Environmental Water Managemement Plan

Carina Bend

mallee
catchment management authority

Version Number	Description	Issued To	Issue Date
1	Draft V1 for project team review	M. Cooling	30/3/2016
2	Draft V1 for Mallee CMA review	E. Healy	07/04/16
3	Draft V2	E. Healy	27/04/16
4	Reviewed and updated	J. Munro	Mar 2020
5	Updated ecological objectives - Water's Edge Consulting	D. Wood (Mallee CMA)	16/12/2020
6	Reviewed and updated to align with DEECA guidelines – Alluvium Consulting Australia	E. Johnston (Mallee CMA)	17/05/2024

Acknowledgement of Country

Mallee Catchment Management Authority (CMA) acknowledges and respects Traditional Owners, Aboriginal communities and organisations. We recognise the diversity of their cultures and the deep connections they have with Victoria's lands and waters. We value partnerships with them for the health of people and Country.

Mallee CMA Board, management and staff pay their respects to Elders past, present and emerging and recognise the primacy of Traditional Owners' obligations, rights and responsibilities to use and care for their traditional lands and waters.

Abbreviations and acronyms

ACHRIS	Aboriginal Cultural Heritage Register and Information System
AHD	Australian Height Datum
AM	Adaptive Management
AVIRA	Aquatic Value Identification and Risk Assessment
BWS	Basin Wide Strategy
CAMBA	China-Australia Migratory Bird Agreement
CEWH	Commonwealth Environmental Water Holder
CMA	Catchment Management Authority
Ctf	Commence to flow
DCCEEW	Department of Climate Change, Energy, the Environment and Water (C'wth)
DEECA	Department of Energy, Environment and Climate Action (Victorian)
DELWP	Department of Environment, Land, Water and Planning (Victorian, now DEECA)
EPBC	Environment Protection and Biodiversity Conservation
EVC	Ecological Vegetation Class
EWMP	Environmental Water Management Plan
EWP	Environmental Watering Plan
EWR	Environmental Water Reserve
FFG	Flora and Fauna Guarantee
IAP2	International Association of Public Participation
IWC	Index of Wetland Condition
JAMBA	Japan-Australia Migratory Bird Agreement
MDBA	Murray-Darling Basin Authority
LTWP	Long Term Watering Plan
RAP	Registered Aboriginal Party
ROKAMBA	Republic of Korea – Australia Migratory Bird Agreement
SMART	Specific, Measurable, Achievable, Relevant, Time-bound
SWP	Seasonal Watering Proposal
VBA	Victorian Biodiversity Atlas
VEWH	Victorian Environmental Water Holder
VWMS	Victorian Waterway Management Strategy
WMU	Waterway Management Unit

Executive Summary

Environmental Water Management Plans (EWMPs) have been developed for key sites in the Mallee region. The Mallee Waterway Strategy 2014-22 (Mallee CMA, 2014) identified 23 Waterway Management Units (WMU) from 216 targeted waterways in the Mallee. The hydrological interconnectedness and commonality of threats impacting on the waterway values were used to group the WMUs into planning units. This EWMP has been developed for Carina Bend, which is within the Happy Valley WMU. The EWMP will help to guide future environmental watering activities for this area.

Carina Bend features a lagoon system nearly 5km in length (Carina Bend Wetland) as well as one smaller unnamed wetland and low meander scroll complexes supporting river red gum woodland vegetation communities. The central floodplain supports higher terraces with black box and lignum vegetation communities.

Carina Bend supports species of high conservation significance including Murray cod and the White-bellied Sea-eagle, which rely on open freshwater habitat. Several additional threatened species have been recorded nearby to Carina Bend such as the Regent Parrot, Brown Tree-Creeper, White-browed Tree Creeper and Carpet python. These species rely on the health of large mature river red gums, which are prevalent within the target area. The wetland potentially provides excellent seasonal habitat for fish, frogs and waterfowl.

The long-term management goal for the Carina Bend EWMP is:

"To provide a water regime that will support the health of fringing mature river red gum and provide seasonal habitat for native fish, frogs and waterfowl."

The ecological objectives to support the management goal for Carina Bend are:

CB1: By 2030, improve condition and maintain extent from baseline levels of river red gum (*Eucalyptus camaldulensis*) to sustain communities and processes typical of such communities at the Carina Bend asset.

CB2a: By 2030, protect and restore biodiversity by maintaining representative populations of small bodied native fish at the Carina Bend asset, including gudgeon spp (*Philypnodon* spp) and Murray-Darling rainbow fish *(Melanotaenia fluviatilis*).

CB2b: By 2030, protect and restore biodiversity by maintaining representative populations of frogs at the Carina Bend asset.

CB3a: By 2030, maintain nesting and recruitment of non-colonial waterbirds (N1, N2, N3 and N4, after Jaensch 2002) at the Carina Bend asset, by maintaining a mixture of tree, low vegetation/shrubs, and ground/islet nesting habitat.

CB3b: By 2030, maintain representative populations of shallow-water and deep-water feeding guilds of waterbird (F2 and F3, respectively, after Jaensch 2002) at the Carina Bend asset, by maintaining a mixture of shallow and deep-water habitats.

CB4a: By 2030, improve vital habitat at the Carina Bend asset by increasing the diversity of aquatic macrophytes present across a range of Water Regime Indicator Groups.

CB4b: By 2030, improve condition and maintain extent from baseline levels of lignum (*Duma florulenta*) to sustain communities and processes reliant on lignum communities at the Carina Bend asset.

The optimal watering regime aims to maintain Carina Bend Wetland as a semi-permanent freshwater wetland, with a seasonally inundated fringe.

The regime includes filling Carina Bend Wetland every second year in late winter/early spring to 46m AHD and allowing water levels to fall naturally by seepage and evaporation over summer and autumn. This will support fringing river red gum communities and aquatic values. In every fourth year, the wetland should be filled to 46.7m AHD to inundate the lignum communities in September, with water levels allowed to fall naturally by seepage and evaporation over summer and autumn.

Environmental watering at the site is managed via temporary pumps and temporary earthen banks. Culverts are also present at the site.

This document identifies key knowledge gaps for Carina Bend and provides recommendations for monitoring of the site to adaptively manage the environmental watering of the site and maximise environmental outcomes.

Table of Contents

1 Introduction

This Environmental Water Management Plan (EWMP) has been prepared by the Mallee Catchment Management Authority (CMA) to establish the long-term management goals of Carina Bend.

The Carina Bend EWMP was first developed in 2012 and updated in 2016 and 2020. This document is a full revision of the EWMP, to update content and to align the EWMP with version 6 of the EWMP Guidelines for rivers and wetlands released by the Department of Energy, Environment and Climate Action (DEECA, formerly DELWP) in 2022 (DELWP 2022).

1.1 PURPOSE AND SCOPE OF AN EWMP

An EWMP is a management plan for a wetland, wetland complex or river system that sets out the environmental watering goals and objectives, and the water regime required to meet the set objectives. An EWMP describes the:

- consultation undertaken for EWMP preparation and implementation
- asset overview and characteristics
- water-dependent environmental values present
- water-related threats to the environmental values
- management goals for the asset
- environmental objectives, targets and values that environmental watering of the asset will support or improve
- watering requirements needed to meet environmental objectives
- environmental water delivery infrastructure, management and constraints
- risks associated with environmental water delivery
- outcomes intended to be demonstrated through monitoring and assessment, and
- knowledge gaps to address

Further information on the purposes of EWMPs and how they relate to other plans, strategies and policies is provided in Appendix 1.

1.2 POLICY CONTEXT

Management of environmental water in Victoria is a statewide partnership between the Victorian Environmental Water Holder (VEWH), catchment management authorities (including Melbourne Water), DEECA, land managers including Parks Victoria and local councils, water corporations, Traditional Owner groups, and interstate agencies including the Commonwealth Environmental Water Holder (CEWH) and the Murray–Darling Basin Authority (MDBA).

Environmental watering in Victoria has historically been supported by management plans such as EWMPs, 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 help managers evaluate how well those assets responded to the water they received or what could be done better.

National and State Acts, policies and strategies determine management of the target area. Legislation relevant to Carina Bend and the management of its environmental values are listed in Table 1.

Table 1. Legislation, conventions, and listings relevant to the target area

Legislation	Jurisdiction
Environment Protection and Biodiversity Conservation Act 1999	National
Flora and Fauna Guarantee Act 1988	State
China - Australia Migratory Bird Agreement (CAMBA) Japan - Australia Migratory Bird Agreement (JAMBA) Republic of Korea - Australia Migratory Bird Agreement (ROKAMBA)	National (relevant international agreements administered under the *EPBC Act*)

A regional context document (North, 2014a) has been prepared to compliment the Mallee CMA EWMPs and should be read in conjunction with this document.

2 Partnership and Consultation

2.1 TARGET AUDIENCE

This section identifies the target audience and modes of consultation necessary to manage environmental water delivery, report against stated objectives and targets, and promote adaptive management over the life of the EWMP.

Engagement with stakeholder groups is based on the International Association of Public Participation (IAP2) spectrum (Figure 1). The spectrum allows for a tailored approach based on stakeholder groups and their needs.

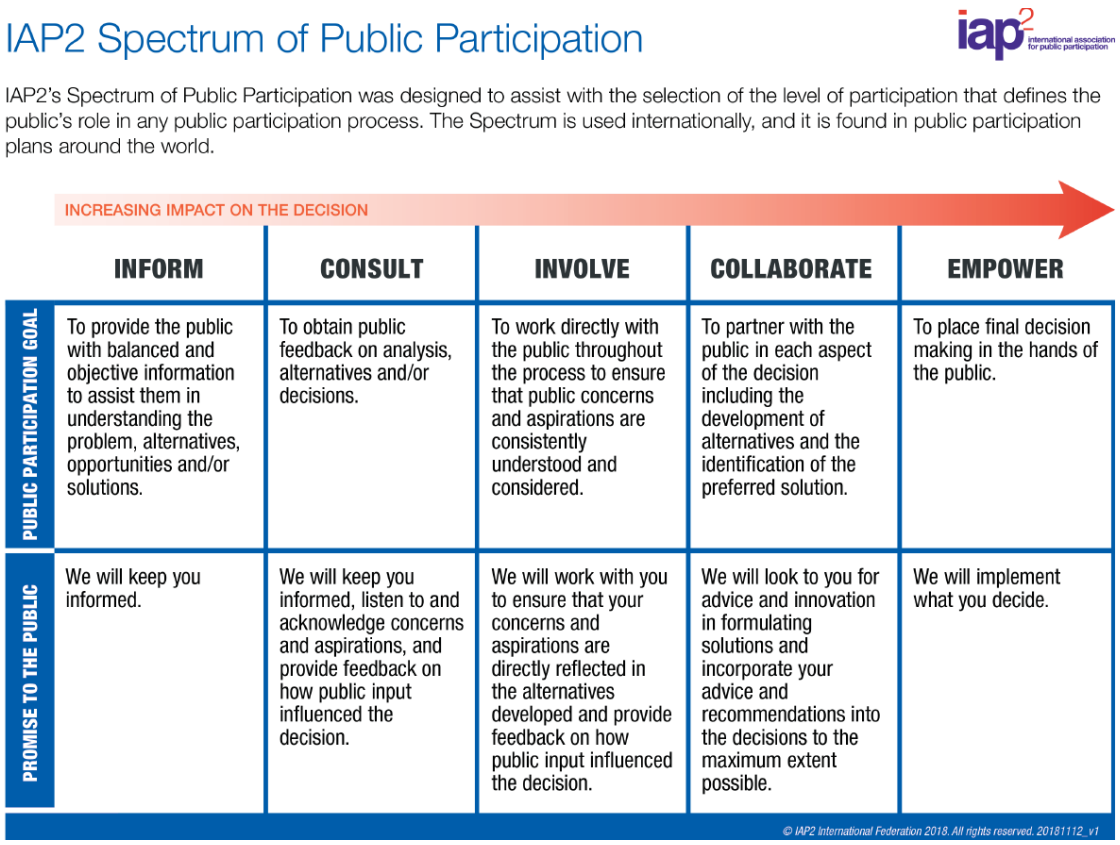

Figure 1. IAP2 Spectrum (Source: (c) International Association for Public Participation www.iap2.org)

Table 2 lists the main stakeholder groups with an interest in environmental water based on their needs and interests and level of engagement required. To read more about the role of specific stakeholders in overseeing environmental water at Carina Bend, refer to Sections 3.2 and 3.4.

Mallee CMA develops a communication and engagement plan each year that covers environmental watering events for the entire Mallee CMA region, including Carina Bend. This ensures that all stakeholders and community members are aware of the Carina Bend environmental watering operations.

Table 2. Stakeholder groups with an interest in environmental water at Carina Bend

Stakeholder groups	Stakeholders	Needs and interests	IAP2 level	Consultation modes
Public land managers	Parks Victoria	Managing impacts from watering such as access, State-level environmental management	Collaborate	Monthly Meetings
	Department of Energy, Environment and Climate Action (DEECA)	State level environmental management planning, land manager, threatened species manager	Collaborate	Monthly Meetings
	Mallee CMA	Regional waterway and environmental management	N/A	N/A
River operators	Goulburn Murray Water (GMW)	Manage Water Storage	Collaborate	Formal Meetings
Local government	Swan Hill Rural City Council	Access during watering events.	Involve	Meetings, phone calls, correspondence.
Aboriginal Stakeholders	See Section 2.4: Traditional Owners	Ongoing connection to Country and protection of cultural heritage and values. Environmental impacts and benefits. Environmental watering regimes and how these may be timed to support/promote cultural values. Assistance in planning and implementation of programs.	Involve	Ongoing engagement with Mallee CMA's Aboriginal engagement team. Engagement is largely undertaken in-person and, where possible, on Country.
Environmental Water Holders	Victorian Environmental Water Holder	Decision-making around annual environmental water usage.	Collaborate	Formal Meetings
Private landholders	Local landholders	Assistance in planning and implementation of programs	Inform	Directly affected landholders will be informed of watering proposals and asked to provide feedback if relevant.
Community representatives	Annuello Landcare Group Wemen Progress Association Mildura Birdlife	Watering benefits and impacts on local communities, such as access to parks and river during watering events.	Consult	Via existing groups such as the Mallee CMA Land and Water Committee. Mallee CMA social media and news

2.2 DEVELOPING/UPDATING THE EWMP

In the development of this EWMP, Mallee CMA carried out community consultation in the following ways:

- Discussions with the Mallee CMA Land and Water Advisory Committee
- Workshops and on-country engagement with Traditional Owners (see Section 2.4)
- Meetings with Agency stakeholders
- Meetings with landholders
- Online surveys
- In-person engagement at local events such as markets and environmental group meetings
- Social media platforms.

2.2.1 Verifying asset values

Asset values at Carina Bend have been established through environmental assessments and the development of previous versions of this EWMP. Consultation has been a key part of these processes with Traditional Owners, community members and technical specialists. Mallee CMA has continued to engage on asset values throughout the development of the EWMP, particularly with Traditional Owners and private and public landholders.

2.2.2 Informing proposed management objectives, targets and approaches

Mallee CMA has a long working relationship with those who have an extensive knowledge of Carina Bend and floodplain ecosystems. This work has been central to providing a basis for local knowledge and expertise.

Combined with the Seasonal Watering Proposal, the data and knowledge from the proposed monitoring activities will guide future watering events, as part of the adaptive management approach.

2.2.3 Promoting adaptive management

Mallee CMA and other partners will take an adaptive management approach considering both varying seasonal conditions and lessons learned from previous events.

After the annual adaptive management checkpoint, Mallee CMA will adapt the EWMP if needed, which would then go through consultation, giving stakeholders the opportunity to comment on any updates.

2.3 COMMUNITY ENGAGEMENT

To inform the EMWP update community stakeholders were engaged in-person during local events such as the Red Cliffs Markets and local environmental group meetings. This engagement included a 'Pins in Maps' activity, where the community provided information on uses and values at specific locations at the site.

Community stakeholders were also engaged via an online survey, which was hosted on the Mallee CMA website in December 2023 – January 2024. The survey was designed to enable community members, landholders, recreational users, environmental groups and other interested parties to provide input to the plans.

The survey supplements earlier community engagement about the Carina Bend EWMP, and annual community engagement that informs the Seasonal Watering Proposal (SWP). Community consultation occurs at the IAP2 level of CONSULT.

Details of community engagement conducted as part of the update is provided in Appendix 2.

2.4 TRADITIONAL OWNERS

Engagement with Traditional Owners was conducted in a group setting at the INVOLVE level of the IAP2 framework, with the level of interest and involvement self-determined by Traditional Owners. Mallee CMA held discussions with Traditional Owners representatives from Culpra Milli Corporation, Munatunga Elders, Gilbie Aboriginal Corporation, Latji Latji Mumthelang, Tati Tati Land and Water Indigenous Corporation, Wadi Wadi Nation, Tati Tati Wadi Wadi Land and Water Indigenous Cooperation, and Dadi Dadi Weki Weki Aboriginal Cooperation attended the meeting on Country at Liparoo in October 2023. Through this engagement activity, Traditional Owner stakeholders were asked to identify the values/uses at Carina Bend by placing pins on a map where these uses and values occurred. Information from this consultation has informed cultural site use and values incorporated into this EWMP. In-line with the EWMP guidelines, consultation with Traditional Owners is ongoing.

3 Asset Overview

The Mallee CMA region is situated in the north-west of Victoria. The area of responsibility is close to 39,000 km2 (3.9 million ha) and has a regional population estimated to be 67,000. Population centres include Mildura, Birchip, Sea Lake, Ouyen, Robinvale, Red Cliffs and Merbein. The boundaries of the Mallee CMA region cover almost one fifth of Victoria, making it the largest area managed by a CMA in the state.

Approximately 40% of the land area within the Mallee CMA boundary is public land, consisting mainly of national parks, reserves, wilderness, and large areas of riverine and dryland forests. The other 60% is predominantly dryland crops, but there is also a significant investment in irrigated horticulture including grapes, citrus, almonds, olives and vegetables along the River Murray corridor. Irrigated crops contribute over 40% of the value of agricultural production for the region.

The site for this plan is the Carina Bend sub-unit of the Happy Valley WMU (referred to herein as Carina Bend). Carina Bend is located 25km south west of Robinvale on the River Murray floodplain (Figure 2).

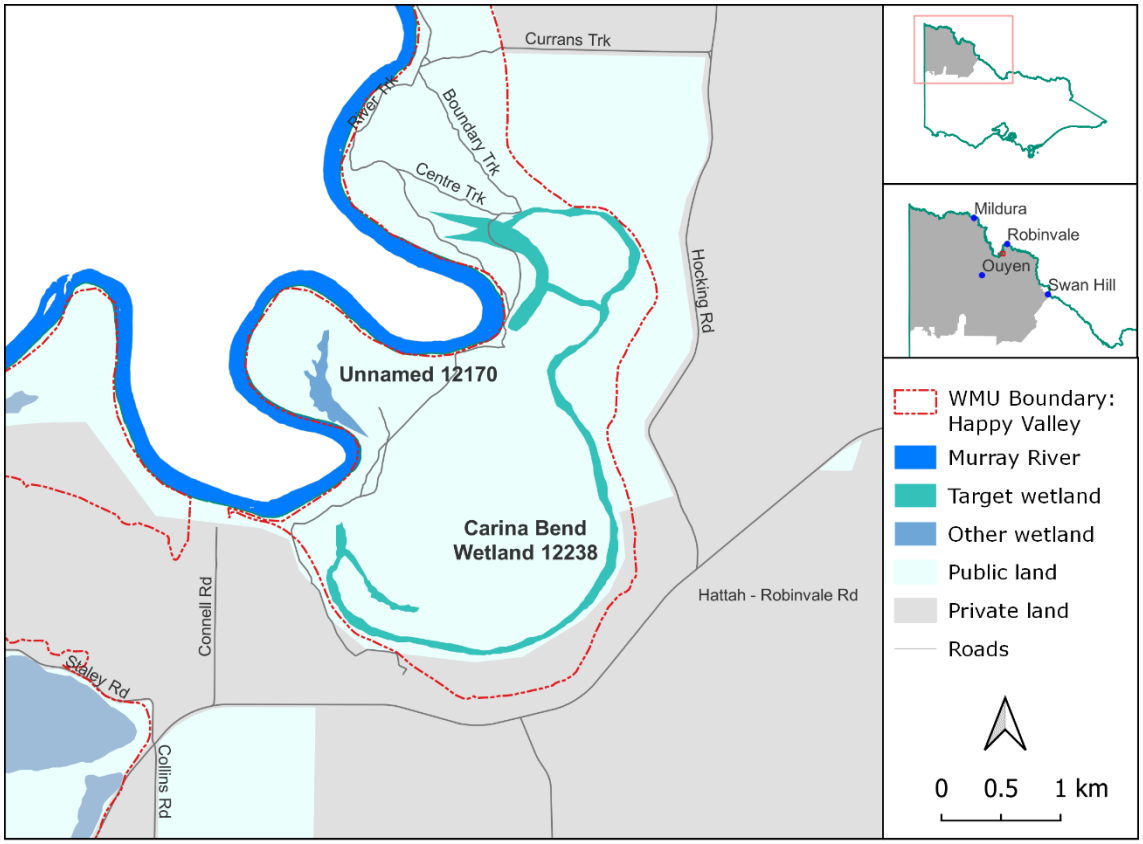

Figure 2. Current wetlands at Carina Bend

Carina Bend is situated on the River Murray floodplain, 25km south west of Robinvale, between the townships of Wemen and Happy Valley. The Carina Bend sub-unit features a lagoon system nearly 5km in length (Carina Bend Wetland) as well as one smaller, unnamed wetland and low meander scroll complexes that support river red gum woodland vegetation communities. The central floodplain supports higher terraces with black box and lignum vegetation communities (Ecological Associates, 2007b).

Until recently, wetlands that comprise the south western end of Carina Bend Wetland (from the entry point at 1081.5 river km) have been used to hold irrigation water (Ecological Associates, 2007b).

3.1 CATCHMENT SETTING

Carina Bend is in the Robinvale Plains bioregion within the Mallee CMA region. The majority of the bioregion is a narrow gorge confined by the cliffs along the River Murray. These are entrenched within older up-faulted Cainozoic sedimentary rocks. Alluvium deposits from the Cainozoic period gave rise to the red brown earths, cracking clays and texture contrast soils (Vertosols, Chromosols and Sodosols). The floodplain supports Riverine Grassy Forest and Riverine Grassy Chenopod Woodland ecosystems (DEECA, 2023b).

Carina Bend is part of an extensive floodplain woodland complex that extends along the River Murray in the Robinvale area. To the immediate southwest of Carina Bend is the Pound Bend sub-unit of the Happy Valley WMU (managed via the Pound Bend EWMP) and the Wemen Flora and Fauna Reserve. Further southwest is the Wemen-

Liparoo sub-unit of the Happy Valley WMU (managed via the Wemen-Liparoo EWMP). The Hattah-Kulkyne National Park is located ~18km west of Carina Bend.

3.2 LAND STATUS AND MANAGEMENT

Several agencies and individuals are involved in managing the land and water at Carina Bend (Table 3). Land management boundaries are shown in Figure 3.

Carina Bend is subject to three public land classifications: Proposed Murray River Park, River Murray Reserve and Carina Bend Riverine Forest (Crown Land). Parks Victoria is the public land manager at Carina Bend. There is also an area of private land within Carina Bend.

Table 3. Land and water managers at Carina Bend

Organisation	Management Role
Department Energy, Environment, and Climate Action (DEECA) - Minister for Water (Victoria)	• Oversee Victoria's environmental water management policy framework, and its implementation. • Administer the broader water allocation and entitlements framework and the *Water Act 1989* (Vic).
Mallee CMA	• The waterway manager that plans and identifies environmental water needs across the Mallee region under the *Water Act 1989* (Vic). • Approves and manages delivery of environmental water and monitoring and reporting of outcomes, in accordance with environmental objectives.
Parks Victoria	• The land manager for the Crown land under the *National Parks Act 1975* (Vic) and *Crown Land (Reserves) Act 1978* (Vic) • Manages pests and specific environmental impacts. • Supports watering on public land and manages any impacts, for example by engaging with site visitors about environmental water-related matters and managing public access during and after an event.
Victorian Environmental Water Holder	• Manager of Victoria's environmental water entitlements
Private landholders	• Land managers of a southeastern area of Carina Bend

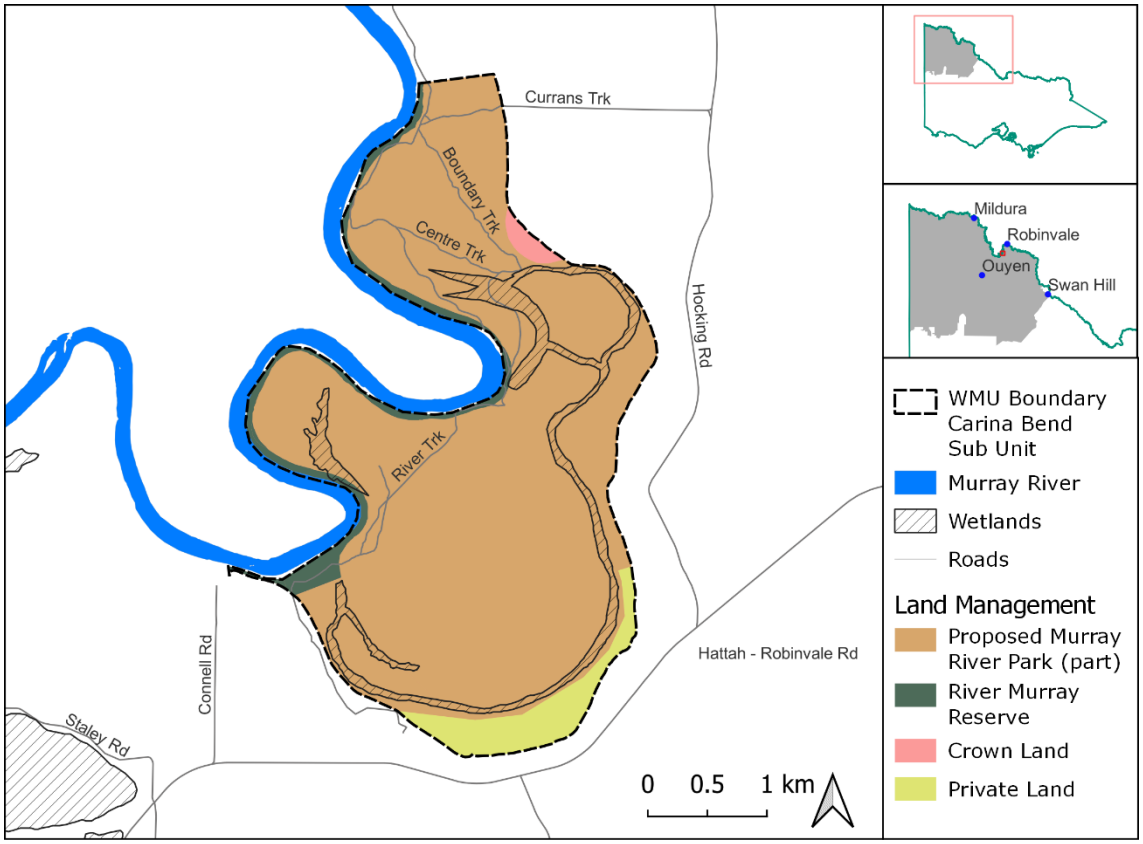

Figure 3. Land management boundaries at Carina Bend

3.3 ASSET CHARACTERISTICS

An overview of the main characteristics of the wetlands at Carina Bend is provided in Table 4. Wetland types found within Carina Bend are shown in Figure 4.

Table 4. Wetland characteristics at Carina Bend

Characteristics	Description
Name	Carina Bend
Mapping ID (Wetland Current layer)	Carina Bend Wetland (ID: 12238) Unnamed wetland (ID: 12170)
Area of wetlands in target area	74.12 ha
Bioregion	Robinvale Plains
Conservation status	Bioregion conservation status: areas of EVCs listed as Vulnerable, Depleted and Least Concern
Land status	Public land: Proposed Murray River Park, River Murray Reserve, Carina Bend Riverine Forest (Crown land)
Land manager	Parks Victoria, DEECA, private landholders

Characteristics	Description
Surrounding land use	Dryland cropping, irrigation agriculture (almonds, grapes and oranges), town of Happy Valley
Water supply	Natural inflows from the River Murray and local catchment runoff
Wetland category (Wetland Current layer)	Carina Bend Wetland: Unknown (regions of shallow freshwater marsh, deep freshwater marsh and permanent open freshwater Corrick classes). Unnamed wetland 12170: Unknown (shallow freshwater marsh Corrick class)
Wetland depth at capacity	Carina Bend Wetland: Approximately 3m at the deepest points Unnamed wetland 12170: depth unknown (shallow)

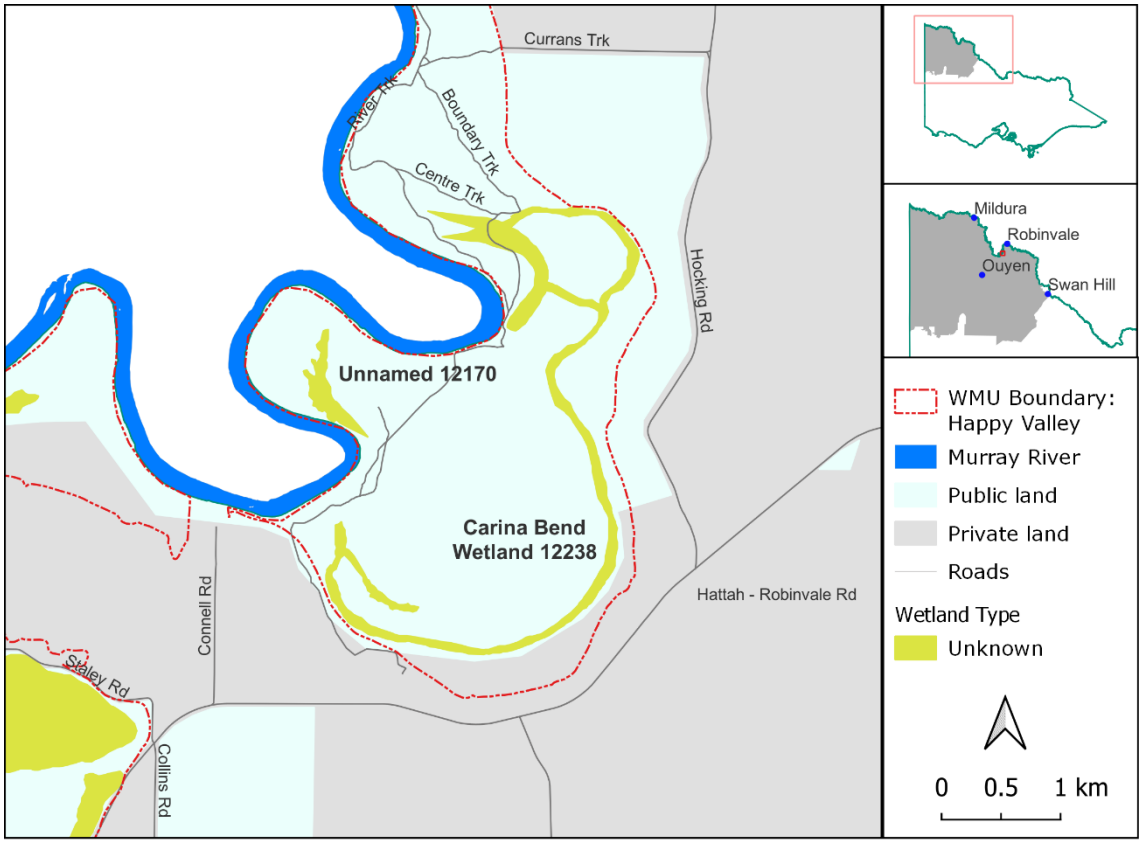

Figure 4. Wetland types at Carina Bend

The Mallee Waterway Strategy 2014-2022 identifies Carina Bend Wetland as a medium priority wetland in the Mallee CMA region.

The whole of Carina Bend has a water requirement as a floodplain complex, but the focus of this plan is the area of the floodplain where environmental water can be managed currently. This target area consists of Carina Bend Wetland and an area of Grassy Riverine Forest / Floodway Pond Herbland Complex and Intermittent Swampy Woodland. The target area is 135.9 ha, as shown as the inundation extent at 46.7 m AHD in Figure 5.

Unnamed wetland #12170 is excluded from the target area. Expansion of the target area is possible only with significant alterations to River Murray operations such as large releases from storage. This is beyond the scope of this EWMP but is being addressed at the Murray-Darling Basin scale.

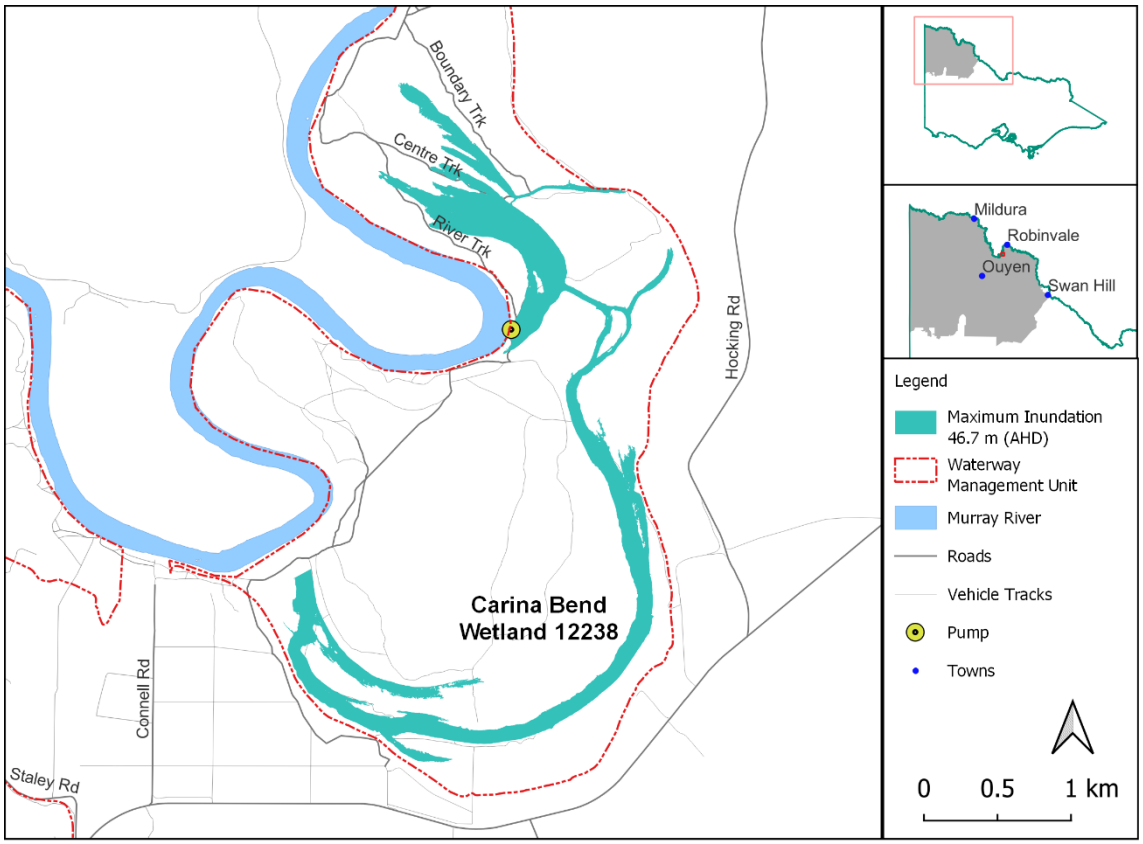

Figure 5. Maximum inundation extent at Carina Bend (46.7 mAHD)

3.3.1 Conceptualisation of the site

Carina Bend is represented in a conceptual model (Figure 6) which is a visual representation of the processes and components within the target area that are discussed throughout this EWMP.

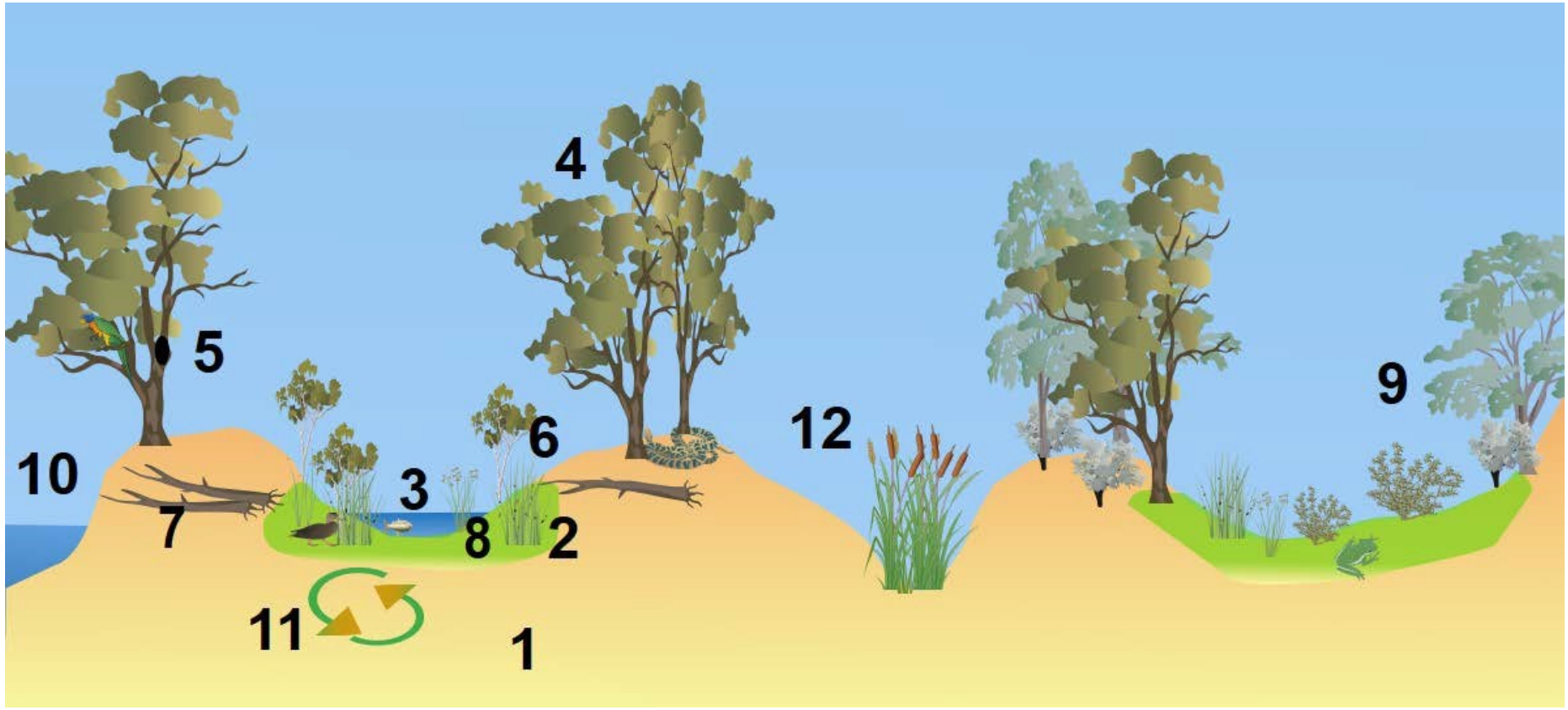

Figure 6. Carina Bend Conceptual Model

1) The Carina Bend Wetland is comprised of a series of wetlands nearly 5km long that can join up during high flows. The deepest points are approximately 3 metres.
2) Prior to river regulation parts of these wetlands would have been inundated annually during winter flows. Water levels would have dropped over the summer and autumn exposing the wetland edges and encouraging macrophyte growth.
3) Watering to support semi-permanent water in the channel will provide habitat for small-bodied fish such as gudgeon species and reliable aquatic habitat for waterfowl.
4) Mature, hollow bearing river red gum line the wetlands and River Murray frontage. Watering Carina Bend wetland will result in improved tree health for significant areas of river red gums along the channel.
5) Hollows in mature river red gum provide important habitat for fauna including the regent parrot and carpet python which have been recorded breeding at the site.
6) The northern end of Carina Bend Wetland spreads out into areas of shallow water and sandy benches. During and following inundation, the Lignum Swampy Woodland and Intermittent Swampy Woodland will support a complex habitat structure of macrophyte beds, overhanging river red gum branches, shrubs and lignum. These areas will provide excellent frog habitat.
7) Fallen woody debris provides feeding sites for the brown tree-creeper as they forage for insects from the ground to the canopy. Appropriate inundation frequencies will support tree health and the long-term supply of woody debris.
8) Carina Bend Wetland supports Floodway Pond Herbland in the channel fringed by Intermittent Swampy Woodland. Refer to Section 5.1 for Ecological vegetation class map.
9) Lignum Swampy Woodland, Lignum Swamp and Riverine Chenopod Woodland are present in adjacent, higher areas of the floodplain. Other terraces, wetlands and channels also host areas of Shallow Freshwater Marsh, Grassy Riverine Forest and Shrubby Riverine Woodland. Refer to Section 5.1 for an Ecological Vegetation Class map.
10) River regulation and water extraction for irrigation have reduced the frequency, duration and magnitude of inundation of floodplain wetlands in this section of the River Murray.
11) The floodplain is currently only inundated during very high river flows. Reduced floodplain and wetland inundation have contributed to reductions in the diversity and productivity of riparian and floodplain vegetation communities and a reduction in habitat availability and structural complexity for aquatic and terrestrial fauna. Channels and wetlands are lined with juvenile river red gums that germinated following previous inundation events.
12) Some channels at the site have been modified and deepened for irrigation supply, reducing the width and complexity of the littoral zone.

3.4 ENVIRONMENTAL WATER SOURCES

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, unregulated flows and specific environmental entitlements. Environmental entitlements can be called out of storage

when needed and delivered to wetlands or streams to protect their environmental values and health.

The VEWH is responsible for holding and managing Victoria's environmental water entitlements and sourcing water from the Victorian Murray system for delivery to Carina Bend. This could include water held by the VEWH or CEWH. Details of the VEWH's environmental water entitlements are available at: https://www.vewh.vic.gov.au/watering-program/how-much-water-is-available.

4 Current/Historical Hydrological Regime and System Operations

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

Hydrology at Carina Bend is best described using gauge #414203 (Murray River @ downstream of Euston Weir).

River Murray hydrology

River Murray hydrology has been altered significantly by regulation and diversion upstream. Storages in Victoria and New South Wales are managed to capture water in winter and spring and to deliver this water at manageable flow rates to consumers (primarily irrigators) during the summer. The impact on river hydrology has been a reduction in large winter and spring flow peaks and enhancement of low summer flows.

The ecologically significant effects of these hydrological changes have been to:

- largely eliminate flowing water habitat under normal regulated flows
- reduce the frequency and duration of floods that reach higher-level wetlands and floodplain areas.

The river now spends more time fluctuating at very low flows, less than 10,000 ML/d, than under natural conditions. Events that inundate low-lying wetlands, up to 30,000 ML/d, now occur at 40% the frequency of natural conditions. The duration of these events, when they do occur, has also been reduced by almost 40%. The impact on floodplain inundation is also significant. While the duration of events exceeding 70,000 ML/d under current conditions is similar to natural, the frequency of these events has declined to as much as 50% of natural. This has resulted in a major increase in the interval between very high flow events.

Mean annual flows at Euston have been reduced by 49% from natural levels, although seasonality of mean monthly flows is largely unaltered (Maheshwari, Walker and McMahon, 1993; Ecological Associates, 2006)

Wetland Hydrology

Water first enters the system near a former pump station at 1086 river km at flows of >25,000 ML/day at gauge #414203 (P.Goldring pers.comm. 17/01/07:cited in Ecological Associates, 2007b, Table 5). Following this water backs into Carina Bend wetland via an excavated channel

to the north and south. As river levels increase water continues to fill Carina Bend wetland. When fully connected, Carina Bend wetland is over 5 km long. Until recently, water was pumped into Carina Bend wetland for re-lifting for irrigation. This ceased in 2008, when irrigation pumps were taken off the anabranches and relocated to the main channel.

Table 5. Commence to flow rate for Carina Bend

Wetland	Commence to flow (ctf) with River Murray flows
Carina Bend Wetland	25,000 ML/d at gauge #414203

Under pre-regulation condition Carina Bend wetland would have filled on average 67.5 times in 100 years and post-regulation this has reduced by almost 50%. The event duration has also reduced from 98 days by almost 50%.

Under pre-regulation conditions the wetland would have commenced to fill at flows of 25,000 ML/day on average 97.4 times per 100 years compared with 70.2 times per 100 years post-regulation. The median duration of inundation events has been reduced from 177 days to 100 days since river regulation (Gippel, 2014).

4.1 GROUNDWATER AND SALINITY INTERACTIONS

Groundwater and salinity interactions at Carina Bend wetland are a knowledge gap.

4.2 ENVIRONMENTAL WATERING

Environmental watering at Carina Bend wetland began in 2005, and has occurred on several occasions, as shown in Table 6. The water was pumped onto the floodplain using temporary earthen banks and mobile pumps.

Table 6. Summary of environmental watering at Carina Bend

Water year	Time of inflow	Environmental Water Source	Total volume (ML)	Area (ha) inundated
2005	Spring	Surplus flows EWA	468	80
2006	Autumn	Donated	695	100
2009-2010	Autumn-Winter	EWR	1040	74
2010-2011	Summer	Natural flows	unknown	unknown
2012-2013	Spring	Natural flows	unknown	unknown
2016-2017	Spring	Natural flows	unknown	unknown
2017-2018	Spring-Summer	VEWH	800	74
2019-2020	Spring	VEWH	878	74
2021-2022	Spring	Natural flows	unknown	unknown
2022-2023	Spring-Summer	Natural flows	unknown	unknown
2023-2024	Spring	Natural flows	unknown	unknown

Initially environmental water was delivered to Carina Bend as part of an 'emergency response' to assist the vegetation during the prolonged dry conditions which had resulted in a decline in river red gum (*Eucalyptus camaldulensis*) health. The environmental watering flooded the whole of Carina Bend wetland, but it did not reach the broader floodplain. It was effective in improving the health of trees lining the creeks and wetlands in the target area and had the added benefit of providing some drought refuge for waterbirds. Along with increased foliage vigour, it was reported that many of the larger river red gum and black box (*E. largiflorens*) have since flowered and seeded with the bands of young seedlings now forming in and around the wetted-up margins. Wetland plants such as moira grass (*Pseudoraphis spinescens*), spike sedge (*Eleocharis microcarpa*), and marsh clubrush (*Bolboschoenus medianus*) were present. Floodplain fauna that benefited from the watering events include frogs, turtles and invertebrates (Sunraysia Environmental, 2008).

Carina Bend has been watered on 11 occasions from 2005-2023, either naturally or with environmental water, and watering targets are currently being met. Several natural events have inundated Carina Bend and reached higher elevations on the broader floodplain (2010/2011, 2016/2017 and 2022/2023), supporting water-dependent flora and fauna at the site, and ecosystem processes.

5 Water Dependent Values

Wetlands and waterways on the floodplain are a vital component of the landscape. The habitat provided by vegetation communities around wetlands is essential to a range of fauna. Other ecological functions provided by floodplain complexes include water filtration, slowing surface water flow to reduce soil erosion, flood mitigation and reducing nutrient input into waterways. Protecting the ecological functioning of wetlands ensures these services are maintained.

Carina Bend provides a range of shelter and food resources for native fauna, flora and vegetation communities. The types of habitat provided, and consequently the species that utilise the site, change as water inundates the wetlands and floodplain and recedes again.

Flora and fauna data for the site is very limited. While observations from the Victorian Biodiversity Atlas (accessed via NatureKit, DEECA 2023) have been included, it is recommended that flora and fauna surveys are undertaken at the site to improve knowledge of the site's ecological values.

5.1 ENVIRONMENTAL VALUES

5.1.1 Ecosystem type and function

Wetland ecosystems support distinctive communities of plants and animals and support ecosystem functions. Floodplain wetlands perform important functions necessary to maintain the hydrological, physical and ecological health of river systems.

Three key broad ecosystem functions have been identified for the Carina Bend EWMP. Each function is interlinked and must be supported in order for the ecosystem to flourish. The functions are briefly described below.

Connections across floodplains, adjacent wetlands and billabongs (lateral)

Inundating the length of Carina Bend Wetland will provide a range of habitat types: deep pools, shallow benches for macrophyte beds and flooded areas of lignum. During drawdown the wetland will separate into pools joined by Floodway Pond Herbland and mud flats.

Water levels that engage flood channels, wetlands and floodplain surfaces will promote nutrient and carbon cycling and return organic material to the river for further processing (Robertston, Bacon and Heagney, 2001).

Waterbird groups also access a variety of habitat types such as mud flats, flooded lignum and shallow aquatic vegetation which only become available following inundation.

Diversity of habitat for feeding, breeding and nursery

Wetland filling and water recession will increase the extent and species diversity of the band of sedges, rushes and semi-aquatic forbs surrounding wetlands and areas of deeper, semi-permanent water will support submerged aquatic macrophytes. This inundation cycle will promote high levels of aquatic productivity and increased habitat complexity for frogs, small native fish, and waterbirds.

When flooded, the ephemeral flora component of Lignum Swampy Woodland and Lignum Swamp will germinate or expand, providing habitat for frogs, aquatic invertebrates and small native fish and the water birds that prey on these species. Fringing macrophytes will provide a source of food, refuge from predators and nesting sites and materials (Kingsford and Norman, 2002).

River red gum and black box within or adjacent to inundated areas will have increased growth and vigour, ensuring that they can continue to provide hollows for nesting, perch sites, input of leaves and coarse woody debris into the wetlands and floodplain.

Transportation and dilution of nutrients and organic matter and increase in macroinvertebrate productivity and biofilm diversity

Wetland inundation will transport nutrients and carbon into the water column, which will become available for consumption by bacteria, algae, macrophytes and macroinvertebrates.

Drying of wetlands, particularly during summer and autumn, exposes sediments and facilitates decomposition and processing of organic matter. The microbial decay of plant material is an important route for energy and nutrients to enter the food chain (Young, 2001).

Fluctuations in water levels allow exposure of substrates such as large wood and plant stems through a drying cycle, supporting a mosaic of biofilm species that offer a range of food resources for macroinvertebrates and fish. Macroinvertebrates with an adult, terrestrial life stage will provide a food source for insectivorous woodland birds.

5.1.2 Flora and Fauna Values

EVCs

Eleven Ecological Vegetation Classes (EVCs) and one EVC complex are modelled as present within the target area.

Table 7 provides a list of these EVCs, along with their bioregional conservation status. Extended descriptions of EVCs are provided in Appendix 3.

The map in Figure 7 displays the spatial arrangement of the EVCs, and Appendix 3 provides detailed descriptions of the EVCs.

Table 7. Ecological Vegetation Classes modelled as present within the Carina Bend target area

EVC Number	EVC Name	Bioregional Conservation Status
98	Semi-arid Chenopod Woodland	Vulnerable
103	Riverine Chenopod Woodland	Depleted
104	Lignum Swamp	Vulnerable
106	Grassy Riverine Forest	Depleted
n/a	Grassy Riverine Forest/Floodway Pond Herbland Complex	n/a
200	Shallow Freshwater Marsh	Vulnerable
295	Riverine Grassy Woodland	Depleted
808	Lignum Shrubland	Least concern
810	Floodway Pond Herbland	Depleted
813	Intermittent Swampy Woodland	Depleted
818	Shrubby Riverine Woodland	Least concern
823	Lignum Swampy Woodland	Depleted

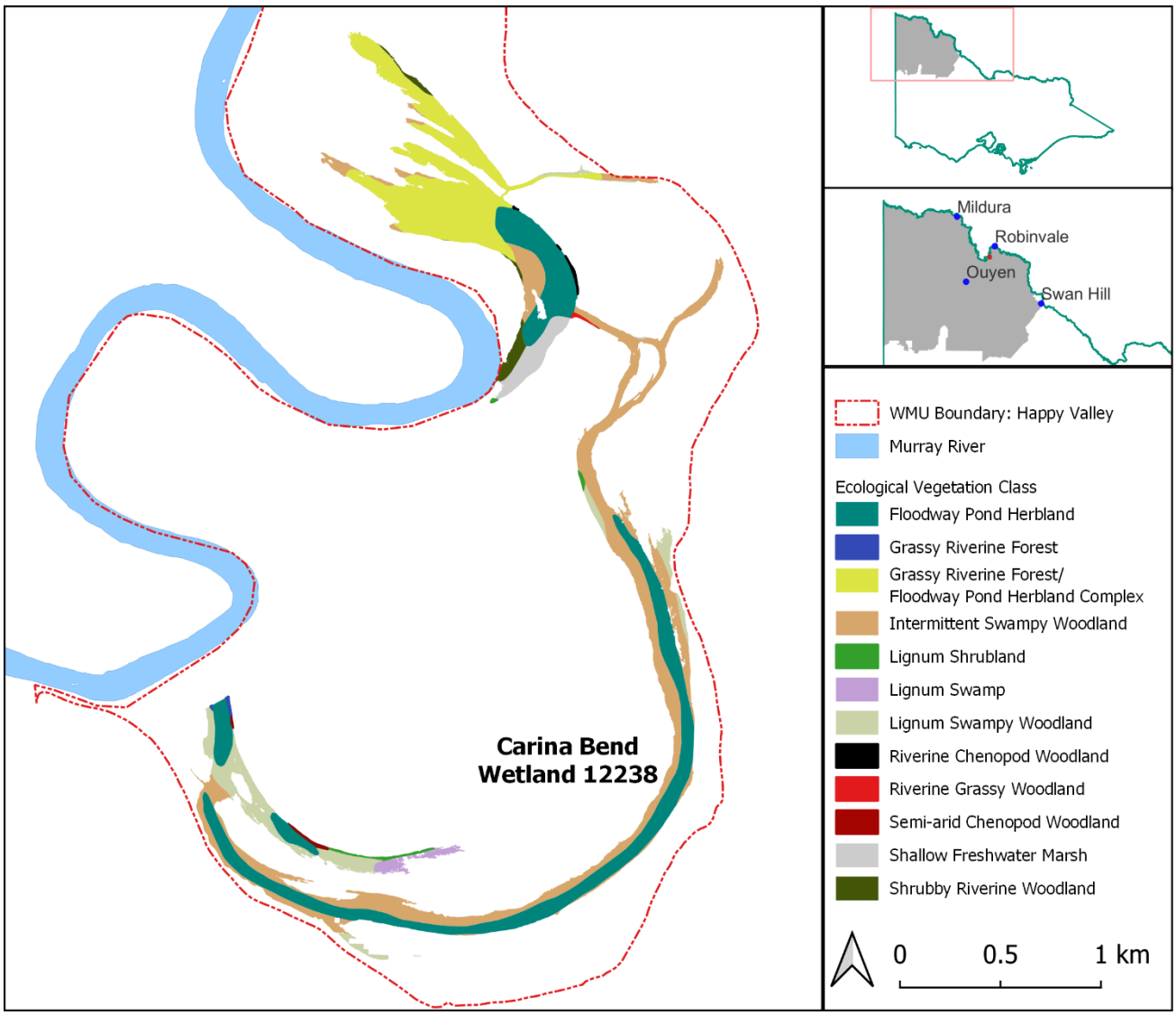

Figure 7. Spatial arrangement of Ecological Vegetation Classes at the Carina Bend target area

Low meander scrolls on the floodplain adjacent to the Murray support vegetation communities dominated by river red gum such as Grassy Riverine Forest (EVC 106) and Intermittent Swampy Woodland (EVC 813) (Ecological Associates, 2007b). At its northern end, Carina Bend Wetland spreads out into areas of shallow water and sandy benches, supporting Grassy Riverine Forest/Floodway Pond Herbland Complex and then (slightly higher up) Intermittent Swampy Woodland (EVC 813) on the floodplain.

Grassy Riverine Forest (EVC 106) is a river red gum forest to 25m tall with an understorey of eumong (*Acacia stenophylla*), tangled lignum (*Duma florulenta*) and a range of tussock grasses and occasional tall shrubs.

Intermittent Swampy Woodland (EVC 813) is comprised of an overstorey of river red gum and black box to roughly 15m tall, with an understorey of eumong, scattered shrubs such as tangled lignum and a range of grasses and sedges. With frequent inundation it is dominated by flood stimulated species in association with inundation-tolerant flora (Figure 8 and Figure 9).

Figure 8. Intermittent Swampy Woodland in the drainage line that connects Carina Bend Wetland to the River Murray in the south (February 2016)

Ideal flooding for river red gum recruitment is late spring to early summer (Johns and et al., 2009), while ideal flood timing for river red gum maintenance and survival is winter to spring following the natural flooding pattern (Dalton, 1990).

Higher terraces on the central floodplain support black box woodlands and lignum wetlands (Ecological Associates, 2007b). Black box provides essential habitat and foraging opportunities for a range of species including mammals and reptiles and supports a high proportion of ground foraging and hollow-nesting birds. Black box can tolerate a range of moisture and salinity conditions (Roberts and Marston, 2011) however recruitment and establishment are linked to the elevated and continued soil moisture associated with flood events. Under extended periods of dry conditions black box is likely to decline and eventually die (Ecological Associates, 2007a).

Figure 9. Intermittent Swampy Woodland present on the terraces above Carina Bend Wetland (February 2016)

Lignum Swampy Woodland (EVC 823) and Lignum Swamp (EVC 104) are present on terraces adjacent to Carina Bend Wetland. Lignum Swampy Woodland has an overstorey of 15m tall black box and river red gum and an understorey dominated by lignum, along with eumong and a mix of chenopod shrubs, grasses and sedges that can survive extended dry periods. Lignum

Swamp is typically treeless, subject to only infrequent inundation and dominated by lignum, with a range of chenopod shrubs, herbs and grasses.

During and after inundation, the bed of Carina Bend Wetland will host Floodway Pond Herbland (EVC 810) (Figure 10). Floodway Pond Herbland is up to 30cm tall, has a large component of ephemeral grass, sedge and herb species, and is associated with floodway systems with a regular wetting and drying cycle.

Figure 10. Carina Bend Wetland's wide flat channels are lined with river red gum dominated Intermittent Swampy Woodland. During and after inundation, Floodway Pond Herbland would be present within the channel bed, shown here in a dry phase (February 2016)

Wetland depletion and rarity

The conservation significance of Victorian wetland types has been determined by comparing the estimated extent prior to European settlement with the remaining extent.

Carina Bend Wetland contains regions of three wetland types under the Corrick classification:

- Permanent Open Freshwater,
- Shallow Freshwater Marsh, and
- Deep Freshwater Marsh.

Since European settlement, Permanent Open Freshwater has suffered a slight loss across the state (-6%) and has gained area in Mallee CMA (+5%), possibly due to raised weir levels along the River Murray permanently inundating wetlands that would previously have been only inundated seasonally. Within the Robinvale Plains Bioregion it has reduced in extent (-1%).

Shallow Freshwater Marsh and Deep Freshwater Marsh have declined to a much greater extent across the state, (-60% and -70% respectively); with variable losses within the Mallee CMA (-6% and -45% respectively) and within the Robinvale Plains Bioregion (-4% and -37% respectively) (Table 8).

Table 8. Table of regional change in area of wetland type

Corrick category	Wetland Name	Total area (ha)	Percentage change in wetland area from 1788 to 1994		
			Change in Victoria	Change in Mallee CMA	Change in Robinvale Plains bioregion
Permanent Open Freshwater	Carina Bend wetland (part)	25.6	-6%	+5%	-1%
Shallow Freshwater Marsh	Unnamed wetland 12170	10.9	-60%	-6%	-4%
	Carina Bend Wetland (part)	11.7			
Deep Freshwater Marsh	Carina Bend Wetland (part)	14.4	-70%	-45%	-37%

Fauna

Eleven species of fauna have been observed at Carina Bend (Appendix 4). Carina Bend supports two species listed under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and Victoria's Flora and Fauna Guarantee Act 1988 (FFG Act) (Table 9).

Table 9. Listed species of fauna found at Carina Bend

Scientific Name	Common Name	FFG Act Status	EPBC Act Status
Maccullochella peelii	Murray cod	Endangered	Vulnerable
Haliaeetus leucogaster	White-bellied sea-eagle	Endangered	n/a

The permanent open freshwater and deep freshwater marsh habitat of Carina Bend can support opportunistic breeding by large bodied native fish, and Murray cod (*Maccullochella peelii*) have been recorded at the site. Murray cod are considered main channel specialists as this is where they spawn and recruit, though juveniles may possibly be found in the floodplain and lakes (Rogers and Ralph, 2011).

The white-bellied sea-eagle (*Haliaeetus* leucogaster) is conservation listed under the Victoria's FFG Act, and also listed under the EPBC Act for its marine status. It is a large raptor that is usually distributed around the Australian coastline, but also inhabits major waterways such as the River Murray (DCCEEW 2024). Its habitat is characterised by large areas of open water (swamps, rivers and seas, DCCEEW 2024), and is therefore regarded as indirectly water dependent because of this habitat requirement.

Several indirectly water-dependent listed species have been observed nearby to Carina Bend, but outside the spatial extent of the area used for NatureKit and Protected Matters searches in this EWMP update. Species include the brown treecreeper (*Climacteris picumnus victoriae*), the white-browed treecreeper (*Climacteris affinis*), hooded robin (*Melanodryas cucullata cucullate*), regent parrot (*Polytelis anthopeplus monarchoides*) and the carpet python (*Morelia spilota metcalfei*). These species are indirectly water-dependent due to habitat requirements (e.g. dependent on nesting hollows in riparian trees).

Despite only a limited number of listed fauna being identified in Victorian Biodiversity Atlas (VBA) records, it is fair to assume that more listed species are likely to occur due to the availability of habitat and nearby sightings.

Flora

Only two species of fauna have been recorded in the VBA at Carina Bend (accessed via NatureKit, Table 10, Appendix 5). Mallee CMA have made several incidental observations of tangled lignum (*Duma florulenta*) at Carina Bend, which is a feature species of Intermittent Swampy Woodland, Lignum Swamp, Lignum Shrubland and Lignum Swampy Woodland EVCs.

Table 10. NatureKit Flora Observations at Carina Bend

Scientific Name	Common Name
Eucalyptus camaldulensis	River red gum
Eucalyptus largiflorens	Black box

5.1.3 Current condition

The condition of wetlands within the target area of Carina Bend has not been assessed using the Index of Wetland Condition (IWC) method. The condition information described below is based on brief field observations and limited existing literature. It should be considered a high priority to undertake a condition assessment of wetlands at Carina Bend using the Index of Wetland Condition.

Field inspections undertaken in December 2019 found wetlands at Carina Bend to be in a drawdown phase following a spring water delivery. Healthy mature river red gums line the River Murray frontage and Carina Bend Wetland and new recruitment was observed within the wetland (Figure 11, Figure 12). Aquatic grass (*Moira spp*. nc) was also seen growing along the margins of the inundated area (Figure 13). In contrast, river red gum on high terraces outside the main Carina Bend Wetland channel continued to show evidence of poorer health in the 2019 inspection.

Figure 11. Healthy mature river red gum line the edges of Carina Bend Wetland (December 2019).

Figure 12. River red gum recruitment within Carina Bend wetland (December 2019)

Figure 13. Aquatic grass (Moira grass spp. n.c.) growing along the margins of the inundated area of Carina Bend Wetland (December 2019). Source: Mallee CMA.

A significant flood event occurred along the River Murray in the summer of 2022/2023. This event inundated all parts of the floodplain, excluding sand dunes and elevated peaks, and is anticipated to support river red gum and black box communities on higher terraces.

Continuation of watering at Carina Bend wetland will result in improved tree health for significant areas of river red gums along the considerable length of the wetland channel.

5.2 SHARED BENEFITS

5.2.1 Traditional Owner Cultural Values

The Mallee region has been occupied for thousands of generations by Indigenous people with human activity dated as far back as 23,400 years ago. The region's rich and diverse Indigenous heritage has been formed through the historical and spiritual significance of sites associated with this habitation; together with the strong connection Traditional Owners continue to have with the natural landscapes of the Mallee.

In Indigenous culture, water is inseparable from the land, air, plants and animals. Caring for and healing Country is an inherited cultural obligation that is reliant upon having water in the landscape in the right place, at the right time of year. Water creates and sustains life and is a living and cultural entity that connects Traditional Owners to Ancestors, Country, cultural practice and identity.

Within the Mallee CMA region, the River Murray and its associated waterways continue to be culturally significant areas for many Aboriginal groups. The high number of Indigenous cultural heritage sites throughout the Murray floodplain is unique in Victoria because of their concentration and diversity. It is typical to find high densities of identified Indigenous cultural heritage sites located around, or close to, freshwater sources. The Aboriginal Heritage Regulations 2018 define "areas of cultural heritage sensitivity" which include land within 200 m of named waterways and land within 50 m of registered Aboriginal cultural heritage places. A review of the Aboriginal Cultural Heritage Register and Information System (ACHRIS 2024) confirms that Carina Bend Wetland and the River Murray are defined as areas of cultural heritage sensitivity.

Carina Bend Wetland is an important Indigenous cultural heritage site and contains burial sites, shell middens and hearths. Traditional Owner representatives attending the on-Country engagement in October 2023 emphasised the importance of protecting cultural heritage at Carina Bend when carrying out environmental watering. Representatives also identified camping and fishing as important values at the site.

Indigenous involvement for Carina Bend during the most recent update of this EWMP included Wadi Wadi Nation, Wadi Wadi Land and Water Indigenous Cooperation, and Dadi Dadi Weki Weki Aboriginal Cooperation. There is currently no Registered Aboriginal Party (RAP) for the area nor any current applications for RAP status (VAHC 2024).

5.2.2 European Heritage Values

A historical pumping station is also present at Carina Bend and is covered by a Heritage Overlay under the Swan Hill planning scheme.

5.2.3 Recreational Values

Carina Bend provides opportunities for nature-based recreation for residents and visitors to the region. Recreation opportunities include walking, trail bike riding, four wheeling driving, picnicking, socialising, camping, fishing, birdwatching, kayaking, swimming and nature appreciation.

5.2.4 Economic Values

Carina Bend has previously been used for grazing and firewood collection. Surrounding land uses include irrigated agriculture (almonds, grapes and oranges) and dryland cropping.

5.2.5 Educational Values

In consultation undertaken via an online survey in 2024, no educational values were identified at Carina Bend.

5.3 TRAJECTORY OF CHANGE

The hydrology of the River Murray and Carina Bend Wetland has significantly changed since river regulation. The wetland is inundated less frequently and for shorter durations. Without environmental watering the conditions of river red gum and black box communities are anticipated to decline. Photopoint monitoring is undertaken at Carina Bend Wetland to monitor wetland condition over time (Figure 14).

Figure 14. Photopoint monitoring at Carina Bend Wetland (left) photo 24/3/2010 in dry phase (right) photo taken 01/04/2020 during wet phase

6 Managing Water Related Threats

The Aquatic Value Identification and Risk Assessment (AVIRA) database is an on-line tool used by Victorian waterway managers to store data about the values, threats and risks to waterway health in their region. The database evaluates threats for a range of sub-indices including water regime, invasive fauna and acid sulphate soils (Peters, 2009).

Invasive fauna aquatic

Although no formal observations of common carp (*Cyprinus carpio*) have been recorded in NatureKit, wetlands at Carina Bend are likely to support the invasive species. Carp have been found to contribute to the loss of aquatic vegetation and increased turbidity, degrading the habitat for waterfowl (Purdey and Loyn, 2008) and native fish. Common carp also competes with the native fish for habitat and food (Mallee CMA, 2003).

Invasive fauna terrestrial

Introduced species including red fox (*Vulpes vulpes*) and common starling (*Sturnus vulgaris*), European rabbit (*Oryctolagus cuniculus*) and cat (*Felis catus*) are anticipated to be present at Carina Bend.

Foxes and cats predate on native birds and mammals and both are listed as potentially threatening processes under the *Flora and Fauna Guarantee Act 1988* (DSE, 2002, 2004a).

Rabbits can over-browse flora species and reduce survival and recruitment success, cause erosion, compete with native herbivores for food and burrows and support high populations of introduced predators such as foxes and cats (DPE 2024).

Invasive flora wetland

Agricultural and other weeds are an ongoing threat on the River Murray floodplain and have been recorded at Carina Bend.

Overland flow is occurring from privately held irrigation land within the WMU sub-unit. These flows could act as a vector for weed propagules and favour weed species by increasing nutrient levels at the site.

An irrigation channel located on private land at Carina Bend is completely choked by cumbungi (*Typha sp.*) due to stable shallow flooding during summer.

Changed water regime

As discussed in the hydrology section of this EWMP, the hydrology of the target area has been greatly impacted by the regulation of the River Murray. The proposed water regime (refer Section 7) takes into account the impacts of regulation of the primary water source of the wetland (River Murray), and other activities which may impact the wetland water regimes and proposes a watering regime that will support the achievement of the environmental objectives and goals of the site.

The Mallee Waterway Strategy 2014-2022 identifies Carina Bend Wetland as a medium priority wetland in the Happy Valley WMU. A risk of this prioritisation is that there may be insufficient water to deliver the required water regime at Carina Bend.

Management of water-related threats

Management of water related threats at Carina Bend is undertaken through maintaining the optimal watering regime. As part of this process, the wetlands will periodically be allowed to dry out, enabling the reduction of invasive aquatic species such as European carp. Drawdown and inundation of wetlands in line with the optimal watering regime will also manage invasive flora species not suited to natural water cycles.

ASSESSING RISK

Consideration of risk provides a link between recognition of system threats and key management processes, including 10 year and seasonal planning. Risk assessments are composed of both likelihood and consequence components. In this instance, likelihood is influenced by the probability that there will be sufficient environmental water to meet environmental water requirements.

From a seasonal watering perspective, prioritisation of watering actions will be based on short-term consequence given the uncertainty around long-term water availability. While consequence for an individual wetland can be determined, environmental water allocations require consideration of the consequences at larger scales. For the Mallee CMA it is their region, for the VEWH it is Victoria and the CEWH it is the Murray-Darling Basin.

Not all consequences can be readily identified so we have provided a process that can be followed in Appendix 6.

7 Management Goals, Objectives and Targets

7.1 MANAGEMENT GOAL

The management goal for Carina Bend is:

"*To provide a water regime that will support the health of fringing mature river red gum and provide seasonal habitat for native fish, frogs and waterfowl*."

This goal is linked to regional goals of the Mallee Waterway Strategy 2014-2022, which are to:

- maintain or improve habitat within waterways and on surrounding riparian land;
- manage all land tenures for water quality benefits and respond appropriately to threatening events (both natural and pollution based);
- restore appropriate water regimes and improve connectivity;
- protect the extent and condition of Cultural Heritage (Indigenous and non-Indigenous) sites associated with waterways; and
- increase community capacity for, awareness of and participation in waterway management.

7.2 ENVIRONMENTAL OBJECTIVES AND TARGETS

Environmental objectives represent the desired environmental outcomes of the site, based on the management goal (above) as well as the key values (see Section 5.1). It is intended that EWMP objectives will be described in terms of the primary environmental outcomes, in most cases ecological attributes. The focus of the objectives should be on the final ecological outcomes and not the drivers *per se*.

During 2020, the environmental objectives (formally ecological objectives) were analysed and refined, with the intent of improving the specificity and measurability of the objectives through the development of targets, and to improve line of sight to the Basin Plan. While the process attempted to maintain the intent and integrity of the original objectives, it provided an opportunity to reassess the suitability of these objectives for the asset. The rationalisation, assessment of SMARTness, mapping to Basin Plan and update of each objective for Carina Bend can be found in Section 5.8.1 of Butcher et al. (2020) and provided in Appendix 7.

While every attempt has been made to make the following objectives and targets as complete as possible, there remain gaps as critical information is not currently available. As such, baselines are not able to be set at this time, and formal observations of some species are lacking. In the interests of moving forward, the objectives and targets have been written in a way (i.e. red highlighted text) that allows this information to be included at a later stage as this information becomes available.

Table 11. Environmental objectives for Carina Bend

EWMP Objective	Target
CB1: By 2030, improve condition and maintain extent from baseline levels of river red gum (*Eucalyptus camaldulensis*) to sustain communities and processes typical of such communities at the Carina Bend asset.	By 2030, a positive trend in the condition score of river red gum dominated EVC benchmarks at 80% of sites over the 10 year period. OR By 2030, at stressed sites (see Wallace et al. 2020): in standardised transects that span the floodplain elevation gradient and existing spatial distribution, ≥70% of viable trees will have a Tree Condition Index Score (TCI) ≥ 10. Baseline condition of river red gum tress at the Carina Bend asset needs to be established.
CB2a: By 2030, protect and restore biodiversity by maintaining representative populations of small bodied native fish at the Carina Bend asset, including Gudgeon spp (*Philypnodon* spp) and Murray-Darling Rainbow Fish *(Melanotaenia fluviatilis*).	By 2030, maintain self-sustaining populations of (Gudgeon spp (*Philypnodon* spp) and Murray-Darling Rainbow Fish (*Melanotaenia fluviatilis*) at the Carina Bend asset. Measured as: • Adults or Young-of-Year for each species recorded in 8 out of 10 years Small bodied native species are yet to be recorded at the Carina Bend Asset
CB2b: By 2030, protect and restore biodiversity by maintaining representative populations of frogs at the Carina Bend asset	By 2030, maintain self-sustaining populations of frogs at the Carina Bend asset including: No species specified in EWMP – maintain spp. in 80% of years.
CB3a: By 2030, maintain nesting and recruitment of non-colonial waterbirds (N1, N2, N3 and N4, after Jaensch 2002) at the Carina Bend asset, by maintaining a mixture of tree, low vegetation/shrubs, and ground/islet nesting habitat.	There is a lack of data on species that breed at the site. The expectation is that the list of species commonly nesting at the Carina Bend asset will be confirmed over time. By 2030, at least two of the following species to be recorded as nesting and/or breeding at the Carina Bend asset in 7 out of any 10-year period in which nesting/breeding conditions are suitable: Representative N1 and N2 species include: White-bellied Sea Eagle (*Haliaeetus leucogaster*), Representative N3 and N4 species include: Australasian Grebe (*Tachybaptus novaehollandiae*), Masked Lapwing (*Vanellus miles*), Pacific Black Duck (*Anas supercilliosa*)
CB3b: By 2030, maintain representative populations of shallow-water and deep-water feeding guilds of waterbird (F2 and F3, respectively, after Jaensch 2002) at the Carina Bend asset, by maintaining a mixture of shallow and deep-water habitats.	By 2030, 80% of representative F2 and F3 species recorded at Carina Bend in 8 years out of any 10-year period where conditions are suitable. Representative F2 species include: Australasian Grebe (*Tachybaptus novaehollandiae*), Pacific Black Duck (*Anas superciliosa*), White-necked Heron (*Ardea pacifica*), Australian White Ibis (*Threskiornis molucca*), Masked Lapwing (*Vanellus miles*), Australasian Shoveler (*Anas rhynchotis*). Representative F3 species include: Australian Pelican (*Pelecanus conspicillatus*), Great Cormorant (*Phalacrocorax carbo*), Little Black Cormorant (*Phalacrocorax sulcirostris*), White-bellied Sea Eagle (*Haliaeetus leucogaster*) Feeding habitat defined as a mixture of deep feeding areas (water >1 m) and shallow feeding areas (<0.5 m depth and or drying mud) with intermittent inundation of densely vegetated shrublands.
CB4a: By 2030, improve vital habitat at the Carina Bend asset by increasing the diversity of aquatic macrophytes present across a range of Water Regime Indicator Groups.	By 2030, increase diversity of native of macrophytes at the Carina Bend asset with ≥2 species from each of the following Water Regime Indicator Groups present in 80% of years: • Aquatic (small floating) (Asf) (no species recorded) • Aquatic (obligate submerged) (Aos) (no species recorded) • Aquatic (submerged to partially emergent) (Ase) (no species recorded) • Aquatic graminoids (persistent) (Agp) (no species recorded) • Aquatic to semi-aquatic (persistent) (Asp) (Spiny Mud-grass *Pseudoraphis spinescens*) • Seasonally immersed – low growing (Slg) (Marsh Club-sedge *Bolboschoenus medianus*, Rough Raspwort *Haloragis aspera*, Poison Pratia *Lobelia concolor*, Blue Rod *Stemodia florulenta*) • Seasonally inundated – emergent non woody (Sen) (Warrego Summer-grass *Paspalidium jubiflorum*)
CB4b: By 2030, improve condition and maintain extent from baseline levels of Lignum (*Duma florulenta*) to sustain communities and processes reliant on Lignum communities at the	By 2030, condition in standardised transects that span the floodplain elevation gradient and existing spatial distribution at Carina Bend, ≥70% of Lignum plants in good condition with a Lignum Condition Score (LCI) ≥4.

Carina Bend asset.	

7.3 REGIONAL SIGNIFICANCE

As shown above in Section 5, Carina Bend supports a range of environmental values with local, regional and Murray-Darling Basin significance. These values inform the above environmental objectives. Details of links between the environmental objectives and environmental outcomes at a regional and basin scale are provided in Appendix 7.

The management goals and environmental objectives and targets are aligned with the regional goals of the Mallee Waterway Strategy 2014-2022 as described in Section 7.1. The Mallee Waterway Strategy 2014-2022 identifies Carina Bend Wetland as a medium priority wetland in the Happy Valley WMU. The wetland is recognised for its rare and threatened communities and species, and for its cultural heritage values.

7.4 ALIGNMENT TO BASIN PLAN

The primary environmental outcome of the Basin Plan is the protection and restoration of water-dependent ecosystems and ecosystem functions in the Murray-Darling Basin, with strengthened resilience to a changing climate. The MDBA is required to measure progress towards achieving the objectives of the Basin Plan Environmental Watering Plan (EWP) (Chapter 8 of the Basin Plan) by using the targets in Schedule 7 and having regard to the long-term average sustainable diversion limits, ecological objectives and ecological targets. These are set out in Long-Term Watering Plan's (LTWP), the Basin-wide Environmental Watering Strategy (BWS) and annual Basin environmental watering priorities. Details on the alignment of the updated Carina Bend EWMP environmental objectives to the Basin Plan are provided in

Table 12. The mapping of objectives to Schedule 7 targets, the BWS and LTWP are provided by Butcher et al., 2020 in Appendix 7.

Table 12. Mapping of environmental objectives to the Basin Plan

EWMP Objective	Alignment with Basin Plan		
	8.05 Ecosystem and biodiversity	**8.06** Ecosystem function	**8.07** Ecosystem resilience
CB1: By 2030, improve condition and maintain extent from baseline levels of river red gum (*Eucalyptus camaldulensis*) to sustain communities and processes typical of such communities at the Carina Bend asset.	8.05,3(b)	n/a	n/a
CB2a: By 2030, protect and restore biodiversity by maintaining representative populations of small bodied native fish at the Carina Bend asset, including gudgeon spp (*Philypnodon* spp) and Murray-Darling rainbow fish *(Melanotaenia fluviatilis*).	8.05,3(b)	n/a	n/a

EWMP Objective	Alignment with Basin Plan		
	8.05 Ecosystem and biodiversity	**8.06** Ecosystem function	**8.07** Ecosystem resilience
CB2b: By 2030, protect and restore biodiversity by maintaining representative populations of frogs at the Carina Bend asset	8.05,3(b)	n/a	n/a
CB3a: By 2030, maintain nesting and recruitment of non-colonial waterbirds (N1, N2, N3 and N4, after Jaensch 2002) at the Carina Bend asset, by maintaining a mixture of tree, low vegetation/shrubs, and ground/islet nesting habitat.	8.05,3(a) 8.05,3(b)	8.06,6(b)	n/a
CB3b: By 2030, maintain representative populations of shallow-water and deep-water feeding guilds of waterbird (F2 and F3, respectively, after Jaensch 2002) at the Carina Bend asset, by maintaining a mixture of shallow and deep-water habitats.	8.05,3(a) 8.05,3(b)	8.06,6(b)	n/a
CB4a: By 2030, improve vital habitat at the Carina Bend asset by increasing the diversity of aquatic macrophytes present across a range of Water Regime Indicator Groups.	8.05,3(b)	8.06,6(b)	n/a
CB4b: By 2030, improve condition and maintain extent from baseline levels of lignum (*Duma florulenta*) to sustain communities and processes reliant on lignum communities at the Carina Bend asset.	8.05,3(b)	8.06,6(b)	n/a

8 Environmental Water Requirements and Intended Water Regime

The management objectives at Carina Bend focus on providing a flow regime that more closely reflects natural events and improve the capacity of the target area to support native flora and fauna.

River red gum woodlands require flooding every two to four years with durations of two to four months. Flood events may differ and a variation in ponding duration around the mean requirement for this species is encouraged. Although the timing of flooding is not vital for river red gum, spring- summer flooding encourages greater growth. Timing is however important for understorey plant communities – flooding in spring encourages a diversity of emergent macrophytes while flooding in summer tends to promote common reed (*Phragmites australis*) and cumbungi. The critical interval for river red gum woodland inundation is five to seven years to prevent deterioration of tree condition (Roberts and Marston, 2011).

Lignum can tolerate a wide range of wet and dry conditions as well as moderate salinity levels. Frequencies of one to three years are needed to maintain large shrubs with vigorous canopy while flooding every three to five years for maintenance of healthy shrubs. Intervals of seven to ten years can be tolerated by small shrubs but these are not suitable as nesting platforms. Durations of three to seven months sustain vigorous canopy, but waterlogging is detrimental. Although the timing of flooding is not crucial for lignum, following natural seasonality is encouraged to provide for understorey and wetland plants (Roberts and Marston, 2011).

Flooding of wetland and floodplain vegetation in spring and summer provides a source of food, refuge and nesting sites and materials for waterbirds (Kingsford and Norman, 2002).

8.1 WATERING REQUIREMENTS AND INTENDED WATERING REGIME

The magnitude, timing and duration of watering of different zones at Carina Bend (i.e., hydrological objectives) are shown in Table 13.

Table 13. Hydrological objectives at Carina Bend

Level (m AHD)	Zone	Timing	Frequency (years in 10)	Duration (months)
44.7	Exposed wetland bed	Late summer/early autumn	10	1-6 months
45.5	Littoral zone	Late winter/early summer	10	4-6 months
46	Fringing river red gum	Late winter/early spring	5	2-4 months
46.7	Lignum wetlands	Early spring/late summer	2.5	3-7 months

The wetland watering regime has been derived from the ecological and hydrological objectives. To allow for adaptive and integrated management, the hydrological objectives have been framed using the seasonally adaptive approach. This means that a watering regime is identified for optimal conditions, as well as the maximum and minimum tolerable watering scenarios.

The optimal watering regime is described below. Due to the inter-annual variability of these estimates (particularly the climatic conditions), determination of the predicted volume

requirements in any given year will need to be undertaken by the environmental water manager when watering is planned.

The watering regime has been derived following review of the pre-regulation hydrology data.

Optimal watering regime

The optimal watering regime is to maintain Carina Bend Wetland as a semi-permanent freshwater wetland, with a seasonally inundated fringe. Fill Carina Bend Wetland every second year in late winter/early spring to 46m AHD, with water levels falling naturally by seepage and evaporation over summer and autumn. In every fourth year, fill wetland to 46.7m AHD to inundate the lignum communities in September, with water levels falling naturally by seepage and evaporation over summer and autumn.

Minimum watering regime

Fill Carina Bend Wetland every second year to 46m AHD to maintain fringing river red gum health, with water levels falling naturally by seepage and evaporation over summer and autumn to expose the wetland bed.

Maximum watering regime

The maximal watering regime is to maintain Carina Bend Wetland as a permanent freshwater wetland, with a seasonally inundated fringe. Fill Carina Bend Wetland every second year in late winter/early spring to 46.7m AHD, with water levels falling naturally by seepage and evaporation over summer and autumn. Top up when water levels fall below 45.5m AHD in summer to maintain inundation of the littoral zone. In every fourth year allow water levels to fall naturally through seepage and evaporation over summer and autumn, allowing exposure of the wetland bed.

8.2 EXPECTED WATERING EFFECTS

This section aims to explicitly outline potential watering actions to achieve the stated environmental objective, and expected watering effects.

Objective code	Environmental Objective	Potential Watering Action	Expected Watering Effect
CB1	**CB1**: By 2030, improve condition and maintain extent from baseline levels of river red gum (*Eucalyptus camaldulensis*) to sustain communities and processes typical of such communities at the Carina Bend asset.	Facilitate flooding to 46.0 m AHD every two years, with a ponding duration of 2-4 months. Allow water to recede over summer / autumn	Condition and extent of river red gum is improved/maintained from baseline levels
CB2a	**CB2a**: By 2030, protect and restore biodiversity by maintaining representative populations of small bodied native fish at the Carina Bend asset, including gudgeon spp (*Philypnodon* spp) and Murray-Darling rainbow fish *(Melanotaenia fluviatilis*).	Maintain permanent open freshwater areas throughout the year. Maintain a minimum water level of 44.7 m AHD during late summer / early autumn every year. Facilitate watering to 45.5 m AHD in late winter / early summer for a duration of 4-6 months to inundate the littoral zone every year. Allow water levels to recede over autumn / winter.	Areas of exposed sediments are inundated in spring to increase zooplankton abundance and availability of vegetation, to coincide with breeding. Sediments around the fringe of the wetland in autumn/winter are exposed to allow for consolidation of sediments and germination of amphibious and terrestrial plants. Cover and spawning substrate are provided upon re-inundation.

Objective code	Environmental Objective	Potential Watering Action	Expected Watering Effect
CB2b	**CB2b**: By 2030, protect and restore biodiversity by maintaining representative populations of frogs at the Carina Bend asset	Maintain a minimum water level of 44.7 m AHD during late summer / early autumn every year. Facilitate watering to 45.5 m AHD in late winter through early summer for a duration of 4-6 months to inundate the littoral zone every year. Allow water levels to recede over autumn / winter.	Appropriate seasonal variation in water levels provides suitable habitat and food resources for frogs.
CB3a	**CB3a**: By 2030, maintain nesting and recruitment of non-colonial waterbirds (N1, N2, N3 and N4, after Jaensch 2002) at the Carina Bend asset, by maintaining a mixture of tree, low vegetation/shrubs, and ground/islet nesting habitat.	Facilitate seasonally variable watering to support natural wetting and drying cycles of the wetlands. Maintain permanent ponding with variations in water levels. Time inflows preferably in late winter / early spring, allow water levels to recede over summer / autumn.	Suitable habitat (food, refuge) is provided in flooded wetland vegetation in spring and summer. For example, live and dead trees are inundated, enabling nesting by white-bellied sea-eagles. The inundation of shrubs/low vegetation supports nesting of N3 species such as Australasian grebes.
CB3b	**CB3b**: By 2030, maintain representative populations of shallow-water and deep-water feeding guilds of waterbird (F2 and F3, respectively, after Jaensch 2002) at the Carina Bend asset, by maintaining a mixture of shallow and deep-water habitats.	Facilitate seasonally variable watering to support natural wetting and drying cycles of the wetlands. Maintain permanent ponding with variations in water levels. Time inflows preferably in late winter / early spring, allow water levels to recede over summer / autumn.	Suitable habitat (food, refuge) is provided in flooded wetland vegetation in spring and summer: Deep water (>1.0m) foraging habitat is provided (via inundation) to support F3 species such as grebes and cormorants. Foraging habitat in shallow open water (<0.5m depth) and mudflats is provided for F2 species such as white-bellied sea eagle, Australasian grebes and little black cormorant on fringes, and as water recedes over summer and autumn.
CB4a	**CB4a**: By 2030, improve vital habitat at the Carina Bend asset by increasing the diversity of aquatic macrophytes present across a range of Water Regime Indicator Groups.	Maintain a minimum water level of 44.7 m AHD during late summer / early autumn every year. Facilitate watering to 45.5 m AHD in late winter / early summer for a duration of 4-6 months to inundate the littoral zone every year. Allow water levels to recede over autumn / winter.	Suitable conditions for germination, growth and reproduction for a variety of aquatic macrophytes are maintained through seasonal variation in water levels.
CB4b	**CB4b**: By 2030, improve condition and maintain extent from baseline levels of lignum (*Duma florulenta*) to sustain communities and processes reliant on lignum communities at the Carina Bend asset.	Facilitate flooding to 46.7 m AHD every 4 years during spring (September), with ponding duration of 3-7 months. Allow water to recede over summer / autumn	Condition and extent of lignum and lignum communities is maintained or improved from baseline levels.

8.3 SEASONALLY ADAPTIVE APPROACH

To allow for adaptive and integrated management, the watering requirements have been framed using an adaptive approach which identifies priorities for environmental watering under different seasonal conditions. This means that a watering regime is identified for optimal conditions, as well as the maximum and minimum tolerable watering scenarios. The planning scenarios under different seasonal conditions for Carina Bend are described in Figure 15. The example watering actions presented in Figure 15 are indicative of the actions that may be delivered under the various planning scenarios. Other factors such as the condition of the site, recent watering history and forecast water availability will also influence the watering actions that are delivered.

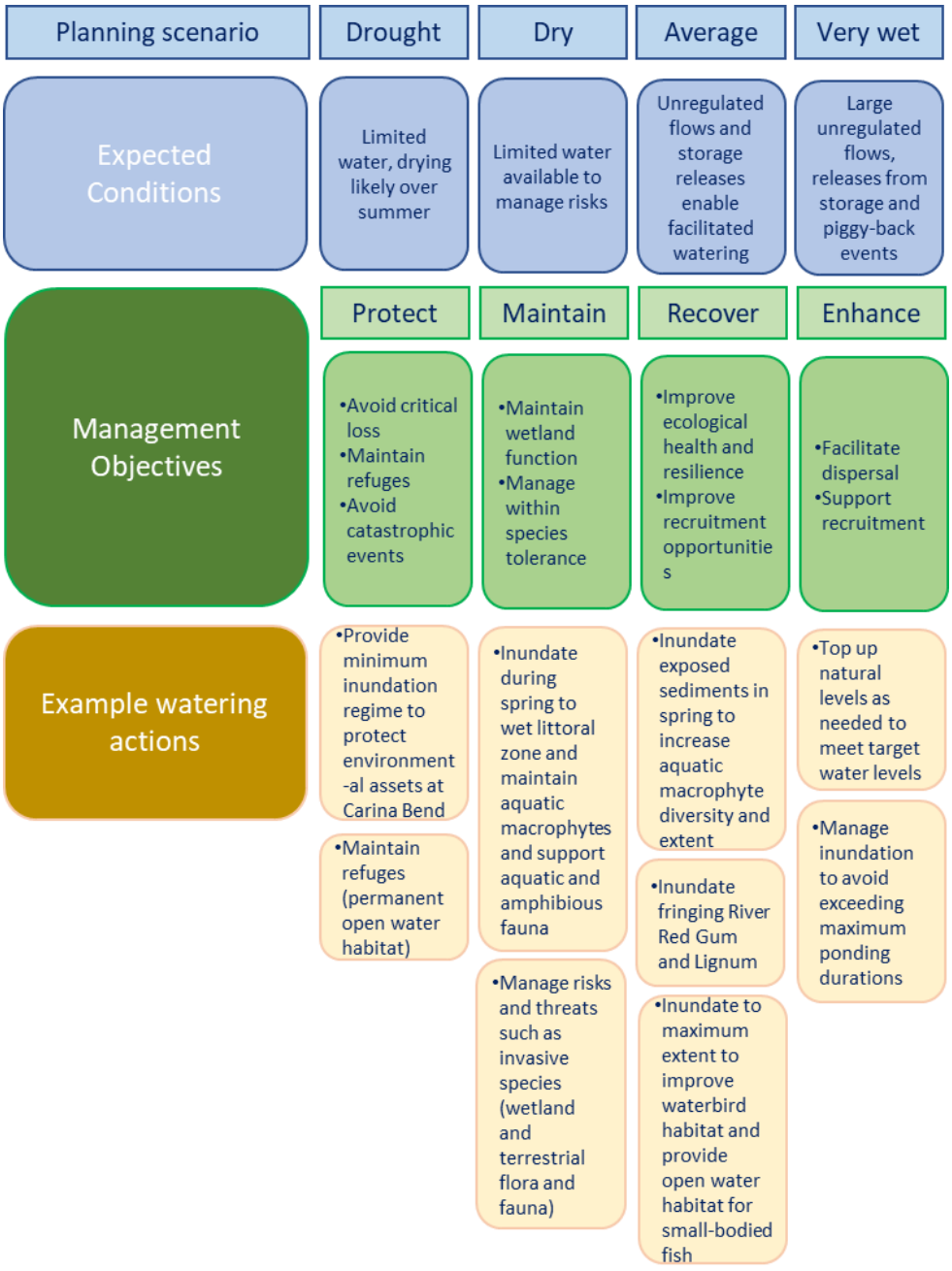

Figure 15. Indicative seasonally adaptive approach

9 Environmental Water Delivery Infrastructure

9.1 WATER DELIVERY INFRASTRUCTURE

Carina Bend is currently able to be watered to a level of 44.8m AHD using temporary pumps located near the road at river km 1082 (Figure 16, Figure 17). Full inundation of the target area to 46.7 m AHD is possible with the use of temporary pumps and temporary earthen levees.

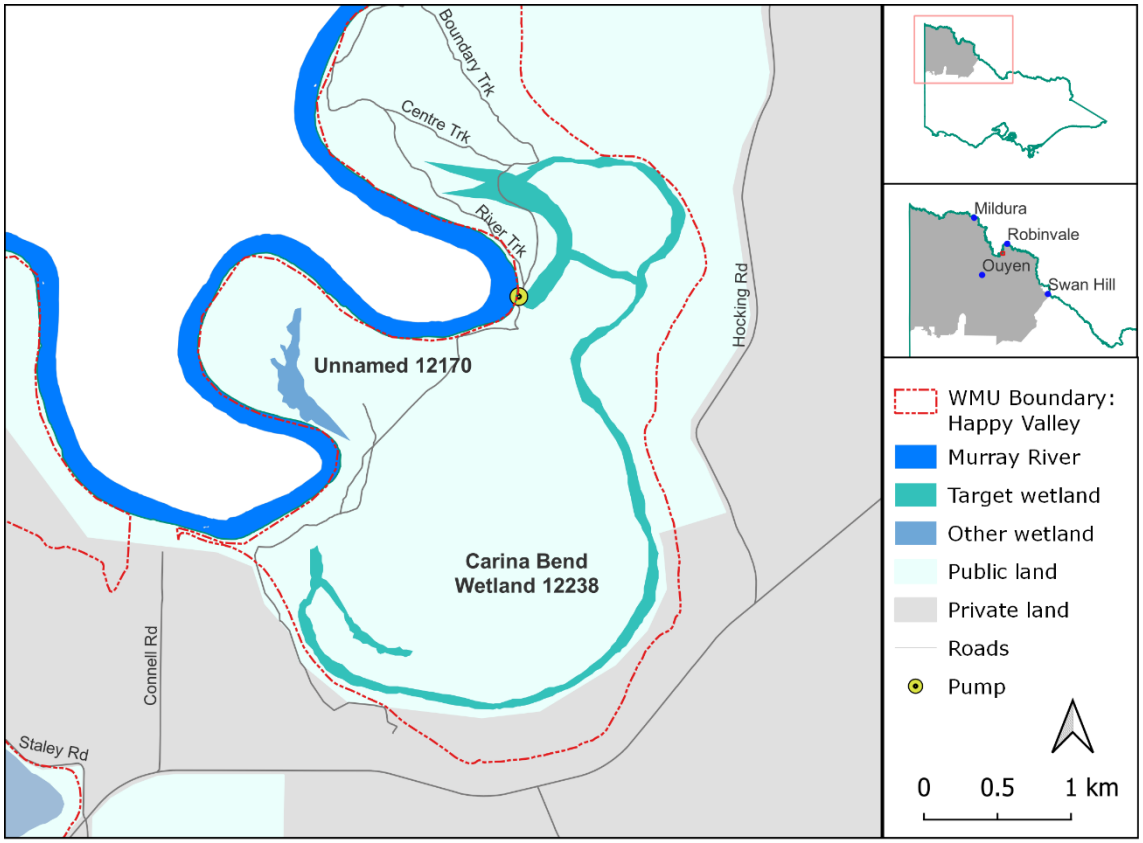

Figure 16. Location of infrastructure at Carina Bend for environmental water delivery.

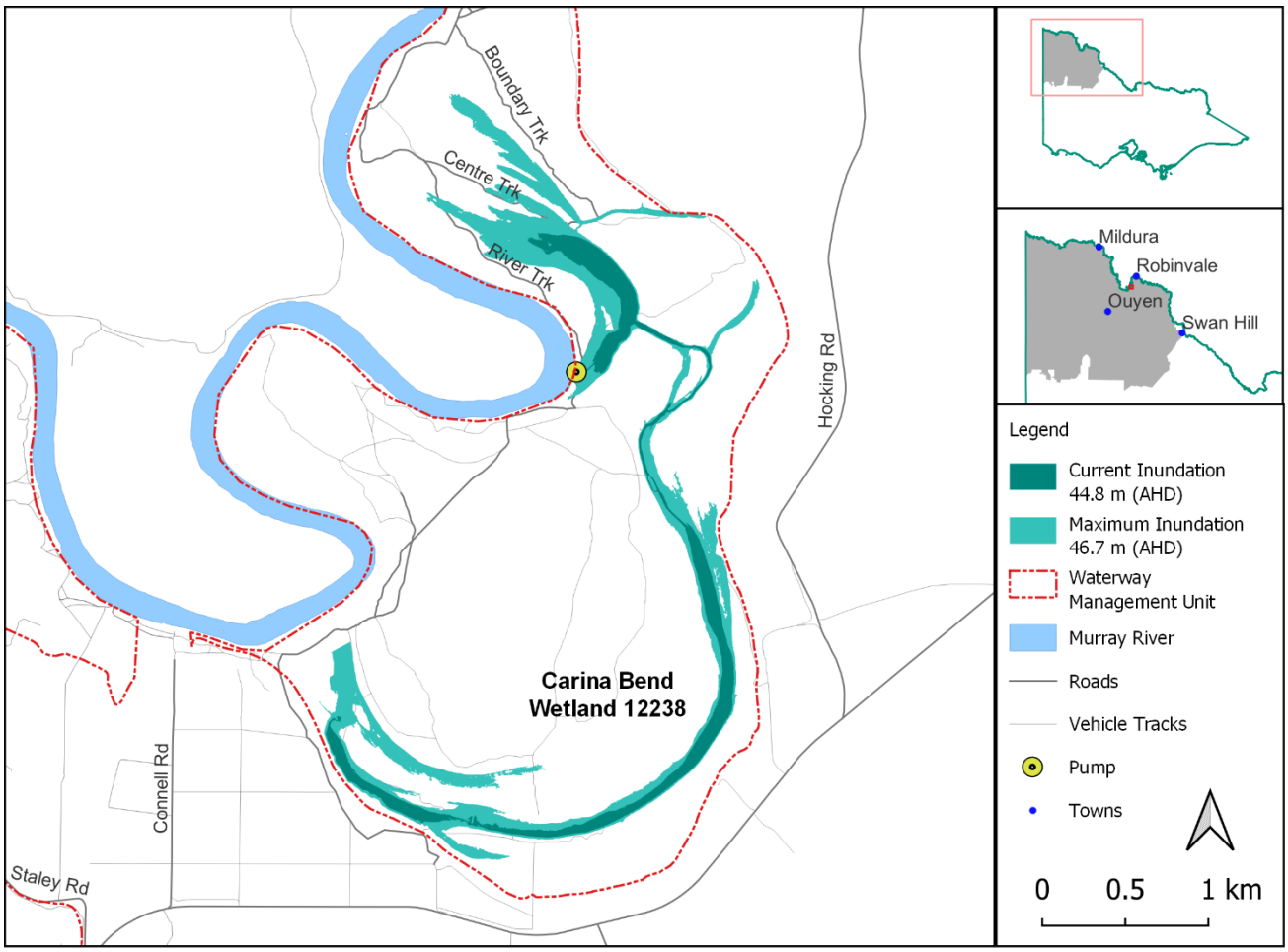

Figure 17. Current inundation extent (44.8 m AHD) and maximum inundation extent (46.7 m AHD) at Carina Bend.

9.2 CONSTRAINTS

Access roads must be maintained to ensure continued access to the target area by management vehicles and visitors. Environmental water pumped into Carina Bend Wetland may be lost back to the river via the road and floodplain channels. Cultural heritage investigations are required to understand cultural constraints to environmental watering at Carina Bend.

10 Demonstrating Outcomes

10.1 ENVIRONMENTAL MONITORING

The foci for monitoring identified for the Carina Bend target area are presented in Table 14. The monitoring methods in Table 14 will enable environmental water managers to assess progress against targets and assist in the adaptive management of the target area to achieve the stated environmental objectives and outcomes.

Table 14. Links between objectives, monitoring foci, questions and methods.

Objective	Monitoring Focus	Monitoring Question	Method	When
Overarching management goal	Health of fringing mature river red gum	By 2030, has the condition and extent of river red gum been maintained or improved?	See for CB1 below.	See for CB1 below.
	Seasonal habitat for native fish, frogs and waterfowl	Are self-sustaining populations of small-bodied native fish, frogs and waterbirds present at Carina Bend?	See for CB2a, CB2b, CB3a and CB3b below.	See for CB2a, CB2b, CB3a and CB3b below.
	Wetland Condition	Has there been an overall improvement in the condition of the target area by 2030?	Undertake IWC method assessment.	Every five years.
Water Regime	Volume	How much water has been delivered and retained in Carina Bend	Lower Murray Water	Annually
	Inundation extent	Which components of Carina Bend were inundated	Sentinel 2	Annually
	Maximum Depth (AHD & depth classes)	When filled, to what height (AHD) and what was area of key depth classes?	CSIRO, MDBA inundation products	Annually
	Minimum Depth (AHD & depth classes)	What was the minimum depth of the residual pool and what was its extent?	Sentinel 2	Annually
CB1	Condition and extent of river red gum	Is the condition of river red gum improving? What is the extent of river red gum compared to the baseline? Are new trees being recruited into the forest and woodland populations?	TSC tool, field assessments. Evaluate survival of seedlings over a 15-year period, transect survey and Tree Condition Index (TCI) score assessments, photo point monitoring, remote sensing. Compare results against benchmark of initial survey.	Annually

Objective	Monitoring Focus	Monitoring Question	Method	When
CB2a	Abundance and diversity of populations of small bodied native fish	Are self-sustaining populations of small-bodied fish (gudgeon spp. and Murray-Darling rainbow fish) present at Carina Bend (with young-of-year recorded in 8 of 10 years)?	Undertake fish surveys targeting small-bodied native fish.	Annually
CB2b	Abundance and diversity of populations of frogs	Are self-sustaining populations of frogs present at Carina Bend?	Undertake frog surveys (audio recordings and/or presence of tadpoles).	Annually
CB3a	Nesting and recruitment of non-colonial waterbirds	Are at least two of the representative waterbirds species recorded as nesting and/or breeding at Carina Bend in 7 of any 10-year period in which conditions are suitable?	Undertake waterbird surveys.	Annually when conditions are suitable
CB3b	Abundance and diversity of populations of shallow-water and deep-water feeding guilds of waterbirds. Condition and extent of shallow and deep-water habitats	Is the condition or extent of shallow and deep water habitats improving with environmental watering? Are 80% of representative shallow-water and deep-water feeding waterbirds recorded at Carina Bend in 8 of any 10 year period where conditions are suitable?	Undertake waterbirds surveys. Undertake habitat assessment	Annually when conditions are suitable
CB4a	Diversity of aquatic macrophytes from across a range of Water Regime Indicators groups	What is the baseline diversity of Water Regime Indicators groups species? By 2030 Are ≥2 species from each of the Water Regime Indicator groups present in 80% of years?	Undertake surveys of aquatic macrophytes at Carina Bend (including species ID and extent). Compare results against benchmark of initial survey.	Every three years
CB4b	Condition and extent of lignum	What is the baseline extent of lignum? Has the extent of lignum changed with environmental watering? Has the condition of lignum improved with environmental watering? By 2030, are ≥70% of lignum plants in good conditions, with a lignum condition score of ≥4?	Undertake lignum population monitoring using standardised transects that span the floodplain elevation gradient and existing spatial distribution. Photo point monitoring. Compare results against benchmark of initial survey.	Every three years

10.2 MONITORING PRORITIES AT THE ASSET

Ecological monitoring is required to demonstrate the effectiveness of environmental watering in achieving environmental objectives, to help manage environmental risks and to identify opportunities to improve the efficiency and effectiveness of the program.

The highest priorities for monitoring at Carina Bend are the monitoring questions that most strongly influence watering decisions and the evaluation of watering effectiveness. The monitoring priorities at Carina Bend are shown in Table 15.

Table 15. Monitoring priorities at Carina Bend

Monitoring Priority	Reason for Priority
Water delivery	Adaptive management: water is managed to meet EWMP objectives.
Index of wetland condition assessments	These provide information on changes in hydrology and water quality that impact on flora and fauna
River red gum condition and extent	To develop baselines to assist condition assessments. Key for assessing progress against objectives of the Basin Plan Environmental Watering Plan (EWP), Basin Plan Schedule 7 targets, Basin wide Environmental Watering strategy (BWS) and Victorian Murray Long Term Watering Plan.
Abundance and diversity of small bodied native fish	To develop baselines to assist condition assessments, and understand drivers of variation in abundance and diversity. Key for assessing progress against objectives of the Basin Plan Environmental Watering Plan (EWP), Basin Plan Schedule 7 targets, Basin wide Environmental Watering strategy (BWS) and Victorian Murray Long Term Watering Plan.
Diversity of frog populations	To develop baselines to assist condition assessments, and understand drivers of variation frog diversity. Key for assessing progress against objectives of the Basin Plan Environmental Watering Plan (EWP), Basin Plan Schedule 7 targets, Basin wide Environmental Watering strategy (BWS) and Victorian Murray Long Term Watering Plan.
Diversity of nesting non-colonial waterbirds	To develop baselines to assist condition assessments and understand drivers of variation in waterbird diversity. Key for assessing progress against objectives of the Basin Plan Environmental Watering Plan (EWP), Basin Plan Schedule 7 targets, Basin wide Environmental Watering strategy (BWS) and Victorian Murray Long Term Watering Plan.
Abundance and diversity of populations of shallow-water and deep-water feeding guilds of waterbirds	To develop baselines to assist condition assessments and understand drivers of variation in waterbird abundance and diversity. Key for assessing progress against objectives of the Basin Plan Environmental Watering Plan (EWP), Basin Plan Schedule 7 targets, Basin wide Environmental Watering strategy (BWS) and Victorian Murray Long Term Watering Plan.
Diversity of aquatic macrophytes	To develop baselines to assist condition assessments and understand drivers of variation in aquatic macrophyte diversity. Key for assessing progress against objectives of the Basin Plan Environmental Watering Plan (EWP), Basin Plan Schedule 7 targets, Basin wide Environmental Watering strategy (BWS) and Victorian Murray Long Term Watering Plan.

Monitoring Priority	Reason for Priority
Lignum condition and extent	To develop baselines to assist condition assessments and understand drivers of variation in lignum condition and extent. Key for assessing progress against objectives of the Basin Plan Environmental Watering Plan (EWP), Basin Plan Schedule 7 targets, Basin wide Environmental Watering strategy (BWS) and Victorian Murray Long Term Watering Plan.

11 Adaptive Management

Mallee CMA uses an adaptive management approach in planning and managing environmental watering actions.

Adaptive management is the process of incorporating new scientific and operational information into the implementation of a project or plan to ensure that management actions are appropriate, effective and contribute to goals efficiently. It is a standard and well-established practice for environmental water management, recognising the inherent uncertainties and risks associated with the complex relationships between changes to hydrology and ecological responses, and the potential for a watering event to provide both positive and adverse outcomes. Figure 18 shows an illustration of the adaptive management cycle for environmental water delivery.

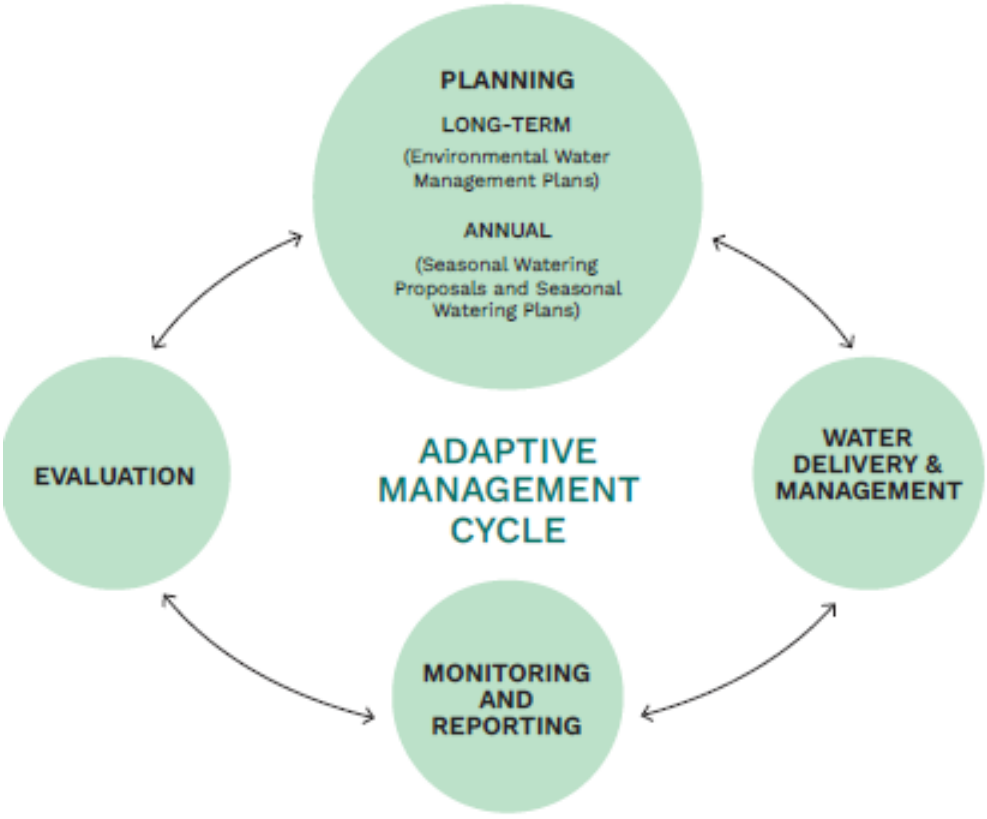

Figure 18. The adaptive management cycle for environmental water delivery and management

Mallee CMA uses three main pathways to identify inputs to the adaptive management process (also referred to as lessons):

- monitoring to detect differences between what was planned and the outcomes at the environmental watering site,
- incidental observations by managers, operators or other observers that identify opportunities to reduce risk or improve outcomes ,
- research or investigations into hydraulic or ecological management practices that could improve the conceptual models on which operations are based.

Mallee CMA formally documents lessons to strengthen organisational memory and provide transparency in continual improvement measures. Recording of lessons is crucial for both annual environmental watering actions and long-term planning. Demonstrating continual improvement provides the justification for monitoring programs and confirms that assets are being managed responsibly.

An adaptive management framework has several components that work together to build lessons learned from environmental watering actions and program partners into the environmental water program. This produces iterative improvements in the way environmental watering is undertaken using the best available evidence.
The EWMP will be constantly refined to incorporate learnings from ecological monitoring as well as feedback from community consultation.
Land managers and river operators are included in the operational planning cycle which include adaptive management processes to incorporate learnings and risk management.

12 Knowledge gaps and recommendations

This plan is based on the best available information at the time of writing. In some cases, information is scarce or outdated. Further investigation and information collection will continue, and the results of this further work will continue to build a better picture of the site and add rigor to future planning. Knowledge gaps at Carina Bend are shown in Table 16.

Table 16. Knowledge gaps and recommendations for the target area at Carina Bend

Knowledge and data gap	Action Recommended	Responsibility
Index of wetland condition assessment	The target area wetlands should be incorporated into the five-yearly Index of Wetland Condition assessments.	Implementation of any of these recommendations would be dependent on investment from Victorian and Australian Government funding sources as projects managed through the Mallee CMA
Native fauna at Carina Bend	Conduct formal assessments of fauna (particularly small-bodied native fish, frogs and waterbirds) to better understand the environmental values and threats at Carina Bend, and to establish baselines for monitoring.	
Native flora at Carina Bend	Conduct formal assessments of flora species at Carina Bend to understand environment values and threats at Carina Bend (including aquatic macrophytes, and water-dependent species and communities) and to establish baselines for monitoring.	
Mechanism to achieve maximal inundation at Carina Bend	Explore mechanisms to achieve maximum inundation of the target area, such as infrastructure or the relaxation of constraints. A concept design report is required to scope the infrastructure requirements at three sites at Carina Bend.	
Private landholder management arrangements	Landholder agreements should be signed outlining the proposed watering regimes and any inundation of private land	
Groundwater, salinity, and surface water interactions	Conduct assessment of groundwater, salinity, and surface water interactions at Carina Bend.	
Cultural values assessment and mapping	Traditional Owners to carry out Cultural values assessment at site to understand cultural constraints to watering.	

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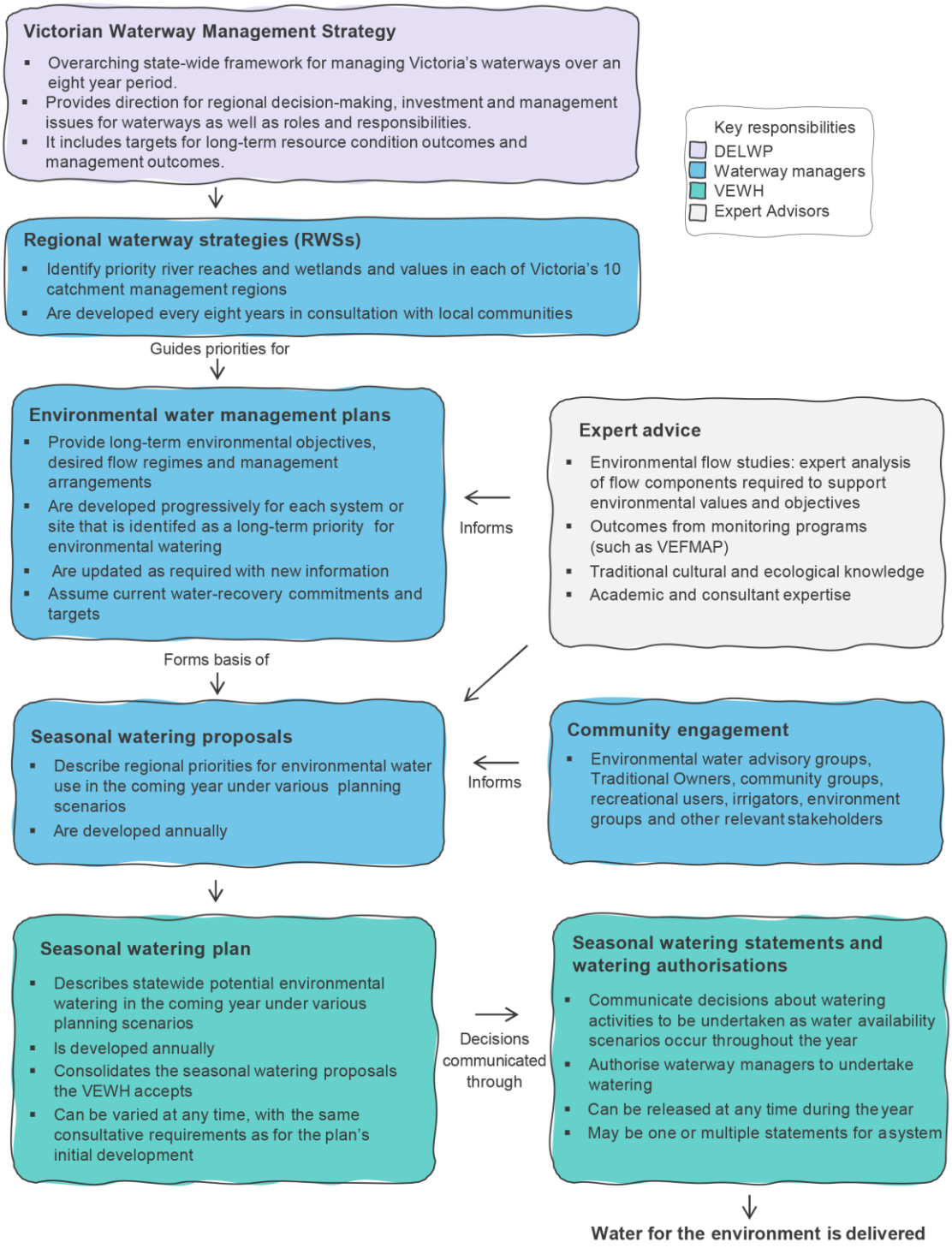
APPENDIX 1. Environmental Water Management Plan Context

Environmental water in Victoria is managed as an integral part of the Victorian Waterway Management Program. The state-level Victorian Waterway Management Strategy (VWMS) provides the overarching framework for environmental water management (see accompanying figure). The Mallee Waterway Strategy (2014-22) drives implementation of the VWMS at the regional level. Information from the Mallee Waterway Strategy 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 a wetland or wetland complex deemed a priority to receive environmental water through the Mallee Waterway Strategy development process. This document is the Environmental Water Management Plan (EWMP) for Carina Bend in the Mallee Catchment Management region.

Environmental watering in the Mallee Region 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. Environmental water management at Carina Bend 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 the Victorian Murray Water Resource Plan and Victorian Murray Long-Term Watering Plan, which apply at Carina Bend.

Mallee Catchment Management Authority (MCMA), the Victorian Department of Energy, Environment and Climate Action (DEECA), the Victorian Environmental Water Holder (VEWH) and Traditional Owner groups have worked together to develop several EWMPs for watered assets throughout the Mallee region. These plans are continually updated through an adaptive management process. A primary purpose of EWMPs is to provide a consistent set of documents that support seasonal watering proposals to be submitted by asset managers to the VEWH annually.



EWMP Policy Context

APPENDIX 2. COMMUNITY AND AGENCY ENGAGEMENT 2024

Community stakeholders were engaged on the update of this and other EWMPs in person at several local events, including local markets (Mildura Market, Red Cliffs Market, Swan Hill Market), local environmental group meetings (Mildura Birdlife meeting, Greening Mildura meeting, Cabarita Inc. day and an environmental volunteer event), and a drop in event at Nangiloc. In-person engagements were designed to enable community input to the plans, and included a 'Pins in Maps' exercise, where stakeholders identified locations of water-dependent values at sites within Carina Bend and other WMU subunits.

Community stakeholders were also engaged on the update of the Carina Bend EWMP via an online survey, which was hosted on the Mallee CMA website in December 2023 – January 2024. The survey and in-person engagements supplement earlier community engagement about the Carina Bend EWMP, and annual community engagement that informs the Seasonal Watering Proposal (SWP). Community consultation occurs at the IAP2 level of CONSULT.

In-person community engagement:

Two community stakeholders provided feedback on Carina Bend at an in-person event at the Red Cliffs Market, stating that they visit Carina Bend wetland for camping and fishing.

Online survey:

Two respondents completed the online survey for Carina Bend. These included:

- a recreational user of the site, who visits every few months during autumn and winter for (in order of importance to the respondent) camping, nature appreciation, socialising, fishing, kayaking, and swimming.
- a visitor to the region who visited during spring for birdwatching and nature appreciation.

Both survey respondents strongly agree to the return of natural watering cycles to the area.

In-person Traditional Owner engagement:

Traditional Owner representatives were engaged on the Carina Bend EWMP at an in-person meeting on-Country at Liparoo in October 2023. Representatives from Culpra Milli Aboriginal Corporation, Munatunga Elders, Gilbie Aboriginal Corporation, Latji Latji Mumthelang, Tati Tati Land and Water Indigenous Corporation, Wadi Wadi Nation, Tati Tati Wadi Wadi Land and Water Indigenous Cooperation, and Dadi Dadi Weki Weki Aboriginal Corperation attended the meeting. A 'pins in maps' exercise was also completed at this meeting. Traditional Owners identified water-dependent values, flora and fauna values, recreational values (including fishing and camping), and other cultural values across Carina Bend Wetland. Recreational and other cultural values were identified at unnamed wetland 12170.

Agency Engagement:

Mallee CMA met with representatives from agency stakeholders Parks Victoria, Lower Murray Water and Mildura Rural City Council in February 2024. Discussions regarding Carina Bend centred on the maintenance of pump infrastructure, and on road trafficability during watering.

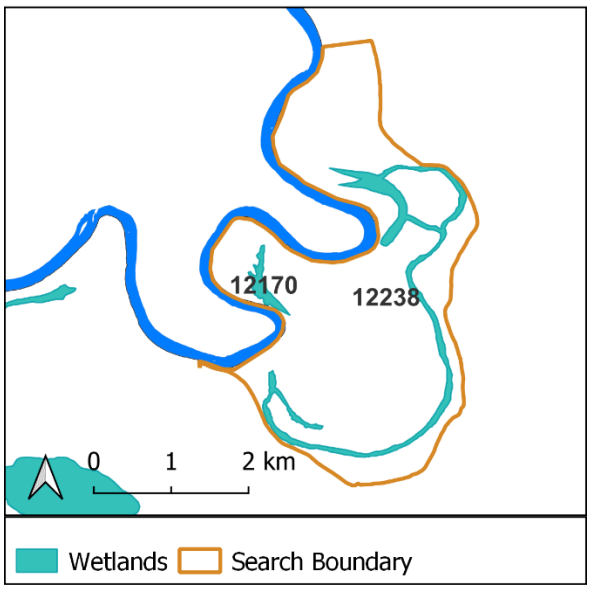
APPENDIX 3. ECOLOGICAL VEGETATION CLASSES

EVC No.	EVC Name	Bioregional conservation status	Description
98	Semi-arid Chenopod Woodland	Vulnerable	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.
103	Riverine Chenopod Woodland	Depleted	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.
104	Lignum Swamp	Vulnerable	Typically treeless shrubland to 4 m tall, with robust (but sometimes patchy) growth of lignum. Widespread wetland vegetation type in low rainfall areas on heavy soils, subject to infrequent inundation resulting from overbank flows from rivers or local runoff.
106	Grassy Riverine Forest	Depleted	Occurs on the floodplain of major rivers, in a slightly elevated position where floods are infrequent, on deposited silts and sands, forming fertile alluvial soils. River red gum forest to 25 m tall with a ground layer dominated by tussock-forming graminoids. Occasional tall shrubs present.
200	Shallow Freshwater Marsh	Vulnerable	Wetland type
295	Riverine Grassy Woodland	Depleted	Occurs on the floodplain of major rivers, in a slightly elevated position where floods are rare, on deposited silts and sands, forming fertile alluvial soils. River red gum woodland to 20 m tall with a ground layer dominated by graminoids and sometimes lightly shrubby or with chenopod shrubs.
808	Lignum Shrubland	Least concern	Relatively open shrubland of species of divaricate growth form. The ground-layer is typically herbaceous or a turf grassland, rich in annual/ephemeral herbs and small chenopods. Characterised by the open and even distribution of relatively small Lignum shrubs. Occupies heavy soil plains along River Murray, low-lying areas on higher-level (but still potentially flood-prone) terraces.
810	Floodway Pond Herbland	Depleted	Low herbland to < 0.3 m tall with occasional emergent life forms, usually with a high content of ephemeral species. Floors of ponds associated with floodway systems. Typically heavy deeply cracking clay soils. Characteristically smaller wetlands with a more regular flooding and drying cycle in comparison to sites supporting Lake Bed Herbland.
813	Intermittent Swampy Woodland	Depleted	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.
818	Shrubby Riverine Woodland	Least concern	Eucalypt woodland to open forest to 15 m tall of less flood- prone (riverine) watercourse fringes, principally on levees and higher sections of point-bar deposits. The understorey includes a range of species shared with drier floodplain habitats with a sparse shrub component, ground-layer patchily dominated by various life-forms. A range of large dicot herbs (mostly herbaceous perennial, several with a growth-form approaching that of small shrub) are often conspicuous.
823	Lignum Swampy Woodland	Depleted	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.

Source: (DEECA, 2023a; DSE, 2004b)

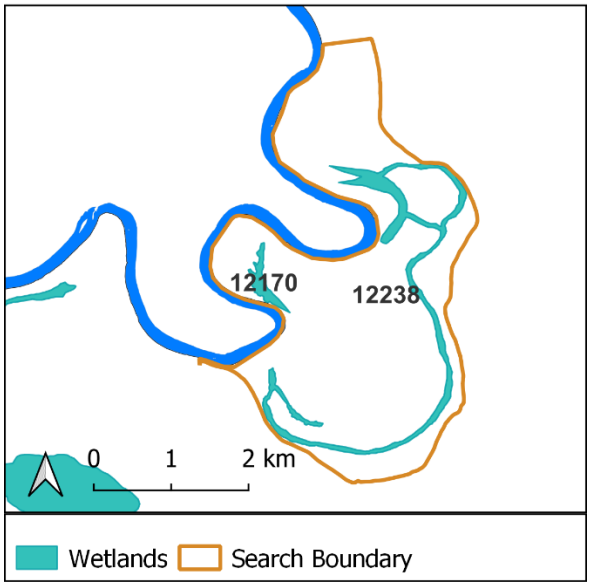
APPENDIX 4. FAUNA SPECIES LIST



Scientific Name	Common Name	Source
Elseyornis melanops	Black-fronted dotterel	NatureKit VBA observation
Phalacrocorax sulcirostris	Little black cormorant	NatureKit VBA observation
Threskiornis spinicollis	Straw-necked ibis	NatureKit VBA observation
Chenonetta jubata	Australian wood duck	NatureKit VBA observation
Anas gracilis	Grey teal	NatureKit VBA observation
Fulica atra	Eurasian coot	NatureKit VBA observation
Tachybaptus novaehollandiae	Australasian grebe	NatureKit VBA observation
Platycercus elegans	Crimson rosella	NatureKit VBA observation
Psephotus haematonotus	Red-rumped parrot	Birdata survey 23 May 2023
Maccullochella peelii	Murray cod	Protected Matters Search
Haliaeetus leucogaster	White-bellied sea-eagle	Protected Matters Search

Source: Naturekit, DEECA 2023, Protected Matters Search Tool DCCEEW 2023.

APPENDIX 5. FLORA SPECIES LIST



Scientific Name	Common Name	Source
Eucalyptus camaldulensis	River red gum	NatureKit VBA observation
Eucalyptus largiflorens	Black box	NatureKit VBA observation
Duma florulenta	Tangled lignum	Mallee CMA observation
Pseudoraphis spinescens	Moira grass	Sunraysia Environmental observation
Bolboschoenus medianus	Marsh clubrush	Sunraysia Environmental observation
Eleocharis microcarpa	Spike sedge	Sunraysia Environmental observation
Acacia stenophylla	Eumong, river coobah	Mallee CMA observation
Typha spp.	Cumbungi	Mallee CMA observation

Source: NatureKit, DEECA 2023

APPENDIX 6. ASSESSING RISKS

Assessing Risk - Consequence

Prioritising wetland watering is often difficult because there is no framework by which the fate of different species can be compared. To support prioritisation, this guide seeks to put each wetland and its associated species within a regional context. The process can also be used when communicating the rationale behind decisions or support engagement by providing a framework for discussion.

The process is presented in Figure A1, with a more detailed explanation provided in Tables A1 and A2.

Table A1.

Row	Question	Rationale	Response	Risk	Go To
1	Will the species persist *in situ*?	If the species will survive without intervention, it becomes a lower priority	Yes	Low	
			No		Row 2
2	Will the species persist in a connected refuge?	If the species has the capacity (its own capability and appropriate connectivity) to survive, it becomes a lower priority	Yes		Table A2
			No		Row 3
3	Is the species common?	If a species is common then there may be other populations that are more likely or easier to protect than the ones in the wetland.	Yes	Med	
			No	High	

Table A2

Row	Question	Rationale	Response	Risk	Go To
1	Is the species short or long lived?	Long-lived species often have greater capacity to endure periods of hardship, whereas short lived species are programmed to die.	Long	Med	
			Short		Row 2
2	Does the species need the wetland to recruit?	If the species requires the wetland to recruit then sustaining will require protection of wetland condition.	No	Med	
			Yes		Row 3
3	Is the species common?	If a species is common then there may be other populations that are more likely or easier to protect than the ones in the wetland.	Yes	Mod	
			No	High	

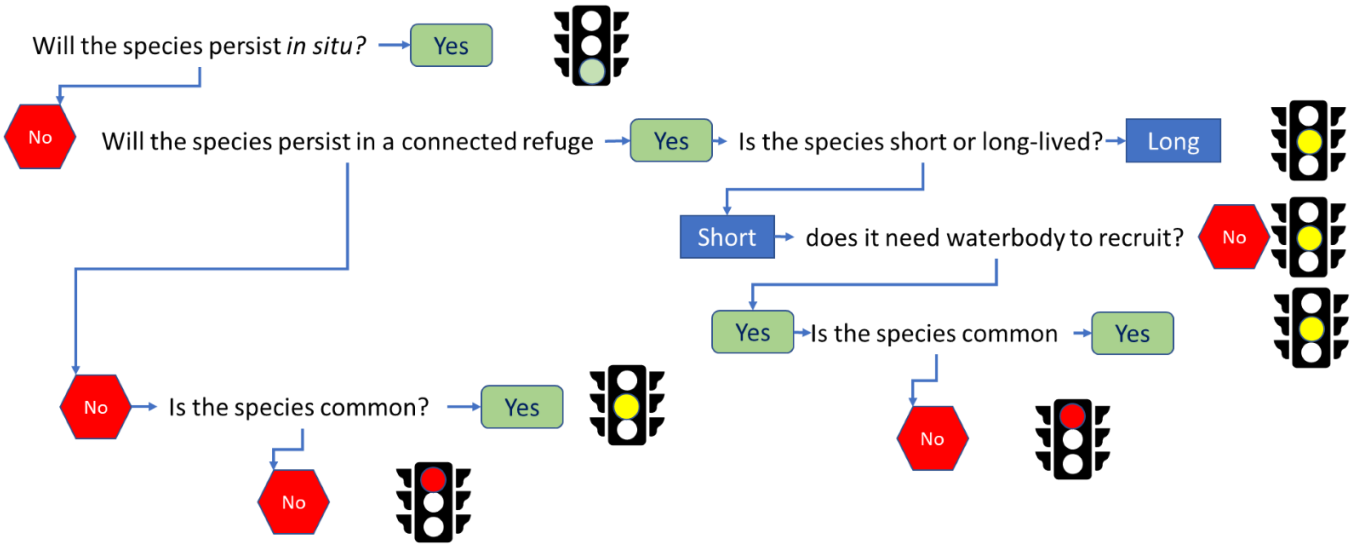


Figure A1 – Decision tree for assessing risk

APPENDIX 7. UPDATED ENVIRONMENTAL OBJECTIVES, FURTHER INFORMATION (FROM BUTCHER ET AL., 2020)

While every attempt was made to make the objectives and targets as complete as possible, there remain gaps as critical information is not currently available. As such, baselines are not able to be set at this time, and formal observations of some species are lacking. In the interests of moving forward, the objectives and targets have been written in a way (i.e. red highlighted text) that allows this information to be included at a later stage as this information becomes available.

5.8 Carina Bend

5.8.1 SMARTness and rationalisation

Site-specific environmental objectives for the Carina Bend EWMP (Riverness and Ecological Associates 2016b).

EWMP objectives
CB1: Support the health of mature River Red Gum trees along the wetland perimeter
CB2: Provide seasonal aquatic habitat that supports a diverse population of native fish and frogs
CB3: Reliable nesting and feeding habitat for waterfowl in winter and spring
CB4: Diverse macrophyte and frog population supported by healthy Lignum Swampy Woodland vegetation

Assessment of SMARTness of current Carina Bend EWMP objectives. Scoring: 1 is criterion met, 0 is criterion not met, and 0.5 is partially met

	Specific		Measurable			Achievable		Relevant		Timely	
Objective	Magnitude clearly specified	Location and scale detailed	Indicators available or easily developed	Can be analysed using accepted statistical practices	Capacity to collect data exists	Under river operating constraints and current climate variability	Considered feasible by knowledgeable stakeholders	Matters driven by environmental watering and/or works and measures	Linked to BP objectives	Absolute date or time period specified	Considers likely lags in response
CB1	0	0	1	1	1	0.5	1	1	0.5	0	0
CB2	0	0	1	1	1	0.5	1	1	1	0.5	0
CB3	0	0	1	1	1	0.5	0.5	1	1	1	0
CB4	0	0	1	1	1	0.5	1	1	1	0	0

Rationalised environmental objectives for the Carina Bend EWMP (Riverness and Ecological Associates 2016b).

Objective	Issue	Outcome
CB1	No issue with objective other than its not fully SMART and no baseline data.	Objective updated to align with Basin Plan language
CB2	This objective will be split, and species-specific information added to objectives and targets	Objective updated to focus on small-bodied fish. The frog aspect will be addressed under 'other fauna'. Frogs – merged with frog component from CB4. No species specified in EWMP therefore can't set target
CB3	This objective will be split into one for feeding and one for nesting.	This objective will be split into one for feeding and one for nesting. Nesting/breeding species are not known.

Objective	Issue	Outcome
CB4	This objective will be split into two and species-specific information added to objectives and targets	Frogs merged with CB2, aquatic macrophytes and Lignum Swampy woodland vegetation dealt with using WRIGs.

5.8.2 Mapping to Basin Plan

Basin Plan Schedule 8 and 9 criteria.

Schedule 8 criteria met	Schedule 9 criteria met
From DELWP (2015a)	
4: FFG Act, EPBC act, DSE Listed **5:** Diverse range of water dependent flora and fauna species	**1:** Supports the creation and maintenance of vital habitats and populations **2:** water quality - ecosystem processes supports the transportation and dilution of nutrients, organic matter and sediment; supports the dilution of carbon and nutrients from the floodplain to the river system **4:** lateral connectivity - (between floodplains, anabranches and wetlands)
Updated assessment	
3(b): Prevents declines in native biota	**1(e):** Vital habitat - preventing decline of native biota

Mapping Carina Bend EWMP objectives to Basin Plan EWP objectives, Schedule 7 targets, BWS QEEO, and LTWP Vic Murray objective.

EWMP objectives	Relevant Basin Plan EWP objective	Relevant Schedule 7 target	Relevant BWS QEEO	LTWP objective
CB1: Support the health of mature River Red Gum trees along the wetland perimeter	8.05,3(b)	Condition of native water dependent vegetation	B2.8	LTWPVM5
CB2: Provide seasonal aquatic habitat that supports a diverse population of native fish and frogs	8.05,3(b) - fish	Condition of priority asset - prevention of decline in native biota Recruitment and populations of native fish	B4.5	LTWPVM15
	8.05,3(b) - frogs	Condition of priority asset - prevention of decline in native biota Recruitment and populations of other native water-dependent biota	None specified	LTWPVM19 LTWPVM20
CB3: Reliable nesting and feeding habitat for waterfowl in winter and spring	8.06,6(b)	Recruitment and populations of native water-dependent birds	B3.4	LTWPVM11

EWMP objectives	Relevant Basin Plan EWP objective	Relevant Schedule 7 target	Relevant BWS QEEO	LTWP objective
CB4: Diverse macrophyte and frog population supported by healthy Lignum Swampy Woodland vegetation	8.05,3(b) - vegetation 8.06,6(b)	Condition of priority asset - prevention of decline in native biota Diversity of native water dependent vegetation Condition of native water dependent vegetation Condition of priority ecosystem functions - creation of vital habitat - habitat for prevention of decline in native species	B2.11	LTWPVM2
	8.05,3(b) - frogs	Condition of priority asset - prevention of decline in native biota Recruitment and populations of other native water-dependent biota	None specified	LTWPVM19 LTWPVM20

5.8.3 Updated objectives for Carina Bend

Current objective	CB1: Support the health of mature River Red Gum trees along the wetland perimeter
Comments	Focus of the objective is the condition of mature RRG
EWP objective(s)	8.05,3(b)
Schedule 7 targets	Condition of native water dependent vegetation
PEA/PEF criteria met	PEA 3(b) Prevents declines in native biota
BEWS QEEO	B2.8 By 2024 improve condition of Black Box and river red gum
LTWP objective	LTWPVM5 Improve the condition of river red gum dominated EVCs
LTWP target	A positive trend in the condition score of River red gums dominated Ecological Vegetation Class (EVC) benchmarks at 80% of sites over the 10 year period to 2025
2020 Objective:	By 2030, improve condition and maintain extent from baseline levels of River Red Gum (*Eucalyptus camaldulensis*) to sustain communities and processes typical of such communities at the Carina Bend asset.
2020 Targets:	By 2030, a positive trend in the condition score of River Red Gum dominated EVC benchmarks at 80% of sites over the 10 year period. OR By 2030, at stressed sites (see Wallace et al. 2020): in standardised transects that span the floodplain elevation gradient and existing spatial distribution, ≥70% of viable trees will have a Tree Condition Index Score (TCI) ≥ 10. Baseline condition of River Red Gum tress at the Carina Bend asset needs to be established.

Current objective	CB2: Provide seasonal aquatic habitat that supports a diverse population of native fish and frogs
Comments	Split objective, with small-bodied fish dealt with here and frogs addressed under 'other fauna'. The EWMP does not include a full list of fish species present, although Gudgeons spp and Murray-Darling Rainbow Fish are mentioned in passing in the text. The objective was modified to one focusing on 'representative populations', with the target to focus on the 2 species mentioned
EWP objective(s)	8.05,3(b)
Schedule 7 targets	Condition of priority asset - prevention of decline in native biota
PEA/PEF criteria met	PEA criterion 3(b) Prevents declines in native biota
BEWS QEEO	B4.5 Improved community structure of key native fish species
LTWP objective	LTWPMV15 Maintain abundance of small-bodied native fish in wetlands
LTWP target	No negative trend in the abundance of small-bodied wetland specialist native fish in 2025
2020 Objective CB2a:	By 2030, protect and restore biodiversity by maintaining representative populations of small bodied native fish at the Carina Bend asset, including Gudgeon spp (*Philypnodon* spp) and Murray-Darling Rainbow Fish *(Melanotaenia fluviatilis*).
2020 Targets CB2a:	By 2030, maintain self-sustaining populations of (Gudgeon spp (*Philypnodon* spp) and Murray-Darling Rainbow Fish (*Melanotaenia fluviatilis*) at the Carina Bend asset. Measured as: • Adults or YoY for each species recorded in 8 out of 10 years
Comments	No species specified in the EWMP – target not able to be set.
EWP objective(s)	8.05,3(b) 8.05,3(a)
Schedule 7 targets	Condition of priority asset - prevention of decline in native biota Condition of priority asset - Vital habitat - feeding, breeding, nursery
PEA/PEF criteria met	PEA 3(b) Prevents declines in native biota PEA 3(a) iii Vital habitat - feeding, breeding, nursery sites
BWS QEEO	None specified
LTWP objective	LTWPVM19 Improve habitat for frog communities LTWPVM20 Maintain species richness of frog communities
LTWP target	Maintain the number of native frog species recorded in 80% of years to 2025
2020 Objective CB2b:	By 2030, protect and restore biodiversity by maintaining representative populations of frogs at the Carina Bend asset
2020 Targets CB2b:	By 2030, maintain self-sustaining populations of frogs at the Carina Bend asset including: No species specified in EWMP – maintain spp in 80% of years.

Current objective	CB3: Reliable nesting and feeding habitat for waterfowl in winter and spring
Comments	
EWP objective(s)	8.06,6(b)
Schedule 7 targets	Recruitment and populations of native water-dependent birds
PEA/PEF criteria met	PEA 3(a) iii Vital habitat - feeding, breeding, nursery sites PEF 1 (c) Vital habitat - feeding, breeding, nursery sites
BEWS QEEO	B3.4 Breeding abundance (nests and broods) for all of the other functional groups to increase by 30-40% compared to the baseline scenario, especially in locations where the Basin Plan improves over bank flows
LTWP objective	LTWPVM11: Improve breeding opportunities for waterbirds
LTWP target	No targets specified for non-colonial breeding species
2020 Objective CB3a:	By 2030, maintain nesting and recruitment of non-colonial waterbirds (N1, N2, N3 and N4, after Jaensch 2002) at the Carina Bend asset, by maintaining a mixture of tree, low vegetation/shrubs, and ground/islet nesting habitat.
2020 Targets CB3a:	There is a lack of data on species that breed at the site. The expectation is that the list of species commonly nesting at the Carina Bend asset will be confirmed over time. By 2030, at least two of the following species to be recorded as nesting and/or breeding at the Carina Bend asset in 7 out of any 10-year period in which nesting/breeding conditions are suitable: • Representative N1 and N2 species include: White-bellied Sea Eagle (*Haliaeetus leucogaster*), • Representative N3 and N4 species include: Australasian Grebe (*Tachybaptus novaehollandiae*), Masked Lapwing (*Vanellus miles*), Pacific Black Duck (*Anas supercilliosa*)
Comments	
EWP objective(s)	8.05,3(a) 8.06,6(b)
Schedule 7 targets	Condition of priority assets – vital habitat (habitat to prevent declines)
PEA/PEF criteria met	PEA criteria: 3(a)iii Vital habitat - feeding, breeding, nursery sites PEF criteria: 1(c) Vital habitat - feeding, breeding, nursery sites
BEWS QEEO	B3.1: Number and type of waterbird species present in the Basin will not fall below current observations
LTWP objective	LTWPVM13: Improve feeding areas for waterbirds
LTWP target	Appropriate water regime to support feeding and habitat areas for guilds of waterbirds delivered at 50% of sites, 8 years in 10
2020 Objective CB3b:	By 2030, maintain representative populations of shallow-water and deep-water feeding guilds of waterbird (F2 and F3, respectively, after Jaensch 2002) at the Carina Bend asset, by maintaining a mixture of shallow and deep-water habitats.

2020 Targets CB3b:	By 2030, 80% of representative F2 and F3 species recorded at Carina Bend in 8 years out of any 10-year period where conditions are suitable. • Representative F2 species include: Australasian Grebe (*Tachybaptus novaehollandiae*), Pacific Black Duck (*Anas superciliosa*), White-necked Heron (*Ardea pacifica*), Australian White Ibis (*Threskiornis molucca*), Masked Lapwing (*Vanellus miles*) Australasian Shoveler (*Anas rhynchotis*) • Representative F3 species include: Australian Pelican (*Pelecanus conspicillatus*), Great Cormorant (*Phalacrocorax carbo*), Little Black Cormorant (*Phalacrocorax sulcirostris*), White-bellied Sea Eagle (*Haliaeetus leucogaster*) • Feeding habitat defined as a mixture of deep feeding areas (water >1 m) and shallow feeding areas (<0.5 m depth and or drying mud) with intermittent inundation of densely vegetated shrublands.

Current objective	**CB4: Diverse macrophyte and frog population supported by healthy Lignum Swampy Woodland vegetation**
Comments	Adopted WRIGs developed by DELWP. Some species need to be identified as currently not all aquatic WRIGs represented in the flora lists in the EWMP. Frog population captured in CB2.
EWP objective(s)	8.05,3(b) 8.06,6(b)
Schedule 7 targets	Condition of priority asset - prevention of decline in native biota Diversity of native water dependent vegetation Condition of native water dependent vegetation Condition of priority ecosystem functions - creation of vital habitat - habitat for prevention of decline in native species
PEA/PEF criteria met	PEA 3(b) Prevents declines in native biota PEF 1(e) Vital habitat - preventing decline of native biota
BWS QEEO	B2.11 To maintain the current extent of non-woody vegetation
LTWP objective	LTWPVM2 Improve the species richness of aquatic vegetation in wetlands
LTWP target	None specified for non-woody vegetation
2020 Objective CB4a:	By 2030, improve vital habitat at the Carina Bend asset by increasing the diversity of aquatic macrophytes present across a range of Water Regime Indicators Groups.
2020 Targets CB4a:	By 2030, increase diversity of native of macrophytes at the Carina Bend asset with ≥2 species from each of the following Water Regime Indicator Groups present in 80% of years: • Aquatic (small floating) (Asf) (no species recorded) • Aquatic (obligate submerged) (Aos) (no species recorded) • Aquatic (submerged to partially emergent) (Ase) (no species recorded) • Aquatic graminoids (persistent) (Agp) (no species recorded) • Aquatic to semi-aquatic (persistent) (Asp) (Spiny Mud-grass *Pseudoraphis spinescens*)

	• Seasonally immersed – low growing (Slg) (Marsh Club-sedge *Bolboschoenus medianus*, Rough Raspwort *Haloragis aspera*, Poison Pratia *Lobelia concolor*, Blue Rod *Stemodia florulenta*) • Seasonally inundated – emergent non woody (Sen) (Warrego Summer-grass *Paspalidium jubiflorum*)
Comments	Split to cover Lignum
EWP objective(s)	8.05,3(b) 8.06,6(b)
Schedule 7 targets	Condition of priority asset - prevention of decline in native biota Condition of water-dependent vegetation Diversity of native water dependent vegetation
PEA/PEF criteria met	PEA 3(b) Prevents declines in native biota PEF 1(e) Vital habitat - preventing decline of native biota
BWS QEEO	B2.10 Maintain extent of Lignum along the Murray River from the junction with the Wakool River to downstream of Lock 3, including Chowilla and Hattah Lakes
LTWP objective	LTWPVM8: Improve the condition of shrub and lignum dominated EVCs
LTWP target	A positive trend in the condition score of Shrub and Lignum dominated EVC benchmarks at 50% of sites over the 10 year period to 2025
2020 Objective CB4b:	By 2030, improve condition and maintain extent from baseline levels of Lignum (*Duma florulenta*) to sustain communities and processes reliant on Lignum communities at the Carina Bend asset.
2020 Targets CB4b:	By 2030, condition in standardised transects that span the floodplain elevation gradient and existing spatial distribution at Carina Bend, ≥70% of Lignum plants in good condition with a Lignum Condition Score (LCI) ≥4.

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