permanent inundated stream channel for riparian vegetation and to prevent excessive in-stream terrestrial species growth.	
	Jun-Nov	100 ML/d or natural	All	Continuous	Continuous	1,2,4,5,7,8,9	Prevent terrestrialisaton of the lower banks from invasive phragmites and provide increased flow and variability to support fish movement and diversity of habitat.	
Freshes	Dec-May	35-40 ML/d	Dry & drought	2 per period	3-7 days	1,4,5,6,7,8,9	Prevent terrestrialisation of the lower banks from invasive phragmites and provide increased flow and variability to support fish movement and diversity of habitat.	
	Dec-May	100 ML/d	Average	2 per period	2-7 days	1,4,5,6,7,8,9	Provide variable flow during low flow season for macroinvertebrates (over wood debris to increase biofilm abundance as a food source), fish movement and to maintain water quality and diversity of habitat	
			Wet	3 per period				
	Jun-Nov	400 ML/d	Drought	1 per period	1 day	1,4,5,6,7,8,9	Provide variable flow during high flow season for fish movement and to maintain water quality and diversity of habitat. Also flushes surface sediments from hard substrates for macroinvertebrates.	
			Dry	3 per period	2 days			
			Average	5 per period	3 days			
			Wet	5 per period	4 days			
	Jun-Nov	1,300 ML/d	Dry	1 per period	1 day	1,4,5,6,7,8,9	Wets benches, entraining organic debris and promoting diversity of habitat.	
			Average	2 per period	2 days			
			Wet	3 per period	3 days			
	Jun-Nov	2,600 ML/d	Average	1 per period	2 days	1,4,5,6,7,8,9	Disturbs algae/bacteria/organic biofilm present on rock or wood debris for macroinvertebrates. Wets higher benches entraining organic debris and promoting diversity of habitat.	
			Wet	2 per period	3 days			
Bankfull*	Any	4,000 ML/d	Average	1 per period or natural	2 days	3,4,8	Inundate riparian vegetation to maintain condition and facilitate recruitment. Entrain organic debris in the channel to support macroinvertebrates. Maintain structural integrity of channel.	
			Wet	1 per period				
Overbank*	Aug-Nov	8,000 ML/d	Wet	1 per period	1 day	3,4,8	Inundate floodplain to maintain condition of adult River Red Gums and facilitate recruitment. Entrain organic debris from the floodplain to support macroinvertebrates. Maintains floodplain geomorphic features.	

***** *Please note that bankfull and overbank flows cannot be met with the release of water for the environment.*

Table 8-3: Environmental flow recommendations for the Wimmera River reach 4

FLOW COMPONENT	TIMING	MAGNITUDE	CLIMATIC SCENARIO	FREQUENCY	DURATION	OVERARCHING ENVIRONMENTAL OBJECTIVE	DETAILED ENVIRONMENTAL OBJECTIVE	SOURCE
Cease to flow	Dec-May	0 ML/d	Drought	As infrequently as possible	Less than 21 days in total	1,2,8,9	Limits cease to flow to ensure stress on environmental values is not exacerbated beyond the point of return.	Alluvium (2013)
			Dry					
			Average		Less than 7 days in total			
Baseflow	Dec-May	15 ML/d or natural	All	Continuous	Continuous	1,2,4,5,7,8,9	Maintain edge habitats in deeper pools and runs, and shallow water habitat availability for macroinvertebrates and endemic fish. Maintains near-permanent inundated stream channel for riparian vegetation and to prevent excessive in stream terrestrial species growth.	
	Jun-Nov	30 ML/d	All	Continuous	Continuous	1,2,4,5,7,8,9	Provides flow variability to maintain diversity of habitats.	
Freshes	Dec-May	70 ML/d	Drought	1 per period	2-7 days	1,4,5,6,7,8,9	Prevent water quality decline by flushing pools during low flows. Provide variable flow during low flow season for macroinvertebrates (over wood debris to increase biofilm abundance as a food source), fish movement and to maintain water quality and diversity of habitat.	
			Dry	2 per period				
			Average	2 per period				
			Wet	3 per period				
	Jun-Nov	70 ML/d	Drought	1 per period	1 day	1,4,5,6,7,8,9	Increase the baseflow water depth to provide stimulus for fish movement (not required in drought years, frequently required in wet years). Provide flow variability to maintain water quality and diversity of fish habitats.	
			Dry	3 per period	2 days			
			Average	5 per period	3 days			
			Wet	5 per period	4 days			
	Jun-Nov	200 ML/d	Dry	1 per period	1 day	1,4,5,6,7,8,9	Wets lower benches, entraining organic debris and promoting diversity of habitat.	
			Average	2 per period	2 days			
			Wet	3 per period	3 days			
	Jun-Nov	1,300 ML/d	Average	1 per period	2 days	1,4,5,6,7,8,9	Flush surface sediments from hard substrates to support macroinvertebrates. Wets higher benches, entraining organic debris and promoting diversity of habitat.	
			Wet	2 per period	3 days			
Bankfull*	Any	2,000 ML/d	Average	1 per period, or natural	2 days	3,4,8	Inundate riparian vegetation to maintain condition and facilitate recruitment. Entrain organic debris in the channel to support macroinvertebrates. Maintain structural integrity of channel.	
			Wet	1 per period				
Overbank*	Aug-Nov	6,000 ML/d	Wet	1 per period or natural	1 day	3,4,8	Inundate riparian vegetation to maintain condition and facilitate recruitment. Entrain organic debris in the channel to support macroinvertebrates. Maintain floodplain geomorphic features.	

* *Please note that bankfull and overbank flows cannot be met with the release of water for the environment.*

WATER REQUIREMENTS FOR THE TERMINAL LAKES OF THE WIMMERA RIVER

As discussed in Section 5, the priority wetland values of the terminal lakes are the lake bed and fringing woodland vegetation that relies on periodic inundation, and the significant bird populations that can be supported when the lakes are inundated. Key to these ecological values is that the lakes provide suitable and productive habitat when inundated. This is related to the large extent of the suitable habitat, which allows a significant productive response following inundation. Smaller scale inflow events that result in short duration and shallow inundation events can also provide significant benefit to ecological values.

Providing refuge habitat in an otherwise semi-arid landscape is also beneficial for native fauna in both their dry and wetted phases. When flooded, the lakes and Outlet Creek will support wetland biodiversity values of national and international significance, with the scale of response increasing with the extent of flooding across the system.

The recommended frequency of inundation for wetland vegetation is based on EVC mapping and the associated preferred inundation regimes (Figure 8-1 and Figure 8-2). Table 8-6 summarises the inundation frequencies required to support target EVCs within the terminal lakes system.

It is proposed that the following process could be used to manage the allocation that benefits the lower end of system:

- If Lake Hindmarsh capacity is declining, Commonwealth environmental water (CEWH allocation) may be used to minimise cease-to-flow and then utilised to maintain the lower Wimmera River base flow that will allow for the possibility of any unregulated flows to enter Lake Hindmarsh.
- If Lake Hindmarsh is filled by unregulated flows and is starting to spill into Outlet Creek, CEWH allocation can be used to increase flows to allow water to possibly reach Lake Albacutya.
- If Lake Albacutya is filled, CEWH allocation can be utilised to maintain the level or if spilling increase flows beyond to other terminal lakes. This is appropriate given the CEWH's specific responsibilities regarding Australia's Ramsar obligations.

This is summarised in Table 8-4 below.

Table 8-4: Proposed process to manage CEWH allocation

CURRENT CONDITION OF LAKE HINDMARSH	PROPOSED PRIORITY USE OF CEWH ALLOCATION	OUTCOME
Lake Hindmarsh is below capacity and declining.	Flows used to minimise cease-to-flow duration and frequency. Maintain Wimmera River lower-stretches base flows to allow any unregulated flows to enter Lake Hindmarsh.	Lower stretches of the Wimmera River retain connectivity, better water quality and habitat benefits, which can benefit the end of system when unregulated flows occur.
Lake Hindmarsh is filled and spilling.	Flows used to increase flows down Outlet Creek, which connects lakes Hindmarsh and Albacutya.	Increase flow frequencies, duration and magnitudes further down towards Lake Albacutya.
Lake Albacutya is filled and spilling.	Flows used to maintain Lake Albacutya and other terminal lakes.	Ramsar outcomes met for Lake Albacutya.

Importantly, flows need to be delivered within the capacity of the Wimmera and Lower Mount William Creek to supply water (i.e. they cannot inundate private land, nor be delivered if doing so would threaten the values in the river itself). Delivery is also dependent on there being sufficient volumes held or expected to be held (based on GWMWater forecasts) to ensure critical values can be supported in the Wimmera River and Mount William Creek main channel.

The way the CEWH water is allocated on a very low reliability means the allocation is often not made until after the peak in a year's flow, which could result in CEWH deliveries not coming into play until the following year.

Table 8-5: Expected watering effects at Lake Hindmarsh

POTENTIAL ENVIRONMENTAL WATERING ACTION	EXPECTED WATERING EFFECTS
15-30 ML/day If a wet scenario occurs and Lake Hindmarsh is close to spilling from high unregulated flows, base flows in the Wimmera will not be reduced. The base flows will be used to increase flows as part of agreed objectives of the CEWH and VEWH Operations Advisory Group to allow water to enter Lake Albacutya. Possible high flows extended at the end of high natural flows to extend impact into the lakes. This aimed at reducing evaporation losses rather than maintain Lake levels (i.e. the annual evapotranspiration in the Wimmera catchment is approximately 400mm per year based on the post 1975 historic climate reference period) (DELWP, 2022b).	Increase habitat improvement for birds, native fish, waterbugs and vegetation. Provide movement corridor between locations. Increase numbers of waterbirds and woodland bird numbers. Support opportunistic colonisation of wetland habitats by macroinvertebrates, fish (including invasive species), turtle and frog communities. Increased organic input and vegetation complexity may increase food resources and therefore macroinvertebrate abundance

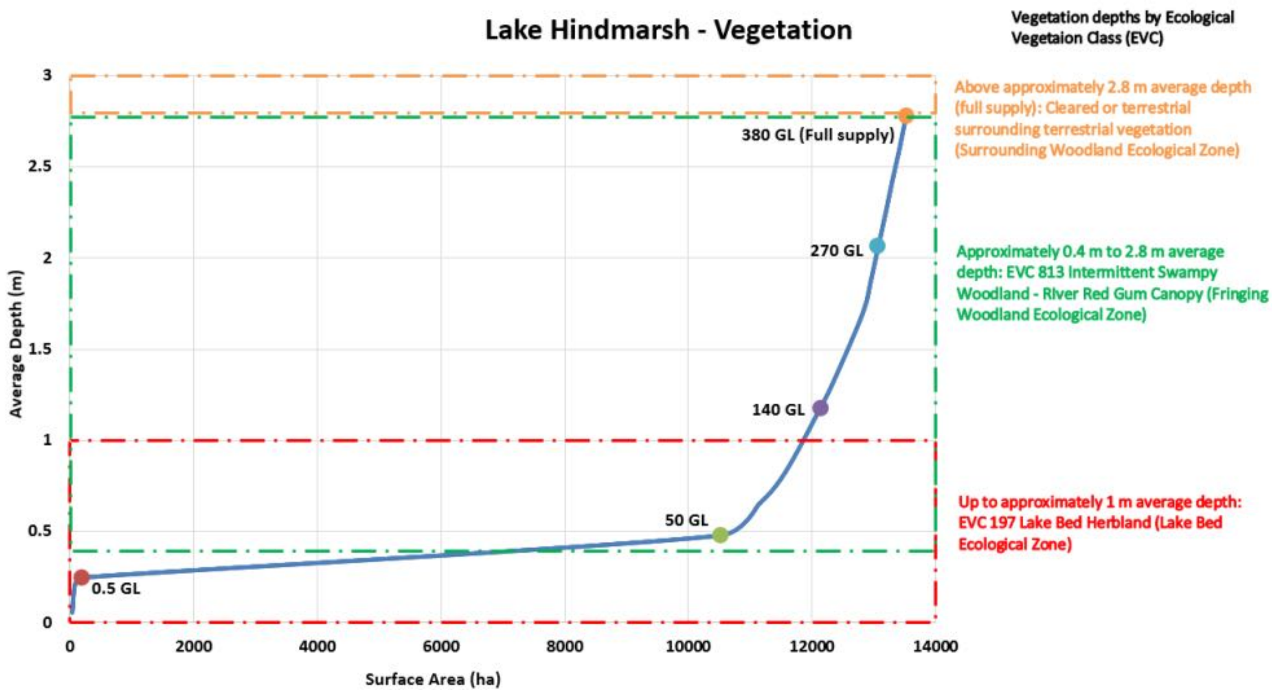

Figure 8-1: Relationship between surface area (ha), volume (GL) and average depth (m) at Lake Hindmarsh and the range of inundation extents required to inundate the different ecological zones and associated EVCs.

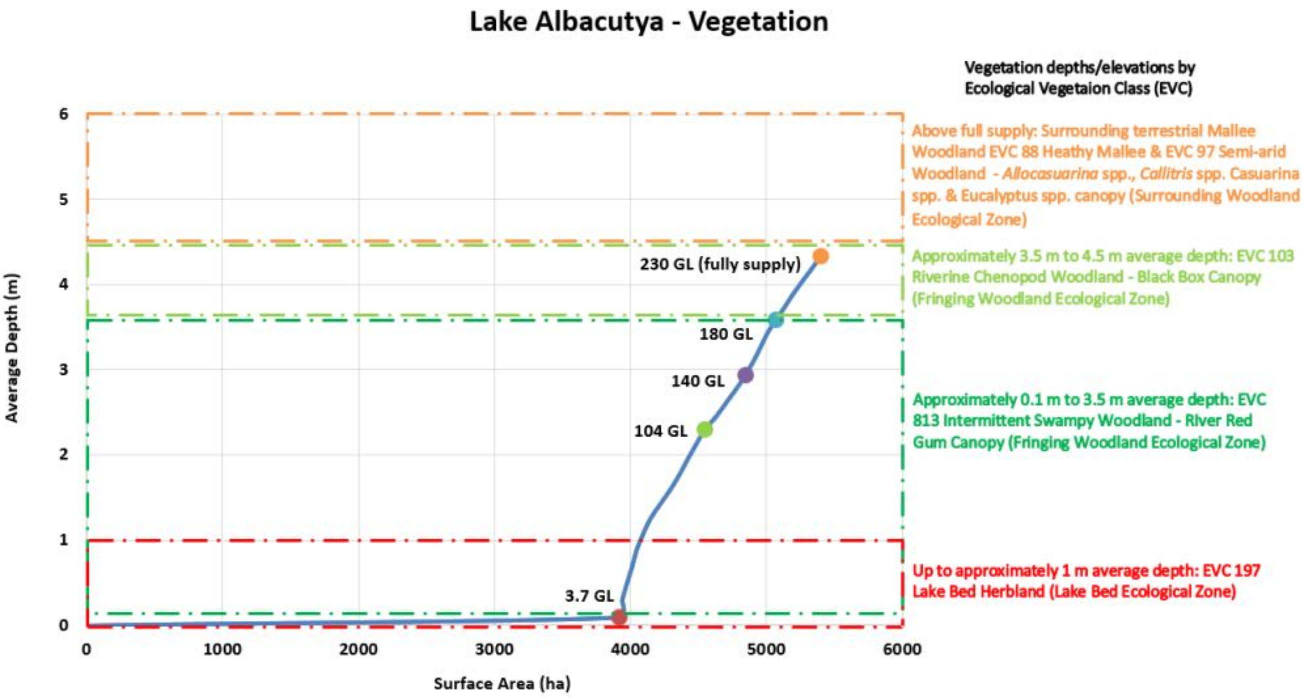

Figure 8-2: Relationship between surface area (ha), volume (GL) and average depth (m) at Lake Albacutya and the range of inundation extents required to inundate the different ecological zones and associated EVCs (Jacobs, 2019).

Table 8-6: Summary of the inundation frequencies required to support wetland EVCs at the terminal lakes and the volumes (rounded to the nearest GL) required to engage (reach the bottom of the extent) and to inundate (cover the whole of the extent) each of the EVCs.

ECOLOGICAL ZONE (EVC)	LAKE HINDMARSH	OUTLET CREEK (B/W H&A)	ROSS LAKES	LAKE ALBACUTYA	OUTLET CREEK	ECOLOGICAL ZONE (EVC)	LAKE HINDMARSH	OUTLET CREEK (B/W H&A)
Lake Bed (EVC 197 Lake Bed Herbland)	Inundate for <3 years in 10, for 1 month to >1 year then dry.	Flow when water is passing to Lake Albacutya. Dry for usually less than 10 consecutive years. Outlet Creek:0.95 GL Cumulative volume: 380 GL	Inundate for 1 month to >1 year every 15-20 years.	Inundate for 1 month to >1 year every 5 -10 years.	Flow when water is passing to Wyperfeld National Park. Dry for usually 15-20 consecutive years. Outlet Creek: 0.65 GL Cumulative volume: 612 GL	Inundate for 1 month to >1 year every approx. 10-20 years.	**Flow** when water is passing to Wyperfeld National Park. Dry for usually approx. 20 consecutive years. Outlet Creek: 0.65 GL Cumulative volume: 615 GL	Inundate for 1 month to >1 year every approx. 10-20 years.
	Lake specific: 0 – 120 GL		Lake specific:0 – 0.2 GL	Lake specific: 0 – 41 GL		Lake specific: 0 – 0.4 GL		Lake specific: 0 – 3 GL
	Cumulative: 0 – 120 GL		Cumulative: 611 GL	Cumulative: 381 – 422 GL		Cumulative: 612 GL		Cumulative: 615 – 618 GL
Fringing Woodland (EVC 813 River Red Gum)	Inundate for <3 years in 10, for 1 month to >1 year then dry.		Inundate for 1 month to >1 year every 15-20 years.	Inundate for 1 month to >1 year every 10-15 years.		Inundate for 1 month to >1 year every approx. 20 years.		Inundate for 1 month to >1 year every approx. 20 years.
	Lake specific: 28 - 380 GL		Lake specific: 0.01 – 0.7 GL	Lake specific: 20 – 175 GL		Lake specific: 0.2 – 1.5 GL		Lake specific: 1.5 – 11.25 GL
	Cumulative: 28 – 380 GL		Cumulative: 612 GL	Cumulative: 400 – 556 GL		Cumulative: 613 - 614 GL		Cumulative: 617 – 627 GL
Fringing Woodland (EVC 103 Black Box)	NA		Inundate for 1 month to >1 year every 15-20 years.	Inundate for 1 month to >1 year every 10-15 years.		Inundate for 1 month to >1 year every approx. 20 years.		Inundate for 1 month to >1 year every approx. 20 years.
			Lake specific: 0.7 – 0.93 GL	Lake specific: 175 – 230 GL		Lake specific: 1.5 – 2 GL		Lake specific: 11.25 – 15 GL
			Cumulative: 613 GL ML	Cumulative: 556 – 611 GL		Cumulative: 614 – 615 GL		Cumulative: 627 – 630 GL

A similar method was used to estimate volumes of water required in each of the lakes to provide foraging habitat for different bird feeding guilds. The volume, surface area and average depth relationship is annotated in Figure 8-3 and Figure 8-4 to show the approximate depth range at which various bird guilds are expected to forage and/or breed. Table 8-7 summarises the watering requirements to support various bird guilds in feeding and breeding in Lakes Hindmarsh and Albacutya.

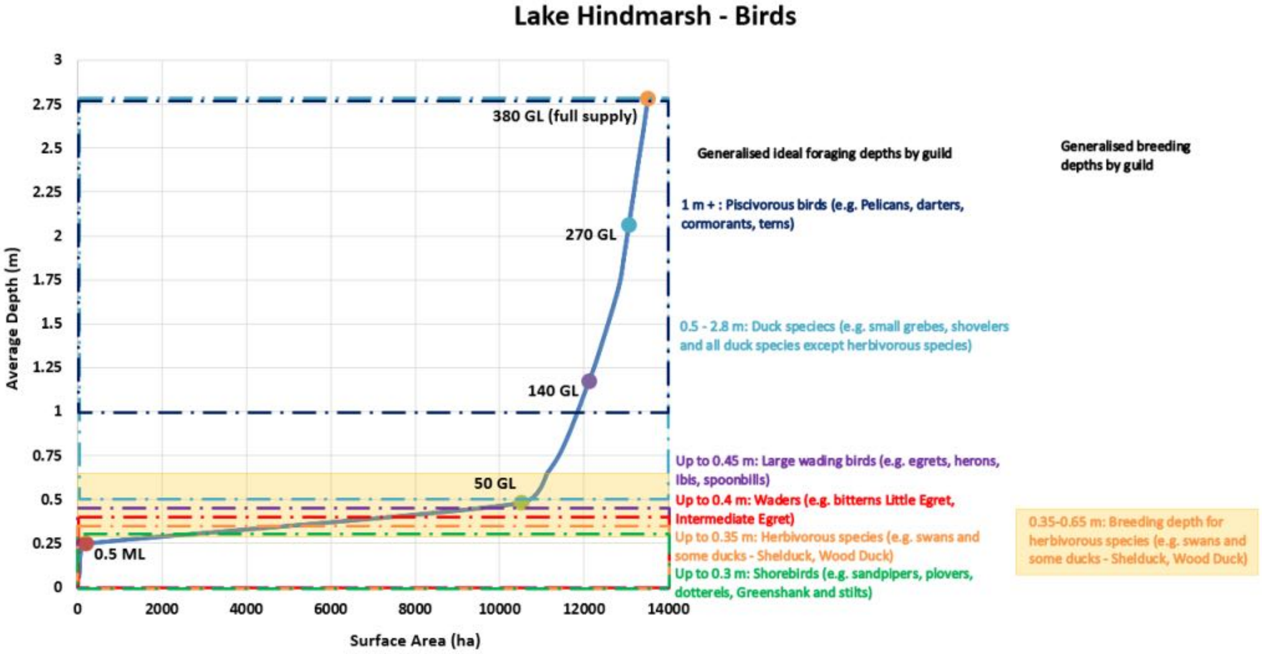

Figure 8-3: Relationship between surface area (ha), volume (GL) and average depth (m) at Lake Hindmarsh and the range of inundation extents required to provide habitat for different bird guilds.

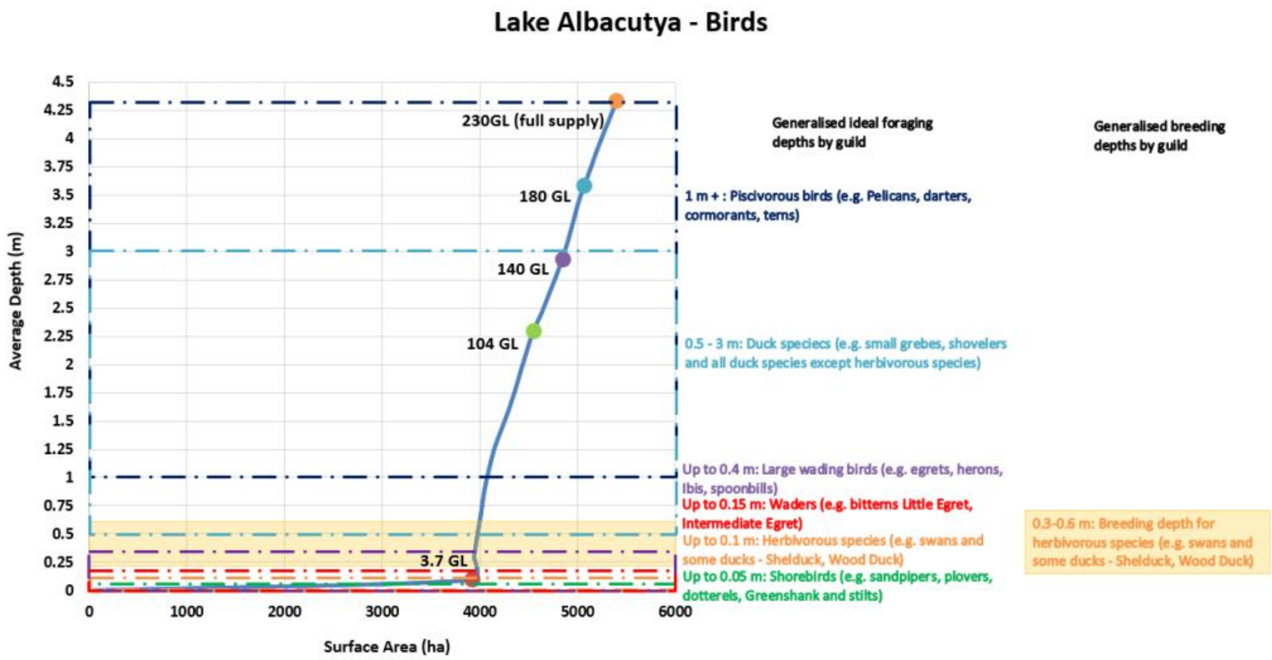

Figure 8-4: Relationship between surface area (ha), volume (GL) and average depth (m) at Lake Albacutya and the range of inundation extents required to provide habitat for different bird guilds.

Table 8-7: Range of full supply characteristics of Lake Hindmarsh and Lake Albacutya corresponding with the idealised feeding depth for the different bird guilds and breeding depth for herbivorous species

BIRD GUILD	AVERAGE DEPTH RANGE	SURFACE AREA RANGE (APPROX.)	VOLUME RANGE (APPROX.)	CUMULATIVE VOLUME (APPROX.)
Lake Hindmarsh				
Shorebirds	0 - 0.3 m	0 - 2,000 ha	0 – 60 GL	0 – 60 GL
Herbivorous species	0 - 0.35 m	0 - 4,000 ha	0 -14 GL	0 – 14 GL
Breeding depth of herbivorous species	0.35 - 0.65 m	4,000 - 11,000 ha	14 – 72 GL	14 – 72 GL
Waders	0 - 0.4 m	0 – 5,000 ha	0 – 20 GL	0 – 20 GL
Large wading birds	0 – 0.45 m	0 – 9,000 ha	0 – 41 GL	0 – 41 GL
Duck species	0.5 – 28 m	10,250 – 13,500 ha	51 – 380 GL	51 – 380 GL
Piscivorous birds	1 – 2.8 m	12,000 – 13,500 ha	120 – 380 GL	120 – 380 G:
Lake Albacutya				
Shorebirds	0 – 0.05 m	0 - 4,000 ha	0 – 2 GL	381 – 383 GL
Herbivorous species	0 – 0.1 m	0 - 4,000 ha	0 – 4 GL	381 – 385 GL
Breeding depth of herbivorous species	0.3 -0.06 m	4,000 – 4,000 ha	12 – 24 GL	393 – 405 GL
Waders	0 – 0.15 m	0 – 4,000 ha	0 – 6 GL	381 – 397 GL
Large wading birds	0 – 0.4 m	0 – 4,000 ha	0 – 16 GL	381 – 397 GL
Duck species	0.5 – 3 m	4,000 – 9,000 ha	20 – 147 GL	401 – 528 GL
Piscivorous birds	1 - 4.3 m	4,100 – 5,400 ha	41 – 230 GL	422 – 611 GL

WATER REQUIREMENTS FOR THE TERMINAL LAKES OF THE YARRIAMBAICK CREEK

Hydrological modelling and water regime analysis for Environmental Water Requirements for Lake Corrong and Lake Lascelles (Ecological Associates, 2006) concluded that only one of the objectives (breeding of birds dependent on wetland vegetation) was not achieved at the time. This was due to the lake not being completely inundated since 1974, exceeding the recommended 20-year maximum interval between inundation events. Since that time the lake filled in 2011 which has met that requirement until 2031 at the earliest. Increased flows in the Yarriambiack Creek brought about by improved environmental water availability will also increase the likelihood of future high flow/flood events filling Lake Corrong although the modelling to quantify the increase in likelihood has not been undertaken.

WATER REQUIREMENTS FOR DOCK LAKE

A review of the fauna and flora species and communities that could be supported by Dock Lake was conducted by consulting with local landholders and specialists, databases, reports and academic texts (Jacobs, 2015). Based on this review it was determined that the best outcome for the lake would be gained by using environmental water to mimic a ‘natural’ watering regime, characterised by periodic inundation followed by slow drawdown and then periods when the lake completely dries. In comparison to holding the lake at a relatively deep level permanently (such as Green Lake) which would benefit relatively few species, a more ‘natural’ wetting/drying would lead to greater floristic diversity at the lake and increased habitat and foraging resources for a range of taxa, especially waterbirds.

This ‘natural’ water regime, characterised by distinct wetting and drying phases, is similar to that proposed for other northern Victoria wetlands where this water regime has enabled environmental water managers to support a mosaic of plant communities and a diverse range of habitats for birds.

The flows study defined a set of water regime elements which would constitute a ‘natural’ wetting/drying regime for Dock Lake and these elements provided the broad scale recommendations which should govern the delivery of environmental water to Dock Lake. It was determined that between 271 ML and 973 ML should be delivered for each wetting event. Firm recommendations were not made for dry, average and wet climatic conditions because the wetting/drying regime should retain some variability, however it was recommended that the frequency of wetting be based on the environmental conditions. The environmental water recommendations for Dock Lake are outlined in Table 8-8.

Table 8-8: Environmental watering recommendations for Dock Lake under wet, average and dry conditions.

CLIMATE CONDITIONS	ENVIRONMENTAL WATER RECOMMENDATIONS
All – Provide under all climate conditions	Fill to between 271 ML (Scenario 16) and 973 ML (Scenario 26) (vary the final volume over wetting events so that across multiple wetting events, the full range of volumes between these scenarios is delivered.) Commence filling between May and September. Inundation period should last at least 3-4 months (but could be as long as 12-14 months). Dry periods (between wetting events) should last for at least 6, but preferably 12 months.
Wet (Annual net evaporation: 805 mm, representative year: 1915)	Wetting events should occur on average five times a decade (once every two years)
Average (Annual net evaporation: 1004 mm, representative year: 1976)	Wetting events should occur on average three times a decade (once every three to four years)
Dry (Annual net evaporation: 1236 mm, representative year: 1965)	Wetting events should occur on average twice a decade (once every five years)
Extended extreme drought conditions	No watering recommended. A long period between inundation events (less than twice per decade) is likely to result in a serious decline in ecological condition.

9 Environmental water delivery infrastructure

9.1 WATER DELIVERY INFRASTRUCTURE

The Wimmera-Mallee system headworks have a long history of development commencing with the construction of Lake Wartook in 1887 through to the completion of Lake Bellfield in 1966. Over this time, the system has been operating through a broad range of climatic conditions. It is necessary to operate the Wimmera-Mallee system headworks as a total integrated system.

A schematic of the Wimmera - Mallee system headworks (not to scale) provided in Figure 4-6 of the report shows the relative elevation, depth, surface areas and connectedness of reservoirs including a representation of the Wimmera Mallee Pipeline. The system is complex, interconnected, with many possible combinations for supply and movement of water.

The successful operation of the system as a whole underpins many important features of the entitlements within the Wimmera and Glenelg[14], including:

- The calculation of available water for seasonal allocations
- the calculation of carryover and system reserve and its distribution across the system
- The ability to trade water
- The successful delivery of water to some entitlement holders or customer groups dependent on parts of the system for their supply
- The delivery of passing flow volumes on behalf of the Environment, without impacting on the reliability of supply to other entitlement holders.

9.1.1 COMPLEMENTARY WORKS AND ACTIVITIES

Waterway management strategies have been developed for the waterways within the Wimmera River System by the Wimmera and Mallee CMAs. They have documented several complementary management activities to try and ensure that the outcomes derived from environmental watering can be maximised.

Program logic models were developed which prescribed a range of actions that would address waterway threats (such as modified flow regimes, degraded water quality and riparian vegetation) (GHD, 2012). Typically, this includes invasive plant and animal control (e.g. rabbit, bridal creeper, boneseed) as well the establishment of riparian management agreements to remove threats around livestock impacts on riparian areas.

Other complementary management activities planned to take place over the life of the EWMP include community engagement activities as well as trial interventions to mitigate the threats of carp and saline groundwater intrusions. The WWS also contains the Lake Albacutya Ramsar Site Management Plan. Details around the types and quantities of complementary management activities are outlined in the Wimmera Waterway Strategy 2014-2022 (Wimmera CMA, 2014) and Mallee Waterway Strategy 2014-2022 (Mallee CMA, 2014).

[14] Storage Management Rules for the Wimmera-Mallee System Headworks (updated August 2016)

9.2 CONSTRAINTS

The Wimmera – Mallee Headworks System was designed to harvest and deliver water to the stock and domestic and irrigation channel systems which typically involved outfalling modest volumes (35 ML/d - 400 ML/d) at constant rates for long periods (typically several months). Therefore, the headworks infrastructure was not originally intended to deliver water to waterways (apart from when they are a conduit for water transfers). Therefore, some sites have undergone upgrades to improve their effectiveness in delivering environmental water. However, there remain several sites where physical constraints on environmental water delivery remain.

WIMMERA RIVER

In 2007, Huddleston's Weir was upgraded through the construction of a V-notch in the weir (and associated rock ramp fishway) as well as installing remote operation of gates that allow water to be harvested from the weir into Taylors Lake via the Wimmera Inlet Channel. There still needs to be manual intervention to ensure that the gates are operating effectively (i.e. not caught on debris). This was to enable it to effectively deliver passing flows created from water savings from the Wimmera Mallee Pipeline. To determine compliance with these passing flows, permanent streamflow gauging has been installed at the site.

The Taylor Lake outlet has an operational limitation of 200 ML/day due to bank levels of the outlet channel. The gauge at this outlet also is not accurate due to outlet operational gate issues preventing a past hydraulic flow assessment to be completed.

Town weirs at Horsham, Dimboola and Jeparit have also been modified with up to eight flume gates installed, replacing drop boards to improve the efficiency and accuracy of operation to pass flows through weir pools. Horsham Rural City Council and Hindmarsh Shire Council can operate the weirs to enable the transition of environmental flows through weir pools whilst providing opportunities for weir pools to capture unregulated and passing flows at appropriate times to in part reflect historic arrangements (prior to the completion of the Northern and Wimmera Mallee Pipelines).

Consideration was also made around the impact of constant pool heights on the riverbank which has also been an issue raised during consultation for the EWMP. In 2024, the Hindmarsh Shire Council had listed the Jeparit Weir for repair and/or replacement.

In 2007 an assessment of various features (low level crossings etc.) that could affect the passage of environmental water releases throughout the Wimmera River System was undertaken. The study identified and provided recommendations for several low-level crossings in need of maintenance and/or upgrading to enable them to convey recommended environmental flows based on those made in the original Wimmera River system environmental flows study (SKM, 2008). In their current configuration they pass low flows although at comparatively modest volumes they overtop and cause social impacts (i.e. access issues) and localised erosion.

In 2020, Water Technology was engaged to map the extent and locations of phragmites and typha along the Wimmera River from Horsham through to Lake Hindmarsh and compare those with the results from 2006 (Water Technology, 2020). This more recent work involved analysing the nutrients and biomass associated with the stands of phragmites to understand how water availability and quality were affecting their dynamics. It revealed the presence of high nutrient levels associated with the historic input of treated wastewater from Horsham and irrigation drainage from Quantong through to the 1990s (Water Technology, 2021). As a consequence of this legacy issue, it will take decades to address with flows moving the high nutrients downstream through the annual growth/breakdown cycling of phragmites and typha.

Future actions

Infrastructure constraints will continue to prevent the delivery of larger recommended flow components (400 ML/d to 6000 ML/d) from regulated releases alone, therefore unregulated and/or passing flows will be required to achieve this. The absence of major impoundments on the Wimmera River has meant that large flows cannot be released to meet recommended volumes at compliance points and if necessary, regulated releases from Lake Lonsdale and/or Taylor's Lake can be used to supplement shortfalls in the hydrograph. This will be determined on a case-by-case basis given increasing risks around unintended inundation of land at higher flows.

Wimmera CMA will also continue to work with local government to seek upgrades of low-level crossings impacted by environmental water releases to work towards ensuring sufficient hydraulic capacity.

MT WILLIAM CREEK

For the lower Mt William Creek, GWMWater has advised that minimum flow rates of least 20 ML/day be released to prevent issues with the outlet at the dam wall. 300 ML/day has also been recommended as the operational maximum limit to prevent nuisance flooding.

The Mt William Creek Streamflows Study (Alluvium, 2015) looked at the lower Mt William Creek's hydrology and hydraulics, which involved limited modelling to improve understanding around channel capacities. When higher volumes are released (>100 ML/d) they enter high flow channels (e.g. Sheepwash Creek) attracting additional in-stream losses which affects the ability to meet recommended volumes at downstream compliance points (Alluvium, 2015). In 1910, landholders modified the creek's course north of the Western Highway, changing its 'main' course from the westerly to the easterly course (Wimmera Mallee Water, 1998). Now only the easterly course flows during low-medium flows, entering the Wimmera Inlet Channel and flowing a short distance (about 1 km) before entering the Wimmera River via the "Big Pipe" regulator.

The Wimmera CMA's main priority for Mount William Creek is to address the low flows leaking into Sheepwash Creek due to Trudgeon's Weir still remaining after it was decommissioned. Leakage into the Wimmera Inlet Channel due to the high invert of Big Pipe is a lower priority.

Automating the outlet valves at Lake Lonsdale was undertaken by GWMWater to improve delivery of environmental water releases to Mt William Creek by removing the requirement of staff to manually change flow rates on a daily basis (to easily ensure appropriate rates of flow rise and fall).

Lake Bellfield's distance from the lower Mt William Creek means that using it to supply the lower Mt William Creek is unlikely under most conditions. The minimum release rate from Lake Bellfield is around 50 ML/d (Earth Tech, 2005) to 30 ML/d (Kym Wilson, GWMWater, pers comm.) due to cavitation issues with the valve opening. As a consequence, it would only feasibly be able to provide freshes rather than baseflows.

Future actions

Further investigations are required to determine the most appropriate actions to address constraints in delivery. Larger recommended flows (500 ML/d to 1,500 ML/d) are unable to be delivered by outlets from Lake Lonsdale as well as potentially creating unacceptable impacts on rural land downstream so there are no current proposals to increase the outlet capacity at Lake Lonsdale.

The 2015 study into the creek's hydrology and hydraulics has provided provide further advice around managing releases in order to improve environmental outcomes (Alluvium, 2015). Weirs operated by community members next to the former Trudgeon's Weir and Dadswell's Bridge have a large bearing on the proportion of water entering anabranches or continuing along the main channel. Ongoing management arrangements for these weirs will need to be developed that consider legal, environmental and safety issues. This is a high priority for the Wimmera CMA given the risks to health and safety and impact on creek flows within Mount William Creek.

Investigations into upgrading infrastructure so as to enable passage of low to medium flows along the western branch of the Mt William Creek indicate that given the current configuration at the bifurcation between the two branches, a permanent upgrade is unfeasible, and more investigations are required to better understand the environmental values and watering requirements of the western as opposed to the eastern branch (RPS, 2015). Given the western branch also enters the Wimmera Inlet Chanel upstream of its confluence with the Wimmera River, infrastructure upgrades to enable the effective continuation of flows downstream is required at the Mt William Creek Outfall (RPS, 2015) although the priority is lower than some other sites given the likely infrequent use with the current configuration at the upstream bifurcation.

YARRIAMBIACK CREEK

As mentioned in Section 4, flows in Yarriambiack Creek are dictated by flows in the Wimmera River and there is no ability to directly release flow into the creek. However, a number of low-level crossings have been identified as potential impediments to environmental water releases through slowing the passage of flows such as culverts that are partially blocked and/or of insufficient capacity, derelict bridges and water resource infrastructure (e.g. historic levees) (Earth Tech, 2007). Town weirs at Warracknabeal, Brim and Beulah need to be managed appropriately in order to pass environmental flows.

DOCK LAKE

There is a channel/pipeline linking Dock Lake with Green Lake which has a capacity of approximately 100 ML/d. Currently the infrastructure is in need of de-silting and repair before it could be used for delivery of environmental water (Jacobs, 2015).

Recommendations addressing delivery constraints are listed in detail in the following reports:

- Assessing the Physical Constraints on Environmental Flow Delivery in the Wimmera Catchment (Earth Tech, 2005)
- Wimmera and Glenelg Systems Environmental Metering Program (VEWH, 2014).

Furthermore, the following reports outline a comprehensive analysis of physical features (crossings, informal weirs, debris blockages etc.) that may prevent the effective delivery of environmental water releases:

- Assessing Influences on Environmental Water Releases in the Wimmera, Phase 1, Stages 1 and 2 (Earth Tech, 2006)
- Assessing Influences on Environmental Water Releases in the Wimmera, Phase 2, Stages 1 and 2 (Earth Tech, 2007)
- Influences on Environmental Water Releases in the Wimmera River (SKM, 2008)
- Wimmera Catchment Management Authority – Impediments to Environmental Water Releases Site Review (Catchment Health Engineering, 2015).

10 Demonstrating outcomes – monitoring and assessment

Monitoring is required to demonstrate that watering is achieving long term environmental outcomes. Monitoring is also a critical component of the adaptive management of the Wimmera River and terminal lakes, Mount William Creek and Dock Lake. Two types of monitoring are used to assess the effectiveness of the environmental water regime on objectives and to facilitate adaptive management:

- Long-term condition monitoring
- Intervention monitoring.

Currently the principal monitoring program for the release of environmental water on the Wimmera River is the VEFMAP program.

Since 2009, VEFMAP fish monitoring has taken place at 12 sites along the Reach 3 and 4 of the Wimmera River capturing the fish condition during drought conditions, and also after more consistent environmental flow releases from 2010-11 onwards.

Also, as part of VEFMAP vegetation monitoring transects were established in 2008 at four sites on the Wimmera River and are surveyed every two years. River Red Gum condition has been monitored in the riparian zone of the Wimmera River every two years.

The latest results from VEFMAP Stage 6 (ARI, 2020) can be found here.

The Victorian Government has recently reviewed the VEFMAP program, which will inform the next phase of environmental watering monitoring. It is understood that long term fish condition monitoring is not planned for the Wimmera River system in Stage 7 of VEFMAP.

Continuous water quality monitoring is also undertaken in the Wimmera River with sites located at 415201 – Wimmera River at Glenorchy Weir Tail Gauge (turbidity), 415200 – Wimmera River at Horsham (dissolved oxygen, conductivity and temperature), 415256 – Wimmera River u/s Dimboola (dissolved oxygen, conductivity and temperature), 415246 – Wimmera River at Lochiel Railway Bridge (dissolved oxygen, conductivity and temperature), 415247 – Wimmera River at Tarranyurk (dissolved oxygen, conductivity and temperature).

Future monitoring priorities are detailed in Table 10-2 and Table 10-3.

10.1 MONITORING PRIORITIES FOR THE WIMMERA RIVER AND TERMINAL LAKES

Section 7 sets out the management objectives for environmental water use in the Wimmera River and terminal lakes, Mount William Creek and Dock Lake, which have been aligned with objectives set out in the Long-Term Watering Plan for Wimmera-Mallee prepared for Basin Plan obligations (DELWP, 2015). Table 10-1 sets out target variables to evaluate progress towards the objectives at the asset scale.

Table 10-1: Objectives and target variables for the use of delivery of water for the environment.

THEME	OBJECTIVE	INDICATOR TO BE MEASURED
Fish	Improve abundance of large-bodied native fish	CPU
	Improve species richness of native fish	Species richness
Waterbirds	Improve breeding opportunities for waterbirds	Delivery of water to support breeding in Lakes Hindmarsh and Albacutya
	Improve habitat for waterbirds	Delivery of water to support feeding and/or breeding
	Improve breeding opportunities for colonial-nesting waterbirds	Delivery of water to support breeding
Vegetation	Improve condition of riparian EVCs	Condition of riparian EVCs
	Maintain condition of aquatic vegetation in wetlands	Condition of wetland vegetation
	Maintain condition of river red gum dominated EVCs	Condition of river red gum dominated EVCs
	Improve condition of river red gum dominated EVCs	Condition of river red gum dominated EVCs
	Improve the condition of black box dominated EVCs	Condition of black box dominated EVCs
	Improve the condition of shrub and lignum dominated EVCs	Condition of canegrass or lignum dominated EVCs
Connectivity	Improve longitudinal connectivity between river reaches and with the River Murray	Baseflow and freshflow
	Improve connectivity between floodplains, anabranches and wetlands	Wetland water requirements
Other	Maintain adequate surface water salinity to enable growth and reproduction of aquatic vegetation	Murray-Darling Basin salinity target at Horsham gauge
	Maintain species richness of frog communities	Frog species richness

Table 10-2: Monitoring priorities for the Wimmera River and terminal lakes

MONITORING	HOW	OBJECTIVE MONITORED	REACHES
Fish (juvenile and adult)	Electrofishing, bait traps, fyke nets (as per (SKM, 2006))	Recruitment, maintenance and dispersal of fish species	Wimmera River Reaches 2, 3 and 4, Mount William Creek
Tree canopy condition	River Red Gum and Black Box – tagged trees or remote sensing	Protect floodplain EVCs	Wimmera River floodplain and terminal lakes (specific sites identified in Dyer and Roberts (2006))
Tree growth and recruitment	Seedling survey and growth rate of seedlings targeting areas watered by large freshes	Protect and restore riparian and floodplain EVCs	Wimmera River riparian zone, floodplain and fringing woodlands of terminal lakes (specific sites identified in Dyer and Roberts (2006))
Shrub growth and recruitment	% new growth and other reproduction stages on branches	Protect and restore riparian and floodplain EVCs	Wimmera River riparian zone, floodplain (specific sites identified in Dyer and Roberts (2006))
Understory and aquatic vegetation composition	Quadrats and photopoints	Enable growth and reproduction of submerged aquatic macrophytes and emergent vegetation through mitigating salinity impacts	Wimmera River (specific sites identified in Dyer and Roberts (2006))
Phragmites response to environmental flows	Measure extent and density of Phragmites stands (aerial or cross-section survey)	Enable growth and reproduction of submerged aquatic macrophytes and emergent vegetation through mitigating salinity impacts	Wimmera River (specific sites identified in Dyer & Roberts (2006) and Roberts et al. (2006))
Macroinvertebrate diversity and response to flows	MBI classification and techniques from CEWO long-term monitoring project	Maintain a 'good' diversity of macroinvertebrate species (based on MBI classifications)	Wimmera River sites in WEC (2008) within regulated reaches with macroinvertebrate objectives
Channel dimensions	Cross sections and Digital Elevation Model (from LiDAR)	Channel capacity/integrity	Wimmera River Reaches 2, 3 & 4
Waterbirds	Quarterly surveys during wet conditions	Ecological function of wetlands, maintenance of significant attributes of wetlands	Lake Hindmarsh, Lake Albacutya
Regent Parrots	Annual surveys	Maintenance of significant attributes of wetlands	Lake Hindmarsh, Lake Albacutya
Water quality monitoring of saline pools	Ongoing use of water quality monitoring profile rig	Water quality impacts on fish, macroinvertebrate and vegetation objectives	Wimmera River Reach 4 (Polkemmet Road and Big Bend)
Point water quality monitoring	Point water quality monitoring	Water quality impacts on fish, macroinvertebrate and vegetation objectives	TBD – refuge pools within Wimmera River Reaches 2, 3 & 4

Table 10-3: Monitoring and evaluation priorities for EWMP objectives for Wimmera River and terminal lakes, Mount William Creek and Dock Lake

THEME	OBJECTIVE	INDICATOR/ TARGET REACHES	MONITORING METHOD	VARIABLE TO BE ASSESSED
Wimmera River and Mount William Creek				
Fish	Improve the abundance, movement and species richness of native fish species	Freshwater Catfish (Wimmera River reaches 2, 3, 4) Obscure galaxias, Southern Pygmy Perch and River Blackfish (Wimmera River reach 2, Mount William Creek) Golden and Silver Perch (Wimmera River reaches 2, 3, 4)	Electrofishing, bait traps, fyke nets (as per the Wimmera Native Fish Management Plan (SKM, 2006))	**Abundance** – spatial distribution & age class distribution **Species richness** – number of different species present during monitoring **Movement** – spatial distribution
Vegetation	Maintain the species richness and extent of in-channel aquatic vegetation, improve the abundance of aquatic vegetation.	Wimmera River reaches 2, 3 and 4 and Mount William Creek	Quadrats and photopoints	**Species richness** – number of different species present during monitoring **Abundance** – spatial distribution
	Improve the condition of riparian EVCs	Wimmera River reaches 2, 3 and 4 and Mount William Creek	▪ River Red Gum and Black Box – tagged trees or remote sensing ▪ Seedling survey at pre-designated points ▪ Growth rate at seedlings above/below areas watered by large freshes ▪ % new growth and other reproduction stages on branches	The condition of River Red Gum EVCs in the asset is better at the end than at the start of a 10-year monitoring period as measured by the following sub-targets: ▪ Health of adult River Red Gum trees ▪ Recruitment and survival of juvenile trees ▪ Native species richness ▪ Native species cover/abundance ▪ Recruitment of understorey vegetation
Habitat	Maintain the quality of geomorphic habitat (maintain channel form, clean substrates, prevent stream bed colonisation)	Stream bed and channel of Wimmera River reaches 2, 3 and 4 and Mount William Creek	▪ Environmental flow compliance ▪ Cross-sections ▪ Digital elevation models (from LiDAR	The baseflow and fresh flow requirements as specified in each asset are met in eight years of a ten-year period
	Improve longitudinal connectivity (between river reaches) to facilitate fish movement	Stream bed and channel of Wimmera River reaches 2, 3 and 4 and Mount William Creek	▪ Environmental flow compliance	The baseflow and fresh flow requirements as specified in each asset are met in eight years of a ten-year period

THEME	OBJECTIVE	INDICATOR/ TARGET REACHES	MONITORING METHOD	VARIABLE TO BE ASSESSED
	Maintain refuges for native fish species (prevent loss of channel capacity through sedimentation)	Stream bed and channel of Wimmera River reaches 2, 3 and 4 and Mount William Creek	▪ Cross-sections	Refuge depth and extent
	Maintain adequate surface water salinity to enable growth and reproduction of aquatic vegetation	Stream bed and channel of Wimmera River reaches 2, 3 and 4 and Mount William Creek	Ongoing use of water quality meter or Portable Automated Loggers	Surface water salinity
Macroinvertebrates	Maintain macroinvertebrate diversity	Macroinvertebrates in Wimmera River reaches 2, 3 and 4	MBI classification Sites in WEC (2008) within regulated reaches with macroinvertebrate objectives	**Species richness** – number of different species present during monitoring
Platypus	Improve habitat for Platypus and Rakali	Platypus and Rakali habitat in reaches 2 and 3 and Mount William Creek	▪ Trapping ▪ Environmental DNA	**Abundance** – spatial distribution & age class distribution
Other	Maintain habitat for crayfish communities	Crayfish in Mount William Creek	▪ TBC	**Abundance** – spatial distribution & age class distribution
Wimmera Terminal Lakes				
Vegetation	Provide conditions suitable for the establishment and maintenance of vegetation in the lake bed zone representative of the wetted and dry phases of an episodically inundated wetland in a semi-arid environment	EVC 107 Lake Bed Herbland in lower terminal lakes (i.e. Lake Hindmarsh to Lake Brambruk)	WetMAP monitoring protocol	The condition of wetland vegetation in the asset is better at the end than at the start of a ten-year monitoring period as measured by the following sub-targets: ▪ Cover/abundance of native species ▪ Native species richness ▪ Recruitment of woody and non-woody understorey and survival of juvenile plants
	Provide conditions suitable to maintain vegetation communities in fringing woodland zone	Fringing woodland of the lower terminal lakes and Outlet Creek	VEFMAP and WetMAP monitoring protocol	The condition of River Red Gum dominated EVCs in the asset improves over ten years as measured by the following sub-targets: ▪ Health of adult River Red Gum trees ▪ Recruitment and survival of juvenile trees ▪ Native species richness

THEME	OBJECTIVE	INDICATOR/ TARGET REACHES	MONITORING METHOD	VARIABLE TO BE ASSESSED
				▪ Native species cover/abundance ▪ recruitment of understorey vegetation
Waterbirds	Support waterbird use of the terminal lakes system through improved access to feeding, roosting and breeding habitat during episodic filling of the lakes and provide extensive wetland habitat to support large populations of waterbirds in the lower terminal lakes in years when widespread natural flooding occurs	Waterbirds in lower terminal lakes and Outlet Creek	Environmental flow compliance	▪ Deliver water to support waterbird breeding events in Lakes Hindmarsh and Albacutya. ▪ The minimum water requirement for waterbird feeding and/or breeding is met over a ten-year monitoring period.
Woodland birds	Provide habitat and refuge for migratory and resident woodland bird species.	Birds utilising fringing woodland habitat including Regent Parrot	Annual surveys	Bird surveys when water is present
Fish and macroinvertebrates	Promote biomass of macroinvertebrate and fish communities sufficient to provide food resources for waterbirds during wet phases.	All macroinvertebrate and fish species (including exotic species) within terminal lakes and Outlet Creek	Environmental flow compliance	Fish and macroinvertebrate surveys when water is present
Frogs and turtles	Support the opportunistic colonisation of wetland habitats and Outlet Creek during inundation events by frogs and turtles.	Frog and turtle species in terminal lakes and Outlet Creek including Burrowing Frogs, Marsh Frogs and Eastern Long-necked Turtle.	Environmental flow compliance	Frog and turtle surveys when water is present
Dock Lake				
Vegetation	Return to a seasonal or intermittent wetting and drying cycle to encourage the establishment and maintenance of structurally and floristically diverse native vegetation	Wetland vegetation in Dock Lake	Environmental flow compliance	Vegetation mapping when water is present
Birds	Provide diverse habitat and foraging resources to a suite of birds by varying the water level in the lake over time.	All waterbirds in Dock Lake	Environmental flow compliance	Bird surveys when water is present

THEME	OBJECTIVE	INDICATOR/ TARGET REACHES	MONITORING METHOD	VARIABLE TO BE ASSESSED
Frogs	Encourage the use of Dock Lake by common frog species at times of inundation.	Common frog species in Dock Lake	Environmental flow compliance	Frog surveys when water is present
Macroinvertebrates and microinvertebrates	Engage suitable habitats to attract and support an abundant and diverse community.	All species in Dock Lake	Environmental flow compliance	Macroinvertebrate samples when water is present

11 Knowledge gaps and recommendations

The EWMP has been developed using the best available information to hand. However, despite the ongoing improvements in environmental water management through experience in implementation, there are still a number of knowledge gaps and recommendations that remain that can enhance environmental water management in the Wimmera River. These knowledge gaps, and the recommendations to address them are listed in Table 11-1. These recommendations will be actioned by the Wimmera CMA in conjunction with its water management partners as opportunities and funding allow.

Table 11-1: Knowledge gaps and recommendations following the development of the EWMP

KNOWLEDGE GAP	RECOMMENDATION	WHO	PRIORITY
Effect of flows on saline pools	Undertake monitoring and modelling of pool behaviour in response to interventions.	Wimmera CMA	High
Weir pool hydrology	Undertake monitoring of contributions of stormwater and streamflows and losses from evaporation, extraction and seepage.	Wimmera CMA, local govt.	High
Flow rates and levels at some reaches/lakes	Install flow gauging equipment and update rating tables in particular for the terminal lakes (see Section 3.1).	Wimmera CMA, DEECA	Medium
Instream loss rates	Continue to refine understanding of rates of loss at different times of year for the various regulated reaches using flow gauge data. Enhanced information regarding the flow split between the Wimmera River and Yarriambiack Creek would be very useful in determining loss rates as well.	Wimmera CMA	High
Limited hydrologic models	Improve the spatial extent and update modelled daily flow data to enable refinement of flow recommendations.	Wimmera CMA, DEECA, GWMWater	Medium
Prioritisation of watering actions	Update and enhance the prioritisation tool developed in SKM (2010).	Wimmera CMA, VEWH	High
Cultural values and watering	Investigate options to undertake watering actions to enhance cultural values.	Wimmera CMA, BGLC	High
Social and economic values of waterways	Quantify benefits of waterways to demonstrate the full value of environmental water.	Wimmera CMA	High
Community information on the effects of releases	Maintain regular contact with stakeholders, use Wimmera CMA communications tools (e.g. Facebook, website) to garner information.	Wimmera CMA	High

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Appendices

A-1 FAUNA SPECIES

Table A1-1 provides a list of the fauna species of the Wimmera River, Mount William Creek, Dock Lake and Wimmera River terminal lakes.

Table A1-1: Fauna species of the Wimmera River, Mount William Creek, Dock Lake and Wimmera River terminal lakes.

COMMON NAME	SCIENTIFIC NAME	EPBC	FFG
Amphibians			
Barking Marshfrog	*Limnodynastes fletcherii*		
Bibron’s Toadlet	*Pseudophryne bibronii*		
Common Froglet	*Crinia signifera*		
Common Spadefoot Toad	*Neobatrachus sudelli*		
Growling Grass Frog	*Litoria raniformis*	V	V
Mallee Spadefoot Toad	*Neobatrachus pictus*		
Peron’s Tree Frog	*Litoria peronii*		
Plains Froglet	*Crinia parinsignifera*		
Pobblebonk Frog	*Limnodynastes dumerii dumerii*		
Southern Brown Tree Frog	*Litoria ewingii*		
Southern Smooth Froglet	*Geocrinia laevis*		
Southern Toadlet	*Pseudophryne semimarmorata*		E
Spotted Marsh Frog	*Limnodynastes tasmaniensis*		
Birds			
Australasian Grebe	*Tachybaptus novaehollandiae*		
Australasian Pipit	*Anthus novaeseelandiae*		
Australasian Shoveler	*Spatula rhynchotis*		V
Australasian Swamphen	*Porphyrio melanotus*		
Australian Bustard	*Ardeotis australis*		CE
Australian Hobby	*Falco longipennis*		
Australian Magpie	*Cracticus tibicen*		
Australian Owlet-nightjar	*Aegotheles cristatus*		
Australian Pelican	*Pelecanus conspicillatus*		
Australian Raven	*Corvus coronoides*		
Australian Reed Warbler	*Acrocephalus australis*		
Australian Ringneck	*Barnardius zonarius zonarius*		
Australian Shelduck	*Tadorna tadornoides*		
Australian Spotted Crake	*Porzana fluminea*		

COMMON NAME	SCIENTIFIC NAME	EPBC	FFG
Australian White Ibis	*Threskiornis molucca*		
Australian Wood Duck	*Chenonetta jubata*		
Banded Lapwing	*Vanellus tricolor*		
Banded Stilt	*Cladorhynchus leucocephalus*		
Bar-tailed Godwit	*Limosa lapponica*		
Barking Owl	*Ninox connivens connivens*		CE
Barn Owl	*Tyto alba*		
Black Falcon	*Falco subniger*		CE
Black Kite	*Milvus migrans*		
Black Swan	*Cygnus atratus*		
Black-chinned Honeyeater	*Melithreptus gularis*		
Black-eared Cuckoo	*Chrysococcyx osculans*		
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*		
Black-faced Woodswallow	*Artamus cinereus*		
Black-fronted Dotterel	*Elseyornis melanops*		
Black-shouldered Kite	*Elanus axillaris*		
Black-tailed Native-hen	*Tribonyx ventralis*		
Blue Bonnet	*Northiella haematogaster*		
Blue-billed Duck	*Oxyura australis*		V
Blue-winged Parrot	*Neophema chrysostoma*		
Brown Falcon	*Falco berigora*		
Brown Goshawk	*Accipiter fasciatus*		
Brown Songlark	*Cincloramphus cruralis*		
Brown Thornbill	*Acanthiza pusilla*		
Brown Treecreeper	*Climacteris picumnus*		
Brown-headed Honeyeater	*Melithreptus brevirostris*		
Brush Bronzewing	*Phaps elegans*		
Budgerigar	*Melopsittacus undulatus*		
Buff-banded Rail	*Gallirallus phillippensis*^		
Buff-rumped Thornbill	*Acanthiza reguloides*		
Bush Stone-curlew	*Burhinus grallarius*		CE
Caspian Tern	*Hydroprogne caspia*		V
Chestnut Quail-thrush	*Cinclosoma castanotus*		
Chestnut Teal	*Anas castanea*		
Chestnut-rumped Thornbill	*Acanthiza uropygialis*		
Clamorous Reed Warbler	*Acrocephalus stentoreus*^		
Cockatiel	*Nymphicus hollandicus*		

COMMON NAME	SCIENTIFIC NAME	EPBC	FFG
Collared Sparrowhawk	*Accipiter cirrhocephalus*		
Common Blackbird*	*Turdus merula**		
Common Bronzewing	*Phaps chalcoptera*		
Common Greenshank	*Tringa nebularia*		E
Common Sandpiper	*Actitis hypoleucos*		V
Common Starling*	*Sturnus vulgaris**		
Crested Bellbird	*Oreoica gutturalis*		E
Crested Pigeon	*Ocyphaps lophotes*		
Crested Shrike-tit	*Falcunulus frontatus*		
Curlew Sandpiper	*Calidris ferruginea*		CE
Darter	*Anhinga novaehollandiae*		
Diamond Dove	*Geopelia cuneata*		V
Diamond Firetail	*Stagonopleura guttata*		V
Domestic Goose*	*Anser anser**		
Double-banded Plover	*Charadrius bicinctus*		
Dusky Moorhen	*Gallinula tenebrosa*		
Dusky Woodswallow	*Artamus cyanopterus*		
Eastern Cattle Egret	*Bubulcus coromandus*		
Eastern Great Egret	*Ardea alba modesta*		V
Eastern Rosella	*Platycercus eximius*		
Eastern Shrike-tit	*Falcunculus frontatus*		
Eastern Yellow Robin	*Eopsaltria australis*		
Emu	*Dromaius novaehollandiae*		
Eurasian Coot	*Fulica atra*		
European Goldfinch	*Carduelis carduelis*		
European Skylark*	*Alauda arvensis**		
Fairy Martin	*Petrochelidon ariel*		
Fan-tailed Cuckoo	*Cacomantis flabelliformis*		
Flame Robin	*Petroica phoenicea*		
Fork-tailed Swift	*Apus pacificus*		
Freckled Duck	*Stictonetta naevosa*		E
Fuscous Honeyeater	*Ptilotula fusca*		
Galah	*Eolophus roseicapilla*		
Gilbert's Whistler	*Pachycephala inornata*		
Glossy Ibis	*Plegadis falcinellus*		
Golden Whistler	*Pachycephala pectoralis*		
Great Cormorant	*Phalacrocorax carbo*		

COMMON NAME	SCIENTIFIC NAME	EPBC	FFG
Great Crested Grebe	*Podiceps cristatus*		
Grey Butcherbird	*Cracticus torquatus*		
Grey Currawong	*Strepera versicolor*		
Grey Fantail	*Rhipidura albiscapa*		
Grey Shrike-thrush	*Colluricincla harmonica*		
Grey Teal	*Anas gracilis*		
Grey-crowned Babbler	*Pomatostomus temporalis*		V
Grey-shrike Thrush	*Colluricincla harmonica*		
Gull-billed Tern	*Gelochelidon nilotica macrotarsa*		E
Hardhead	*Aythya australis*		V
Hoary-headed Grebe	*Poliocephalus poliocephalus*		
Hooded Robin	*Melanodryas cucullata*		V
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*		
Horsfield's Bushlark	*Mirafra javanica*		
House Sparrow*	*Passer domesticus**		
Inland Thornbill	*Acanthiza apicalis*		
Jacky Winter	*Microeca fascinans*		
Latham's Snipe	*Gallinago hardwickii*		
Laughing Kookaburra	*Dacelo novaeguineae*		
Little Black Cormorant	*Phalacrocorax sulcirostris*		
Little Corella	*Cacatua sanguinea*		
Little Eagle	*Hieraaetus morphnoides*		
Little Friarbird	*Philemon citreogularis*		
Little Grassbird	*Poodytes gramineus*		
Little Pied Cormorant	*Microcarbo melanoleucos*		
Little Raven	*Corvus mellori*		
Long-billed Corella	*Cacatua tenuirostris*		
Magpie-lark	*Grallina cyanoleuca*		
Major Mitchell's Cockatoo	*Lophocroa leadbeateri*		CE
Mallee Emu-wren	*Stipiturus mallee*	E	E
Mallee Ringneck	*Barnardius zonarius barnardi*		
Malleefowl	*Leipoa ocellata*	V	V
Marsh Sandpiper	*Tringa stagnatilis*		E
Masked Lapwing	*Vanellus miles*		
Masked Woodswallow	*Artamus personatus*		
Mistletoebird	*Dicaeum hirundinaceum*		
Mulga Parrot	*Psephotus varius*		

COMMON NAME	SCIENTIFIC NAME	EPBC	FFG
Musk Duck	*Biziura lobata*		V
Musk Lorikeet	*Glossopsitta concinna*		
Nankeen Kestrel	*Falco cenchroides*		
Nankeen Night Heron	*Nycticorax caledonicus*		
New Holland Honeyeater	*Phylidonyris novaehollandiae*		
Noisy Miner	*Manorina melanocephala*		
Northern Mallard	*Anas platyrhynchos*		
Orange Chat	*Epthianura aurifrons*		
Pacific Black Duck	*Anas superciliosa*		
Painted Button-quail	*Turnix varia*		
Painted Honeyeater	*Grantiella picta*	V	V
Pallid Cuckoo	*Heteroscenes pallidus*		
Peaceful Dove	*Geopelia striata*		
Pectoral Sandpiper	*Caldris melanotos*		
Peregrine Falcon	*Falco peregrinus*		
Pied Butcherbird	*Cracticus nigrogularis*		
Pied Cormorant	*Phalacrocorax varius*		
Pied Currawong	*Strepera graculina*		
Pied Stilt	*Himantopus leucocephalus*		
Pink-eared Duck	*Malacorhynchus membranaceus*		
Plumed Egret	*Ardea intermedia plumifera*		CE
Purple Swamphen	*Porphyrio porphyria*^		
Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*		
Purple-gaped Honeyeater	*Lichenostomus cratitius*		V
Rainbow Bee-eater	*Merops ornatus*		
Rainbow Lorikeet	*Trichoglossus haematodus*		
Red Wattlebird	*Anthochaera carunculata*		
Red-backed Kingfisher	*Todiramphus pyrropygia*		
Red-capped Plover	*Charadrius ruficapillus*		
Red-capped Robin	*Petroica goodenovii*		
Red-kneed Dotterel	*Erythrogonys cinctus*		
Red-lored Whistler	*Pachycephala rufogularis*	V	V
Red-necked Avocet	*Recurvirostra novaehollandiae*		
Red-necked Stint	*Calidris ruficollis*		
Red-rumped Parrot	*Psephotus haematonotus*		
Redthroat	*Pyrrholaemus brunneus*		E
Regent Parrot	*Polytelis anthopeplus*	V	V

COMMON NAME	SCIENTIFIC NAME	EPBC	FFG
Restless Flycatcher	*Myiagra inquieta*		
Rock Dove*	*Columba livia**		
Royal Spoonbill	*Platalea regia*		
Ruddy Turnstone	*Arenaria interpres*		E
Rufous Songlark	*Cincloramphus mathewsi*		
Rufous Whistler	*Pachycephala rufiventris*		
Sacred Kingfisher	*Todiramphus sanctus*		
Satin Flycatcher	*Myiagra cyanoleuca*		
Scarlet Robin	*Petroica boodang*		
Sharp-tailed Sandpiper	*Calidris acuminata*		
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*		
Shy Heathwren	*Calamanthus cautus*		
Silver Gull	*Chroicocephalus novaehollandiae*		
Silvereye	*Zosterops lateralis*		
Singing Honeyeater	*Gavicalis virescens*		
Slender-billed Thornbill (Lowan Mallee)	*Acanthiza iredalei hedleyi*		E
Southern Boobook	*Ninox boobook*		
Southern Scrub-robin	*Drymodes brunneopygia*		
Southern Whiteface	*Aphelocephala leucopsis*		
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*		
Splendid Fairy-wren	*Malurus splendens*		
Spotted Harrier	*Circus assimilis*		
Spotted Nightjar	*Eurostopodus argus*		
Spotted Pardalote (coastal)	*Pardalotus punctatus punctatus*		
Straw-necked Ibis	*Threskiornis spinicollis*		
Striated Pardalote	*Pardalotus striatus*		
Striped Honeyeater	*Plectorhyncha lanceolata*		
Stubble Quail	*Coturnix pectoralis*		
Sulphur-crested Cockatoo	*Cacatua galerita*		
Superb Fairy-wren	*Malurus cyaneus*		
Swamp Harrier	*Circus approximans*		
Tawny Frogmouth	*Podargus strigoides*		
Tawny-crowned Honeyeater	*Phylidonyris melanops*		
Tree Martin	*Petrochelidon nigircans*		
Varied Sittella	*Daphoenositta chrysoptera*		
Variegated Fairy-wren	*Malurus lamberti*		
Wedge-tailed Eagle	*Aquila audax*		

COMMON NAME	SCIENTIFIC NAME	EPBC	FFG
Weebill	*Smicrornis brevirostris*		
Welcome Swallow	*Petrochelidon neoxena*		
Western Gerygone	*Gerygone fusca*		
Whiskered Tern	*Chlidonias hybridus*		
Whistling Kite	*Haliastur sphenurus*		
White-backed Swallow	*Cheramoeca leucosternus*		
White-bellied Sea-Eagle	*Haliaeetus leucogaster*		E
White-breasted Woodswallow	*Artamus leucorynchus*		
White-browed Babbler	*Pomatostomus superciliosus*		
White-browed Scrubwren	*Sericonis frontalis*		
White-browed Treecreeper	*Climacteris affinis*		E
White-browed Woodswallow	*Artamus superciliosus*		
White-eared Honeyeater	*Nesoptilotis leucotis*		
White-faced Heron	*Egretta novaehollandiae*		
White-fronted Chat	*Epthianura albifrons*		
White-fronted Honeyeater	*Purnella albifrons*		
White-naped Honeyeater	*Melithreptus lunatus*		
White-necked Heron	*Ardea pacifica^*		
White-plumed Honeyeater	*Ptilotula penicillatus*		
White-throated Needletail	*Hirundapus caudacutus*		V
White-winged Chough	*Corcorax melanorhamphos*		
White-winged Fairy-wren	*Malurus leucopterus*		
White-winged Triller	*Lalage sueurii*		
Willie Wagtail	*Rhipidura leucophrys*		
Yellow Thornbill	*Acanthiza nana*		
Yellow-billed Spoonbill	*Platalea flavipes*		
Yellow-faced Honeyeater	*Caligavis chrysops*		
Yellow-plumed Honeyeater	*Ptilotula ornatus*		
Yellow-rumped Pardalote	*Pardalotus punctatus xanthopyge*		
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*		
Yellow-tailed Black Cockatoo	*Calyptohynchus funereus*		
Yellow-throated Miner	*Manorina flavigula*		
Zebra Finch	*Taeniopygia castanotis*		
Fish			
Australian Bass	*Macquaria novemaculeata*		
Australian Smelt	*Retropinna semoni*		
Brown Trout*	*Salmo trutta**		

COMMON NAME	SCIENTIFIC NAME	EPBC	FFG
Carp*	*Cyprinus carpio**		
Carp Gudgeon (Complex)	*Hypseleotris klunzingeri*		
Common Galaxias	*Galaxias maculatus*		
Eastern Gambusia*	*Gambusia holbrooki**		
Flat-headed Gudgeon	*Philypnodon grandiceps*		
Freshwater Catfish	*Tandanus tandanus*		E
Golden Perch	*Macquaria ambigua*		
Goldfish*	*Carassius auratus**		
Macquarie Perch	*Macquaria australasica*	E	E
Murray Cod	*Maccullochella peelii*	V	E
Obscure Galaxias	*Galaxias olidus*		
Rainbow Trout*	*Oncorhynchus mykiss**		
Redfin Perch*	*Perca fluviatilis**		
Roach*	*Rutilus rutilus**		
Short-finned Eel	*Anguilla australis*		
Silver Perch	*Bidyanus bidyanus*	CE	E
Southern Pygmy Perch	*Nannoperca australis*		V
Tench*	*Tinca tinca**		
Invertebrates			
Sciron Skipper	*Trapezites sciron eremicola*		
Yabby	*Cherax destructor*		
Western Crayfish	*Geocharax falcata*		
Western Swamp Crayfish	*Gramastacus insolitus*		E
Mammals			
Black Wallaby	*Willabia bicolor*		
Brushtail Possum	*Trichosurus vulpecula*		
Eastern Grey Kangaroo	*Macropus rufogriseus*		
House Mouse*	*Mus musculus**		
Lesser Long-eared Bat	*Nyctophilius geoffroyi*		
Rabbit*	*Oryctolagus cuniculus**		
Rakali	*Hydromys chrysogaster*		
Red Fox*	*Canis vulpes**		
Short-beaked Echidna	*Tachyglossus aculeatus*		
Sugar Glider	*Petaurus breviceps*		
Western Grey Kangaroo	*Macropus fuliginosus*		
Western Pygmy Possum	*Cercartetus concinnus*		
White-striped Freetail Bat	*Tadarida australis*		

COMMON NAME	SCIENTIFIC NAME	EPBC	FFG
Reptiles			
Bearded Dragon	*Pogona barbata*		V
Bougainvilles's Skink	*Lerista bougainvilli*		
Boulenger's Skink	*Morethia boulengeri*		
Curl Snake	*Suta suta*		
Eastern long-necked turtle	*Chelodina longicollis*		
Lace Monitor	*Varanus varius*		E
Large Striped Skink	*Ctenotus robustus*		
Marbled Gecko	*Christinus marmoratus*		
Olive Legless Lizard	*Delma inornata*		
Platypus	*Ornithorhynchus anatinus*		V
Striped Legless Lizard	*Delma impar*	V	E

*Introduced species, V (vulnerable), E (endangered), CE (critically endangered), T (Threatened).

A-2 ECOLOGICAL VEGETATION CLASSES (EVCS)

Table A2-1 provides a list and description of the Ecological Vegetation Classes (EVCs) associated with the Wimmera River and its floodplain.

Table A2-1: Description of EVCs associated with the Wimmera River and its floodplain.

EVC NO.	ECOLOGICAL VEGETATION CLASS NAME	BIOREGION(S)	DESCRIPTION
103	**Riverine Chenopod Woodland**	Wimmera	Grassy and low chenopod-dominated eucalypt woodland to 15 m tall with large range of herbs including several annuals. Occurs on fertile, silty clay-loams associated with alluvial terraces of major rivers in areas receiving >500 mm annual rainfall. Sites are associated with recent Quaternary swamp deposits and may be occasionally inundated during flood events. Clay soils are generally waterlogged in winter and dry and cracking in summer.
641	**Riparian Woodland**	Wimmera Lowan Mallee Murray Mallee	Occurs beside permanent streams, typically on narrow alluvial deposits. Woodland to 15 m tall generally dominated by *Eucalyptus camaldulensis* over a tussock grass-dominated understorey. Tall shrubs may be present and amphibious herbs may occur in occasional ponds and beside creeks. While flooding may be common, sites are rarely inundated for lengthy periods.
813	**Intermittent Swampy Woodland**	Murray Mallee	Eucalypt woodland to 15 m tall with a variously shrubby and rhizomatous sedgy - turf grass understorey, at best development dominated by flood stimulated species in association with flora tolerant of inundation. Flooding is unreliable but extensive when it happens. Occupies low elevation areas on river terraces (mostly at the rear of point-bar deposits or adjacent to major floodways) and lacustrine verges (where sometimes localised to narrow transitional bands). Soils often have a shallow sand layer over heavy and frequently slightly brackish soils.
822	**Intermittent Swampy Woodland/ Riverine Grassy Woodland Complex**	Lowan Mallee Murray Mallee	Eucalypt (+/- Acacia) dominated woodland with (variously shrubby) rhizomatous sedgy - turf grass understorey, including mixtures of flood stimulated species in association with species characteristic of drier riverine woodlands. Rare, riverine floodplains of further north-west.
823	**Lignum Swampy Woodland**	Wimmera Murray Mallee	Understorey dominated by Lignum, typically of robust character and relatively dense (at least in patches), in association with a low Eucalypt and/or Acacia woodland to 15 m tall. The ground layer includes a component of obligate wetland flora that is able to persist even if dormant over dry periods.
56	**Floodplain Riparian Woodland**	Wimmera	An open eucalypt woodland to 20 m tall over a medium to tall shrub layer with a ground layer consisting of amphibious and aquatic herbs and sedges. Occurs along the banks and floodplains of the larger meandering rivers and major creeks, often in conjunction with one or more floodplain wetland communities. Elevation and rainfall are relatively low, and soils are fertile alluviums subject to periodic flooding and inundation.
658	**Riverine Grassy Woodland/ Sedgy Riverine Forest/ Aquatic Herbland Mosaic**	Wimmera	No further description available.
659	**Plains Riparian Shrubby Woodland**	Wimmera	Shrub-dominated eucalypt woodland to 15 m tall with large range of grasses, sedges and perennial herbs. Occurs on moderately fertile, relatively well-drained, sandy alluvial topsoils over heavier subsoils. Associated with Quaternary alluvial deposits along narrow, seasonal streams in plains areas receiving <600 mm annual rainfall.
3	**Sand Ridge Woodland/ Damp Sands Herb-rich Woodland Mosaic**	Wimmera	A low, grassy or bracken-dominated eucalypt forest or open woodland to 15 m tall with a large shrub layer and ground layer rich in herbs, grasses, and orchids. Occurs mainly on flat or undulating areas on moderately fertile, relatively well-drained, deep sandy or loamy topsoils over heavier subsoils (duplex soils).

Table A2-2 provides a list and description of the Ecological Vegetation Classes (EVCs) associated with the terminal lakes of the Wimmera River.

Table A2-2: Description of EVCs associated with the terminal lakes of the Wimmera River.

EVC NO.	ECOLOGICAL VEGETATION CLASS NAME	BIOREGION(S)	DESCRIPTION
829	**Chenopod Grassland**	Murray Mallee	Open to sparse shrubland with a more or less continuous tussock grass sward found on heavy somewhat sodic clay plains fringing the active floodplains of major watercourses such as the Loddon and Avoca Rivers.
89	**Dunefield Heathland**	Murray Mallee	Treeless heathland or low shrubland to 2 m tall. Very scattered small mallee form trees may be present. In recently burnt stands (less than 20 years since fire) an open sub-shrub and ground stratum is also common. Occurs on deep siliceous sand on minor dunes and undulating sandplains where siliceous Lowan Sand of coastal origins has accumulated to some depth.
88	**Healthy Mallee**	Murray Mallee	Low mallee shrubland to low open mallee shrubland to 4 m with a dense to moderately dense understorey of heathy shrubs. Occurs on infertile siliceous Lowan Sand on dunefields and sandplains. This is a prominent EVC in the central Big Desert.
813	**Intermittent Swampy Woodland**	Murray Mallee	Eucalypt woodland to 15 m tall with a variously shrubby and rhizomatous sedgy - turf grass understorey, at best development dominated by flood stimulated species in association with flora tolerant of inundation. Flooding is unreliable but extensive when it happens. Occupies low elevation areas on river terraces (mostly at the rear of point-bar deposits or adjacent to major floodways) and lacustrine verges (where sometimes localised to narrow transitional bands). Soils often have a shallow sand layer over heavy and frequently slightly brackish soils.
822	**Intermittent Swampy Woodland/ Riverine Grassy Woodland Complex**	Murray Mallee Lowan Mallee	Eucalypt (+/- Acacia) dominated woodland with (variously shrubby) rhizomatous sedgy - turf grass understorey, including mixtures of flood stimulated species in association with species characteristic of drier riverine woodlands. Rare, riverine floodplains of further north-west.
107	**Lake Bed Herbland**	Murray Mallee	Herbland or shrubland to 0.5 m tall dominated by species adapted to drying mud within lake beds. Some evade periods of prolonged inundation as seed, others as dormant tuber-like rootstocks. Occupies drying deep-cracking mud of lakes on floodplains. Floods are intermittent but water may be retained for several seasons leading to active growth at the 'drying mud stage'.
91	**Loamy Sands Mallee**	Murray Mallee	Semi-arid low mallee shrubland to 5 m tall, typically supporting scattered shrubs above a hummock grass field layer. Typically occurs on deep drifts of Lowan sands in the lee of ridge systems or occupying dune crests and swales in the parabolic and irregularly arranged dune in the Central Mallee and Sunset Country.
981	**Parilla Mallee**	Murray Mallee	Open mallee to 10 m tall supported by shallow accumulations of aeolian material that have been deposited on the slopes of prominent Parilla Sandstone ridges. The understorey is highly variable comprising numerous floristic variants many of which appear to be strongly influenced by land use and fire regime. A well-developed woody shrub layer is typical in relatively undisturbed remnants.
95	**Red Swale Mallee**	Murray Mallee	Dense to sometimes whipstick form of mallee shrubland to 6 m tall with a typically sparse understorey. This EVC does not necessarily occur in dune swales, however it is often found on low points in the jumbled or parabolic dunefields of the Lowan where the underlying Parilla ridges may be "exposed" and are mantled by a thin layer of aeolian material.
96	**Ridged Plains Mallee**	Murray Mallee	Open, quite grassy mallee woodland to 10 m tall, typical of the gently undulating "plains" of the Wimmera and Southern Mallee. Soils are somewhat variable but are typically duplex with grey or brown sandy clay loam or clay loam topsoils of aeolian origin.

EVC NO.	ECOLOGICAL VEGETATION CLASS NAME	BIOREGION(S)	DESCRIPTION
103	**Riverine Chenopod Woodland**	Murray Mallee	Eucalypt woodland to 15 m tall with a diverse shrubby and grassy understorey occurring on most elevated riverine terraces. Confined to heavy clay soils on higher level terraces within or on the margins of riverine floodplains (or former floodplains), naturally subject to only extremely infrequent incidental shallow flooding from major events if at all flooded.
741	**Salt Paperbark Woodland/Samphire Shrubland Mosaic**	Murray Mallee	No further description available.
93	**Sandstone Ridge Shrubland**	Murray Mallee	Low open mallee to 3 m tall typically with a tall shrubby understorey, or shrubland with scattered emergent mallees. A good field character for this EVC is the dominance or co-dominance of the tall shrub Melaleuca uncinata in shrubland or as an understorey shrub in Mallee vegetation. Confined to the crests of outcropping Parilla sandstone ridges and also where these ridges are at least partially obscured by a shallow mantle of Lowan sand.
98	**Semi-arid Chenopod Woodland**	Murray Mallee	Sparse, low non-eucalypt woodland to 12 m tall of the arid zone with a tall open chenopod shrub-dominated understorey to a treeless, tall chenopod shrubland to 3 m tall. This EVC may occur as either a woodland (typically with a very open structure but tree cover >10%) or a shrubland (tree cover <10%) with trees as an occasional emergent.
97	**Semi-arid Woodland**	Murray Mallee	Non-eucalypt woodland or open forest to 12 m tall, of low rainfall areas. Occurs in a range of somewhat elevated positions not subject to flooding or inundation. The surface soils are typically light textured loamy sands or sandy loams.
90	**Tea-tree Scrub**	Murray Mallee	A dense scrub 2 to 3 m tall of Mallee Tea-tree Leptospermum coriaceum associated with the Outlet Creek system. Tea-tree scrub may represent the colonization of Lowan sand deposits that have either been derived from the riverine system or been recently blown across it. The natural firebreak that the riverine system provides may also be an important determinant of its composition. This vegetation community could also possibly exist as a result of an extremely long period without fire in the EVC Sandplain Heathland.
824	**Woorinen Mallee**	Murray Mallee	Widespread mallee woodland to 12 m tall, associated with the east-west orientated calcareous dunefields of the Woorinen Formation with a low, open chenopod dominated shrub understorey. A diverse array of sub-shrubs, herbs and grasses are also present. Typically occurs on fine textured red-brown sandy loam and clay loam soils.

A-3 FLORA SPECIES

Table 0-1

Table A3-1 provides a list of the flora species of the Wimmera River, Mount William Creek, Dock Lake and Wimmera River terminal lakes.

Table A3-1: Flora Species of the Wimmera River, Mount William Creek, Dock Lake and Wimmera River terminal lakes.

COMMON NAME	SCIENTIFIC NAME	EPBC	FFG
African Box-thorn*	*Lycium ferosissium*		
African Love-grass*	*Eragrostis curvula*		
African Thistle*	*Berkheya rigida*		
Annual Beard-grass*	*Polypogon monspeliensis*		
Annual Bluebell	*Wahlenbergia gracilenta s.l.*		
Annual Cudweed	*Euchiton sphaericus*		
Arabian Grass*	*Schimus barbatus*		
Asparagus*	*Asparagus offcinalis*		
Aster-weed	*Aster subulatus*		
Austral Stork's-bill	*Pelargonium australe*		
Australian Hollyhock	*Malva pressiana s.l.*		
Australian Salt-grass	*Distichlis distichophylla*		
Australian Sweet-grass	*Glyceria australis*		
Balcarra nitida	*Austrostipa nitida*		
Barley-grass*	*Hordeum leporinum*		
Barrel Medic*	*Medicago truncatula*		
Beaded Samphire	*Sarcocornia quinqueflora*		
Bearded Out*	*Avena barbata*		
Bent Goodenia	*Goodenia geniculata*		
Berry Saltbush	*Atriplex semibaccata*		
Bitter-pea	*Daviesia spp.*		
Black Box	*Eucalyptus largiflorens*		
Black Cotton-bush	*Maireana decalvens*		
Black Nightshade*	*Solanum nigrum*		
Black Rapier-sedge	*Lepidosperma carphiodes*		
Black Roly-poly	*Sclerolaena muricata*		
Black-anther Flax-lily	*Dianella revoluta*		
Blackberry*	*Rubus fruticosus spp. agg.*		

COMMON NAME	SCIENTIFIC NAME	EPBC	FFG
Blackheads	*Enneapogon nigricans*		
Blackseed Glasswort	*Tecticornia pergranulata*		
Blue Devil	*Eryngium ovinum*		
Blue Rod	*Stemodia florulenta*		
Bluebell	*Wahlenbergia spp.*		
Bluish Raspwort	*Halogaris glauca f. glauca*		
Blunt Greenhood	*Pterostylis curta*		
Bokhara Clover*	*Melilotus albus*		
Bottle Bluebush	*Maireana excavata*		
Box Mistletoe	*Amyema miqueli*		
Bridal Creeper*	*Asparagus asparagoides*		
Bristly Wallaby-grass	*Austrodanthonia setacea*		
Bronze Bluebell	*Wahlenbergia luteola*		
Brown-back Wallaby-grass	*Austrodanthonia duttoniana*		
Buloke	*Allocasuarina luehmannii*		CE
Burr Medic*	*Medicago polymoprha*		
Burr-grass	*Poaceae tragus*		
Cape weed*	*Arctotheca calendula*		
Chickweed*	*Stellaria media*		
Childing Pink*	*Petrorhagia nanteuilii*		
Clay Plantain	*Plantago cunninghamii*		
Cluster Clover*	*Trifolium glomeratum*		
Clustered Lawrencia	*Lawrencia glomerata*		
Coarse Twine-rush	*Apodasmia brownii*		
Coast Barb-grass	*Parapholis incurva*		
Coast Sand-spurrey	*Spergularia media s.l.*		
Common Blown-grass	*Lachnagrostis filiformis s.s.*		
Common Cotula	*Cotula australis*		
Common Eutaxia	*Eutaxia microphyllia var.*		
Common Everlasting	*Chrysosephalum apiculatum*		
Common Fiddle-neck*	*Amsinkia intermedia*		
Common Grass-sedge	*Carex breviculmis*		
Common Heliotrope*	*Heliotropium europaeum*		
Common Mouse-ear Chickweed*	*Cerastium glomeratum s.l.*		
Common Peppercress*	*Lepidum africanum*		

COMMON NAME	SCIENTIFIC NAME	EPBC	FFG
Common Raspwort	*Gonocarpus tetragynus*		
Common Reed	*Phragmites australis*		
Common Sneezeweed	*Centipeda cunninghamii*		
Common Sow-thistle*	*Sonchus oleraceus*		
Common Spike-salt sedge	*Eleocharis acuta*		
Common Tussock-grass	*Poa labillardierei*		
Common Wallaby-grass	*Austrodanthonia caespitosa*		
Common Water-ribbons	*Triglochin procera s.s.*		
Common Wheat-grass	*Anthosachne scabra s.l.*		
Common Woodrush	*Luzula merdionalis*		
Cotton Fireweed	*Senecio quadridentatus*		
Couch*	*Cynodon dactylon*		
Creamy Candles	*Stackhousia monogyna*		
Creeping Monkey Flower	*Mimulus albus*		
Creeping Myoporum	*Myroprum parvifolium*		
Curled Dock*	*Rumex crispus*		
Daphne Heath	*Brachyloma daphnoides*		
Dense Crassula	*Crassula colorata*		
Desert Jasmine	*Jasminum didymium*		E
Desert Mat-rush	*Lomandra juncea*		
Dissected New Holland Daisy	*Vittadinia dissecta s.l.*		
Dove’s Foot*	*Geranium molle var. molle*		
Dune Fescue*	*Vulpia fasciculata*		
Dwarf Mat-rush	*Lomandra nana*		
Erect Chickweed*	*Moenchia erecta*		
Erect Guinea-flower	*Hibbertia riparia*		
Euryops*	*Euryops abrotanifolius*		
False Hair-grass*	*Pentachistis airoides subsp. Airoides*		
Feather Spear-grass	*Austrostipa elegantissima*		
Feather-heads	*Ptilotus macrocephalus*		
Field Madder*	*Sherardia arvensis*		
Finger Rush	*Juncus subsecundus*		
Flannel Cudweed	*Actinobole ulginosum*		
Flat Spurge	*Chamaeyce drummondii*		
Flatweed*	*Hypochaeris radicata*		

COMMON NAME	SCIENTIFIC NAME	EPBC	FFG
Flecked Flat-sedge	*Cyperus gunnii subsp. Gunnii*		
Floating Club-Sedge	*Isolepis fluitans*		
Floodplain Rustyhood	*Pterostylis cheraphila*	V	E
Fog-fruit*	*Phyla canescens*		
Fox-tail Mulga-grass	*Neurachne alopecuroidea*		
French Catchfly*	*Silene gallica var. gallica*		
Frosted Goosefoot	*Chenopodium desertorium*		
Fuzzy New Holland Daisy	*Vittadinia cuneata*		
Gold Rush	*Juncus flavidus*		
Gold-dust Wattle	*Acacia acinacea s.l.*		
Golden Spray	*Viminaria juncea*		
Golden Wattle	*Acacia pycnantha*		
Golden-top*	*Lamarckia aurea*		
Gorse Bitter-pea	*Daviesia ulicifolia*		
Grass Bindweed	*Convolvulus remotus*		
Grass Triggerplant	*Stylidium graminifolium s.l.*		
Grassland Wood-sorrel	*Oxalis perennans*		
Great Brome*	*Bromus diandrus*		
Green Rush	*Juncus gregiflorus*		
Grey Copperburr	*Sclerolaena diacantha*		
Grey Germander	*Teucrium racemosum s.l.*		
Grey Mulga	*Acacia brachybotrya*		
Hairy Bluebush	*Maireana pentagona*		
Hairy Centrolepis	*Centrolepis strigosea subsp. Strigosa*		
Hairy Pennywort	*Hydrocotyle hirta*		
Hare’s-foot Clover*	*Trifolium arvense var. arvense*		
Health Tea-tree	*Leptospermum myrsinoides*		
Hedge Saltbush	*Rhagodia spenescens*		
Hollow Rush	*Juncus amabilis*		
Hop Clover*	*Trifolium campestre var.campestre*		
Hop Goodenia	*Goodenia ovata*		
Horehound*	*Marrubium vulgare*		
Inland Pigface	*Carpobrotus modestus*		
Ivy-leaf Violet	*Viola hederacea*		
Jersey Cudweed	*Pseudognaphalium luteoalbum*		

COMMON NAME	SCIENTIFIC NAME	EPBC	FFG
Jointed Twig-sedge	*Baumea articulata*		
Joint-leaf Rush	*Juncus holoschoenus*		
Kangaroo Apple	*Solanum aviculare*		
Kangaroo Grass	*Themeda triandra*		
Kidney-weed	*Dichondra repens*		
Knob Sedge	*Carex inversa*		
Knobby Club-sedge	*Ficinia nodosa*		
Large Quaking-grass*	*Briza maxima*		
Leafy Blown-grass	*Lachnagrostis aemula s.s.*		
Leafy Wallaby-grass	*Austrodanthonia bipartita s.l.*		
Leek Lily	*Bulbine semibarbata*		
Lemon Beauty-heads	*Calocephalus citreus*		
Lesser Quaking-grass*	*Briza minor*		
Limestone Copperburr	*Sclerolaena obliquicuspis*		
Little Medic*	*Medicago minima*		
Lobed Wallaby-grass	*Austrodanthonia auriculata*		
London Rocket*	*Sisymbrium irio*		
Madrid Brome*	*Bromus madritensis*		
Mallee Groundsel	*Senecio spanomerus*		
Mallee Honey-myrtle	*Melaleuca brevifolia*		
Mallee Love-grass	*Eragrostis dielsii*		
Mallee Rush-lily	*Tricoryne tenella*		
Mallee Wattle	*Acacia montana*		
Matted Bog-sedge	*Schoenus breviculmis*		
Mediterranean Catchfly*	*Silene nocturna*		
Mediterranean Turnip*	*Brassica tournefortii*		
MIlkmaids	*Burchardia umbellata*		
Narrow-leaf Clover*	*Trifolium angustifolium var.*		
Narrow-leaf Cumbungi	*Typha domingensis*		
Native Couch	*Cynodon dactylon var. pulchellus*		
Native Orache	*Atriplex australasica*		
Native Peppercress	*Lepidium pseudohyssopifolium*		
Nodding Chocolate Lily	*Arthropodium fimbriatum*		
Nodding Saltbush	*Einadia nutans subsp.*		
Northern Barley-grass*	*Hordeoum glaucum*		

COMMON NAME	SCIENTIFIC NAME	EPBC	FFG
One-leaf Cape-tulip*	*Moraea flaccida*		
Onion Grass*	*Romulea rosea*		
Onion Orchid	*Microtis spp.*		
Onion Weed*	*Asphodelius fistulosis*		
Ox-tongue*	*Helminthotheca echioides*		
Pale Flax-lily	*Dianella sp. aff. Longifolia (Riverina)*		
Pale Rush	*Juncus pallidus*		
Pale-fruit Ballart	*Exocarpos strictus*		
Paper Sunray	*Rhodanthe corymbiflora*		
Paterson's Curse*	*Echium plantagineum*		
Perennial Rye-grass*	*Lolium perenne*		
Perennial Veldt-grass*	*Ehrharta calycina*		
Pimpernel*	*Anagallis arvensis*		
Pink Bindweed	*Convolvulus erubescens*		
Plains Sedge	*Carex bicehnoviana*		
Poached-eggs Daisy	*Polycalymma stuartii*		
Poong'ort	*Carex tereticaulis*		
Prairie Grass*	*Bromus catharticus*		
Prickly Lettuce*	*Lactuca serriola*		
Prickly Saltwort	*Salsola tragus subsp. Tragus*		
Prickly Tea-tree	*Leptospermum continentale*		
Prickly Woodruff	*Asperula scoparia*		
Prostrate Knotweed*	*Polygonum aviculare s.l.*		
Quena	*Solanum esuriale*		
Quicksilver Grass*	*Aira cupaniana*		
Rat's-tail Fescue*	*Vulpia myuros*		
Rat-tail Couch	*Sporobolus mitchelii*		
Red Bird's-foot Trefoil	*Lotus cruentus*		
Red Brome*	*Bromus rubens*		
Red Sand-spurrey*	*Spergularia rubra s.l.*		
Red Water-milfoil	*Myriophyllum verrucosum*		
River Mint	*Mentha australis*		
River Red-gum	*Eucalyptus camaldulensis*		
River Tea-tree	*Leptospermum obovatum*		
Rough Raspwort	*Haloragis aspera*		

COMMON NAME	SCIENTIFIC NAME	EPBC	FFG
Rough Sow-thistle*	*Sonchus asper s.l.*		
Rough Spear-grass	*Austrostipa scabra*		
Ruby Saltbush	*Enchylaena tomentose*		
Running Postman	*Kennedia prostrata*		
Saffron Thistle*	*Carthamus lanatus*		
Salt Paperbark	*Melaleuxa halmaturorum*		
Salt Sea-spurrey	*Spergularia sp. 3*		
Saltbush	*Atriplex spp.*		
Sand-spurrey	*Spergularia spp.*		
Scale Shredder	*Lepidobolus drapetocoleus*		
Scarlet Bottlebrush	*Callistemon rugulosus*		
Scarlet Pimpernel*	*Lysimachia arvensis*		
Scented Mat-rush	*Lomandra effusa*		
Sea Barley-grass*	*Hordeoum marinum*		
Seablite	*Suaeda spp.*		
Sharp Buttercup	*Ranunculus muricatus*		
Sharp Club-sedge	*Schoenoplectus pungens*		
Sheep Sorrel	*Acetosella vulgaris*		
Sheep's Burr	*Acaena echinata*		
Short-leaf Bluebush	*Maireana brevifolia*		
Sieber Crassula	*Crassula sieberiana s.l.*		
Silver Banksia	*Banksia marginata*		
Silvery Hair-grass*	*Aira caryophyllea*		
Skeleton Weed*	*Chondrilla juncea*		
Slender Bush-pea	*Pultenaea tenuifolia*		
Slender Centaury*	*Centaurium tenuiflorum*		
Slender Cypress-pine	*Callitris gracilis*		
Slender Dock	*Rumex brownii*		
Slender Hop-bush	*Dodonaea viscosa subsp. Angustissima*		
Slender Thistle species aggregate	*Carduus pycnocephalus/tenuiflorus*		
Slender-fruit Saltbush	*Atriplex leptocarpa*		
Small Cooba	*Acacia ligulata*		
Small Hop-bush	*Dodonaea bursarifolia*		
Small Loosestrife	*Lythrum hyssopifolia*		
Small Purslane	*Calendrinia eremaea*		

COMMON NAME	SCIENTIFIC NAME	EPBC	FFG
Small-flower Flax-lily	*Dianella brevicaulis*		
Small-fruit Water-mat	*Lepilaena bilocularis*		
Small-leaf Goosefoot	*Chonopodium desertorum Subsp. Microphyllum*		
Small-leaved Clematis	*Clematis microphyllia s.l.*		
Smooth Cat's-ear	*Hypochaeris glabra*		
Smooth Hawksbeard*	*Crepis capillaris*		
Soft Brome*	*Bromus hordeaceus subsp. Hordeaceus*		
Soursob	*Oxalis pes-caprae*		
Southern Cane-grass	*Eragrostis infecunda*		
Spear Thistle*	*Cirsium vulgare*		
Spear-grass	*Austrostipa sp.*		
Spider Grass	*Enteropogon acicularis*		
Spiny Flat-sedge	*Cyperus gymnocaulos*		
Spreading Eutaxia	*Eutaxia microphyllia var. diffusa*		
Squirrel-tail Fescue*	*Vulpia bromoides*		
Sticky Hop-bush	*Dodonaea viscosa*		
Sticky Sword-sedge	*Lepidosperma viscidum*		
Stiff Cup-flower	*Pogonolepis muelleriana*		
Stiff Flax-lily	*Dianella sp. aff. Revoluta (North-west Victoria)*		
Stinking Pennywort	*Hydrocotyle laxiflora*		
Stinkwort*	*Dittichia graveolens*		
Streaked Arrowgrass	*Triglochin striata*		
Subterranean Clover*	*Trifolium subterraneum*		
Supple Spear-grass	*Austrostipa mollis*		
Swamp Crassula	*Crassula helmsii*		
Swamp Goodenia	*Goodenia humilis*		
Sweet Briar*	*Rosa rubiginosa*		
Tall Sedge	*Carex appressa*		
Tangled Burr-daisy	*Calotis erinacea*		
Tangled Lignum	*Muehlenbeckia florulenta*		
Tassel Rope-rush	*Hypolaena fastiagata*		
Three-nerve Wattle	*Acacia trineura*		CE
Tiny Bristle-grass*	*Rostraria pumila*		
Toowoomba Canary-grass*	*Phalaris aquatic*		

COMMON NAME	SCIENTIFIC NAME	EPBC	FFG
Totem-poles	*Melaleuca decussata*		
Tufted Burr-daisy	*Calotis scapigera*		
Twiggy Beard-heath	*Leucopogon costatus*		
Twiggy Guinea-flower	*Hibbertia virgata*		
Umbrella Wattle	*Acacia oswaldi*		
Upright Water-milfoil	*Myriophyllum crispatum*		
Vanilla Lily	*Arthropodium spp. (s.s.)*		
Variable Sida	*Sida corrugata*		
Velvety Pink*	*Petrorhagia dubia*		
Wall Fescue*	*Vulpia muralis*		
Water Buttons*	*Cotula cornopifolia*		
Water Couch*	*Paspalum distichum*		
Water Nymph	*Najas spp.*		
Water Pimpernel	*Samolus repens*		
Wattle Mat-rush	*Lomandra filiformis*		
Wedge-leaf Hop-bush	*Dodonaea viscosa subsp. Cuneata*		
Weeping Grass	*Microlaena stipoides var. stipoides*		
Weeping Pittosporum	*Pittosporum angustifolium*		
Wild Gladiolus*	*Gladiolus undulatus*		
Wild Oat*	*Avena fatua*		
Wild Sage*	*Salvia verbenacca*		
Wimmera Rye-grass*	*Lolium rigidum*		
Windmill Grass	*Chloris truncata*		
Wingless Bluebush	*Maireana enchylaenoides*		
Wiry Podolepis	*Podolepis capillaris*		
Woody Cassia	*Senna petiolaris*		
Woolly Clover	*Trifolium tomentosum var.*		
Woolly Mat-rush	*Lomandra leucocephala subsp.*		
Woolly Tea-tree	*Leptospermum lanigerum*		

*Introduced species, V (vulnerable), E (endangered), CE (critically endangered), T (threatened).

A-4 PARTNERSHIP AND CONSULTATION

In addition to the steering committee representatives and stakeholders listed in Section 2 of the main report, the following water management partners were involved in the update of the EWMP and/or provided opportunities for involvement:

- Grampians Wimmera Mallee Water
- Victorian Environmental Water Holder
- Commonwealth Environmental Water Holder
- Department of Energy, Environment and Climate Action.

A-5 PAST ENVIRONMENTAL WATERING HISTORY AT THE ASSET.

HISTORY OF WATER RESOURCE MANAGEMENT AND ENVIRONMENTAL WATER RECOVERY IN THE WIMMERA

The Wimmera Mallee headworks system is very old within the context of water resource management in Victoria with the location of Victoria's first water resource infrastructure works when in 1850's the Wilson brothers built a weir across the Wimmera River and lowered the bed level to increase flows into the Yarriambiack Creek for stock and domestic supply (Van Veldhuisen, 2001). Lake Wartook was the first storage, commissioned in 1887 to supply water to fledgling irrigation colonies and townships like Horsham and Natimuk. Various systems involving weirs, pumps, flumes and channels were designed to take water north to land that was being cleared and converted to cropping and grazing. From 1913 to 1966 the remaining headworks storages were constructed and channels supplied water from Clear Lake in the south to Ouyen and beyond in the north and Wedderburn in the east (Van Veldhuisen, 2001). This provided essential supplies to 35,000 people covering 10% of Victoria (Wimmera Mallee Pipeline Project Planning Group, 2003). Irrigation districts also were established around Quantong, Riverside/Drung and Murtoa. Despite the ever-increasing storage capacity to supply the stock and domestic and irrigation systems, water restrictions were historically common due to the massive volumes used in running channels and filling dams. Following the completion of the Northern Mallee Pipeline, the unrestricted demands could be met 77% of the time for stock and domestic and 74% for irrigation supplies under historical inflows (Wimmera Mallee Pipeline Project Planning Group, 2003).

For decades there has been a widespread acknowledgement that the volume of water harvested to supply towns and farms using open earthen channels and farm dams were having a significant impact on the condition on the region's waterways (Van Veldhuisen, 2001). Apart from wet years when storages were full and/or streamflows were too large to harvest, many of these waterways did not flow at all and their environmental, cultural, social and economic values were frequently under severe threat.

Pioneering work in the late 1980's involved trial 'environmental flows' along the lower Wimmera River and monitoring their effectiveness to demonstrate the need for and value of additional environmental water (Anderson & Morison, 1989). There were also some other operational releases that took place outside of drought conditions that had environmental benefits (e.g. stock and domestic supplies for the lower Burnt Creek). However, the Wimmera system was heavily over-allocated (CSIRO, 2008) and so there simply was not the water available to regularly supply the region's regulated waterways.

It was not until the 1990's that action began to take place to redress this with the progressive construction of several stages of the Northern Mallee Pipeline, meaning that a proportion of water savings created by replacing channels and dams with pipes and tanks became available for environmental flows. In the early-2000's further sections of pipeline were completed, increasing the entitlements available for the environment although the record drought greatly restricted allocations. The severe water shortages brought about by the Millennium Drought provided the trigger for the escalation of pipeline works with the Wimmera Mallee Pipeline completed in 2010. This in turn led to further increases to environmental water availability through the creation of passing flow rules and improving the reliability of the environment's regulated entitlement.

The Wimmera Irrigators' Association also showed leadership with their offer to sell the entire channel-supplied irrigation entitlement for environmental flows and it was subsequently purchased for use in 2012 by the Commonwealth Environmental Water Holder. As of 2019, there is a 40,560 ML regulated environmental entitlement to be shared across the Wimmera and Glenelg systems brought about due to water savings from pipeline projects as well as an additional 28,000 ML of low security environmental entitlement solely for use in the Wimmera system from the irrigation entitlement purchase.

Within that same period there has been just as many changes to environmental water management institutions and policy. Wimmera Catchment Management Authority (CMA) took responsibility for planning for environmental water management in the Wimmera in the early 2000's on behalf of the Minister for Environment. Wimmera Mallee Water, the storage manager responsible for environmental water delivery merged with Grampians Water to create Grampians Wimmera Mallee Water (GWMWater) in 2004. In more recent years, the Victorian Environmental Water Holder and Commonwealth Environmental Water Office were created to manage the now substantial environmental water portfolios across multiple river and wetland systems in their jurisdictions.

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