Environmental Water Management Plan

Photo: Chaffey Bend, Murray River, Mildura

Johnson's Bend and Chaffey Bend

mallee
catchment management authority

Document Control

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Cover image: Chaffey Bend

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

CAMBA	China-Australia Migratory Bird Agreement
CMAs	Catchment Management Authorities
DEECA	Department of Energy, Environment and Climate Action
EA	Ecological Associates
EPBC	Environment Protection and Biodiversity Conservation Act
EVC	Ecological Vegetation Class
EWMP	Environmental Water Management Plan
FFG	Flora Fauna Guarantee Act
JAMBA	Japan-Australia Migratory Bird Agreement
MCMA	Mallee Catchment Management Authority
MDB	Murray-Darling Basin
MDBA	Murray-Darling Basin Authority (formally Murray-Darling Basin Commission, MDBC)
Ramsar	Global treaty adopted in the Iranian city of Ramsar in 1971 that focuses on the conservation of internationally important wetlands
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
VEWH	Victorian Environmental Water Holder
VWMS	Victorian Waterway Management Strategy
WMU	Waterway Management Unit

Executive summary

Environmental Water Management Plans (EWMP) are being prepared for key sites in the Mallee region by the Mallee Catchment Management Authority (CMA) in partnership with the Victorian Department of Energy, Environment, and Climate Action (DEECA). These plans are based on waterway management units (WMUs) of the Murray River floodplain and have been developed to guide future environmental water events at these sites. This EWMP has been developed for Johnsons and Chaffey Bend.

Johnson's and Chaffey Bend is a high-profile site in the Merbein WMU, with high numbers of visitors due to the site's environmental values and its proximity to Mildura. Environmental values for the site include a diverse range of water-dependent flora and fauna species and several vulnerable or depleted Ecological Vegetation Classes (EVCs). In these EVCs, species that are of interest include River red gum and Black box. These communities provide habitat for a wide range of fauna species, some of which are threatened or endangered. The site also contains high recreational, cultural and economic values.

This EWMP was developed in collaboration with key stakeholders, including Parks Victoria, DEECA, and local interest groups. This plan also outlines consultation with Traditional Owners to review and provide input into the plan.

The management goal for the Target Area is 'To support healthy ecosystems across the floodplains.' A number of risks associated with environmental water delivery have been identified, and management measures have been put in place in an attempt to decrease and/or mitigate these risks.

Ecological objectives for this study site include:

> **JCB1:** By 2030, improve condition and maintain extent from baseline levels of River red gum (*Eucalyptus camaldulensis*) to sustain communities and processes reliant on River red gum woodland at the Johnsons & Chaffey Bend asset.
> **JCB2:** By 2030, improve condition and maintain extent from baseline (2006) levels of Black box *(Eucalyptus largiflorens*) to sustain communities and processes reliant of such communities at the Johnsons & Chaffey Bend asset.

The following watering regimes have been developed to sustain and improve the ecological components of the target area:

Table 1. Johnsons and Chaffey Target Watering Regime

Target Watering Regime
Minimum watering regime Inundate River red gum communities along the river three times in ten years with a maximum interval of three years between events. Extend the inundation area to include Black box communities at least once every seven years. Allow ponding on the floodplain for at least three months to maintain River red gum and Black box communities. Timing is not critical in terms of mature tree health but flooding during spring may produce best results.
Optimal watering regime Inundate River red gum communities along the river every one to three years with a maximum interval of three years between events. Extend the inundation area to include Black box communities three times in ten years with a maximum interval of seven years between events. Allow ponding on the floodplain for five months to improve River red gum and Black box communities. Timing is not critical in terms of mature tree health but flooding during spring may produce best results.
Maximum watering regime Inundate the River red gum communities along the river every one to three years with a minimum interval of six months between events. Extend the inundation area to include Black box communities every three years with a minimum interval of one year between events. Allow ponding for up to 6 months (variability in flood duration is encouraged) to improve River red gum and Black box communities. Timing is not critical in terms of mature tree health but flooding during spring may produce best results.

Previous surface water inundation at these assets delivered a poor vegetation health response compared to other watering sites. The poor vegetation health response correlates with the observation that the sites are underlain by a saline hydrogeological system that is influenced by a range of groundwater inputs and processes. These include Salt Interception Scheme bore operation, drainage from the Wastewater Treatment Plant lagoons and associated irrigated areas, irrigation district drainage, and evapotranspiration. These have a significant influence on the system's behaviour. It is suspected that

groundwater plays an important role in vegetation health at this site. Therefore, understanding the relationship between groundwater, surface water and vegetation health is crucial to achieving the management goal and ecological objectives.

Table of Contents

1. Introduction

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.

This Environmental Water Management Plan (EWMP) has been prepared by the Mallee Catchment Management Authority (CMA) to establish the long-term management goals of Johnson's and Chaffey Bend sites to establish the long-term management goals for these sites.

The Johnson's and Chaffey Bend EWMP was developed in 2015 and updated in 2020 to review and update the ecological objectives. The EWMP was updated in 2021 to make it compliant with the draft version 6 of the EMWP guidelines, which were released in early 2021. The latest version of the EWMP (2022) has been updated to incorporate new information and align with Department of Energy, Environment and Climate Action (DEECA) Draft EWMP Guidelines (Version 6 – June 2022).

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

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

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

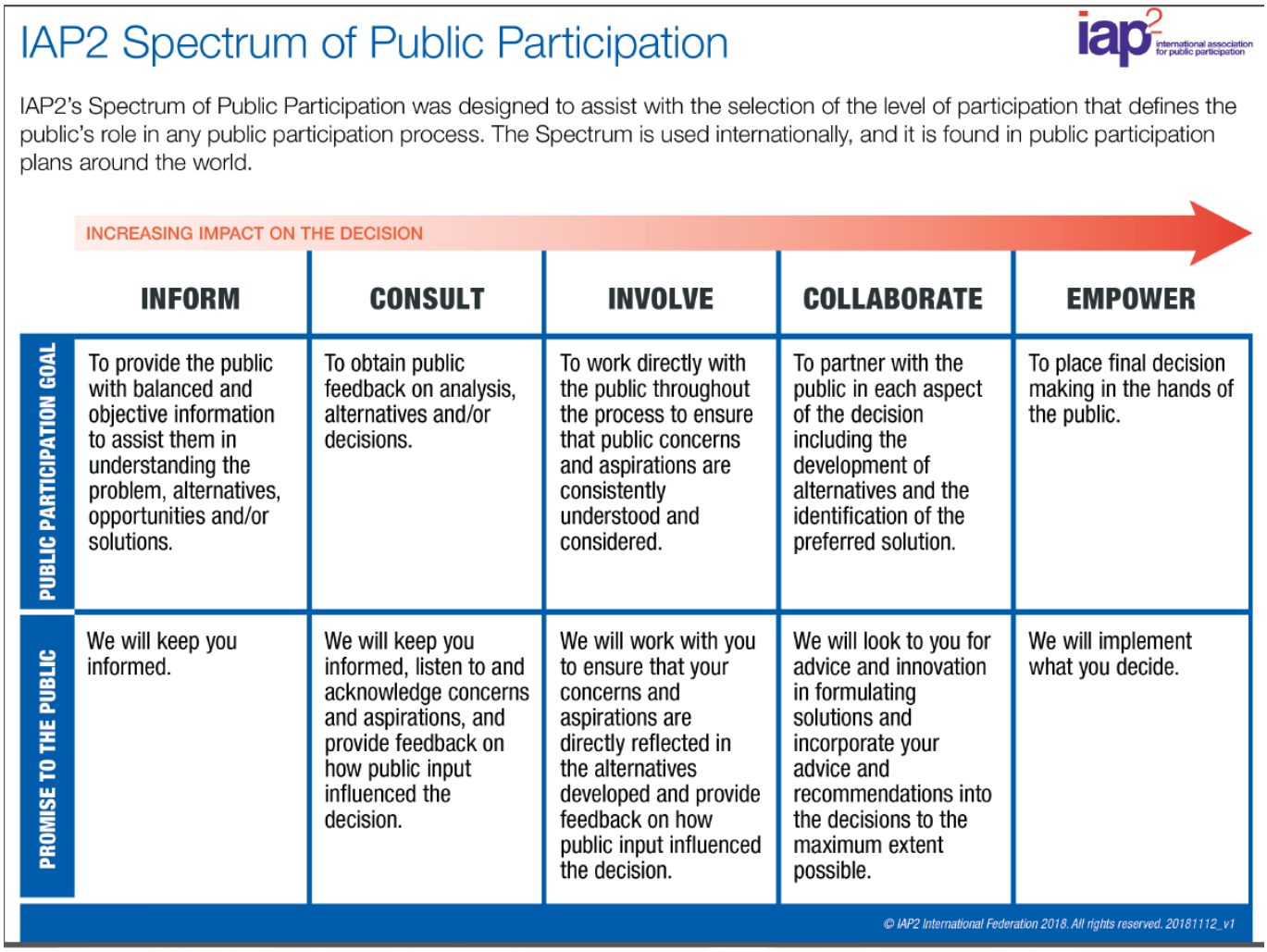
Information on how this EWMP relates to other environmental water documents and policies is included in Appendix 1.

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 different 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.



IAP2 Spectrum of Public Participation

IAP2's Spectrum of Public Participation was designed to assist with the selection of the level of participation that defines the public's role in any public participation process. The Spectrum is used internationally, and it is found in public participation plans around the world.

INCREASING IMPACT ON THE DECISION

	INFORM	CONSULT	INVOLVE	COLLABORATE	EMPOWER
PUBLIC PARTICIPATION GOAL	To provide the public with balanced and objective information to assist them in understanding the problem, alternatives, opportunities and/or solutions.	To obtain public feedback on analysis, alternatives and/or decisions.	To work directly with the public throughout the process to ensure that public concerns and aspirations are consistently understood and considered.	To partner with the public in each aspect of the decision including the development of alternatives and the identification of the preferred solution.	To place final decision making in the hands of the public.
PROMISE TO THE PUBLIC	We will keep you informed.	We will keep you informed, listen to and acknowledge concerns and aspirations, and provide feedback on how public input influenced the decision.	We will work with you to ensure that your concerns and aspirations are directly reflected in the alternatives developed and provide feedback on how public input influenced the decision.	We will look to you for advice and innovation in formulating solutions and incorporate your advice and recommendations into the decisions to the maximum extent possible.	We will implement what you decide.

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 Johnsons and Chaffey Bend, refer to Section 3.2.

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

Table 2. Recent Stakeholder Consultation for Johnsons and Chaffey Bend EWMP

Stakeholder groups	Stakeholders	Needs and interest	IAP2 level	Consultation modes
Traditional Owners and Interested Parties	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.	Collaborate	Via Mallee CMA's Traditional Owner engagement team. Consultation is largely undertaken in-person and, where possible, on Country.
Victorian water holders	VEWH	Make decisions about annual environmental water usage.	Collaborate	Via formal meetings.
River operators	Lower Murray Water	Manage water storage, land management responsibilities.	Collaborate	Via formal meetings.
Scientists	Arthur Rylah Institute, consultancies	Floodplain health, biodiversity and use of environmental water.	Involve	Workshops, meetings, phone calls.
Public land managers	Parks Victoria, DEECA Forest Fire and Regions Group	Managing impacts from watering such as access.	Collaborate	Via monthly meetings.
Local government	Mildura Rural City Council	Access during watering events.	Involve	Meetings, phone calls, correspondence.
Basin-wide river management	MDBA	River Murray operations.	Involve	Via formal meetings.
Private landowners and managers	Adjacent landholders and managers	Possible access to properties during operation as defined in landholder agreements.	Collaborate	Directly affected landholders will be informed of watering proposals and asked to provide feedback if relevant.
Community (interest groups)	Irrigators Community Advisory Groups Environmental, recreational and social groups	Consumptive water use/access. Watering benefits and impacts on local communities such as access to parks and river during watering events.	Inform	Via existing groups such as the Mallee CMA Land and Water Committee. Via Mallee CMA social media and news.
Media	Local, state and national media outlets	Across issues that interest the local community.	Inform	Media packs and media releases.

2.2 Developing/updating the EWMP

Mallee CMA carried out community consultation through the following channels:

- Mallee CMA Land and Water Advisory Committee
- surveys at community events such as farmers' markets
- workshops and on-country visits with Traditional Owners (see Section 2.4)
- campaign emails
- meeting with landholders
- social media channels.

Relevant government agencies were invited to participate in the consultation process via a formal letter. They have also been engaged through existing channels, with discussions and presentations. The key outcomes from this engagement were:

- ensuring that Traditional Owner values were represented in the ecological outcomes
- building more frequent initial watering into the proposed watering regime to help the landscape recover and monitoring outcomes to determine future water needs, in response to Traditional Owner feedback

2.2.1. Verifying asset values

Asset values at Johnsons and Chaffey 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 long worked with those who have an extensive knowledge of Johnsons and Chaffey 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 will guide future watering events, as part of the adaptive management approach (see Section 11: Adaptive Management).

2.2.3 Promoting adaptive management

Mallee CMA and other partners will take an adaptive management approach taking into account both varying seasonal conditions and lessons learned from previous events (see Section 11: Adaptive Management).

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 see any updates.

2.3 Community Engagement

Community stakeholders were engaged via an online survey, which was hosted on the Mallee CMA website in January-February 2023. The survey was designed to enable community, landholders, recreational users, Landcare groups, environmental groups and other interested parties to provide input to the plans. The survey supplements earlier community engagement about the Johnsons and Chaffey Bend EWMPs, and annual community engagement that informs the Seasonal Watering Proposal (SWP). Seven completed surveys were received through this exercise; four participants identified as residents, two participants identified as visitors to the region, and two participants identified as recreational users. Survey participants were asked to rank the values of each site. The results of the ranking are shown in Table 3. For further detail about the outcomes of the 2023 community engagement, refer to appendix 6.

Table 3. Recent Stakeholder Consultation for Johnsons and Chaffey Bend EWMP

Community Value	Use and Value ranking
Exercise, especially walking/running and bike riding	100% of survey participants use Johnsons and Chaffey Bend for walking/running. Exercise was ranked very important (scores of 4.4/5 and 5/5) for survey participants.
Boating	Almost 60% of respondents (4/7) visit Johnsons and Chaffey Bend for boating
Unique landscape features and natural beauty	Respondents for the Historic Wetland (Johnsons Bend) ranked this value as very important (a score of 4.6/5)
Fishing	A respondent to the survey identified fishing as value.
Nature appreciation	A respondent to the survey identified nature appreciation as a value
Traditional Owner Values	Respondents for the Johnsons and Chaffey survey ranked this value as important (a score of 4.2/5).

2.4 Traditional Owners

Johnsons and Chaffey Bend is located within the formally recognised Country of the First People of the Millewa-Mallee Aboriginal Corporation (FPMMAC). FPMMAC have indicated in DEECA's EWMP guidelines how they would like to be consulted about environmental watering. Consultation with FPMMAC, in-line with the EWMP guidelines, is ongoing. Engagement with Traditional Owners is conducted on a one-on-one basis at the COLLABORATE level of the IAP2 framework, with the level of interest and involvement self-determined by each group. Annual consultation is also undertaken with Traditional Owner groups during the development of the SWP for Johnsons and Chaffey Bend.

FPMMAC were engaged in March 2023 to collaborate on the EWMP update process. This involved a presentation to a group of TO's from FPMMAC about the sites included in the update.

Discussions included ecological, social and cultural outcomes and watering regimes to support these. Engagement and discussions about these topics will be on going and essential to future watering programs.

3. Asset overview

The Mallee CMA region is located in the north-west of Victoria. Its area of responsibility covers approximately 39,000 km^2, and major population centres include Mildura, Birchip, Sea Lake, Ouyen, Robinvale, Red Cliffs and Merbein. The Mallee CMA region is the largest catchment in the state given its extent is almost one fifth of Victoria (Figure 1). This catchment runs along the Murray River from Nyah to the South Australia border (MCMA 2014).

Approximately 40% of the land area within the Mallee CMA boundary is public land, consisting mainly of National Parks, reserves, wilderness areas and large tracts of riverine and dryland forests. The other 60% is predominantly dryland cropping by area, but there is also a significant investment in irrigation of grapes, citrus, almonds, olives, and vegetables along the Murray River corridor which contributes over 40% of the value of agricultural production for the region.

In 2007, Ecological Associates (EA) conducted an investigation on water management options for the Murray River floodplain from Robinvale to Wallpolla Island. EA (2007) has divided the floodplain into different Waterway Management Units (WMUs) in which water regimes can be managed independently of another WMU. These WMUs form a basis to develop EWMPs, including this EWMP for Johnsons and Chaffey Bend.

The Johnsons and Chaffey Bend is located between river km 878.5 and 884, 3 km north-west of Mildura. Johnsons Bend is located between 875 and 878 river km, next to and immediately downstream of Chaffey Bend (Figure 2. Target area in Johnsons and Chaffey Bend) (EA 2007). Johnsons and Chaffey Bend are small sites located next to each other and are known to have similarities in natural settings and conditions. Therefore, these two areas are combined into one EWMP.

This EWMP focuses on the area of the Johnsons and Chaffey Bend that is dominated by native vegetation (i.e. the Target Area).

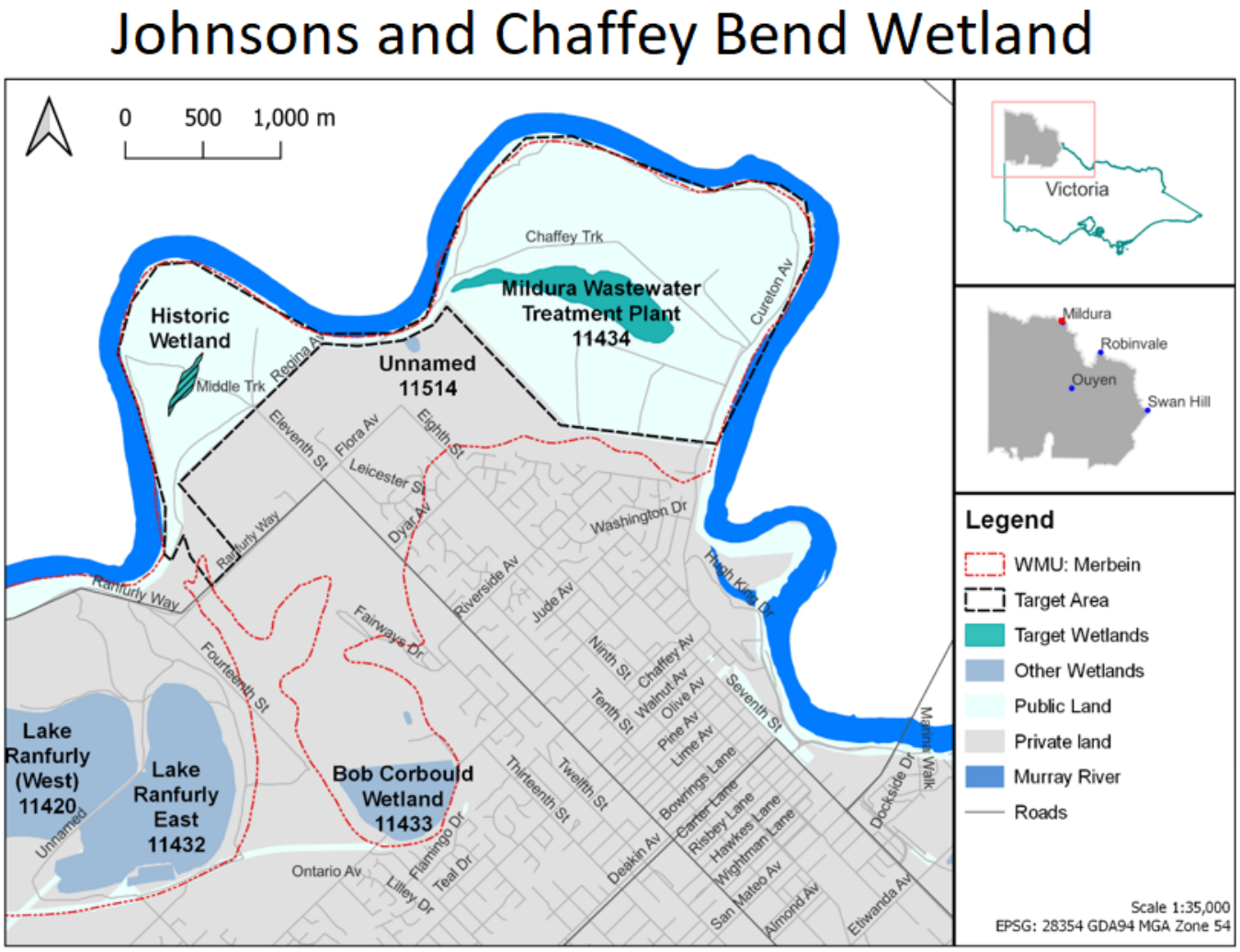


Figure 2. **Target area in Johnsons and Chaffey Bend**

3.1 Catchment setting

Johnsons and Chaffey Bend sites (Figure 2) are within the Murray Scroll Belt bioregion. Johnsons and Chaffey Bend are meander scroll complexes, and support River red gum woodland near the river, and Lignum and Chenopod shrublands and Black box communities inland from the river.

The Johnsons and Chaffey Bend sites are unique in their hydrogeological setting and the natural hydraulic regime of these floodplains has been altered significantly since regulation of the Murray River. They occur immediately downstream of Lock 11, are the target of Salt Interception works, and are located adjacent a significant irrigation district. Part of the Chaffey Bend site is operated as a disposal basin and irrigation disposal area for treated effluent (EA 2007). The Mildura weir and Lock 11 were installed in 1927 for navigation purposes and they are located at river km 884. The Mildura weir was constructed in a unique way, with the Lock and Weir separated by an island (AWE 2009).

Hydrogeological setting

Johnsons and Chaffey Bend is located at the approximate centre of the Murray Geological Basin. The geological units in the region are typical of the Murray Basin, and consist of marine, marginal marine, fluvial, lacustrine and alluvial deposits.

Essentially, the Basin is a closed system with little or no opportunity for discharge to the sea, other basins or aquifer systems. The major mechanism of salt discharge is through the River Murray valley including the floodplain and river itself. Salt

accumulation within the regional aquifers has occurred over thousands of years so that many of the regional aquifers are saline. Saline groundwater inflows are responsible for much of the salt additions to the River Murray from the study region (Brown and Stephenson 1991, AWE 2011).

The major stratigraphic units encountered on the floodplains, in order of increasing depth, include the Coonambidgal Clay, Monoman Formation, Parilla Sands and Lower Parilla Clay. The Coonambidgal Clay consists of fine silts and stiff, low plasticity clays that act as an aquitard at the top of the sedimentary sequence within the River Murray trench. The Monoman Formation forms the floodplain aquifer and consists of grey to brown, fine to coarse sands and clays. The Parilla Sands underlie the Monoman Formation and form the regional aquifer occurring across both the highland and floodplain. The Parilla Sands can be subdivided into an upper and a lower unit. The Upper Parilla Sand consists of unconsolidated to weakly cemented, fine to coarse quartz sands. The Lower Parilla Sands consist of fine, well-sorted sands or silty sands.

3.2 Land status and management

The Johnsons and Chaffey Bend sites are primarily managed by Mildura Rural City Council and Parks Victoria. A strip of land of approximately 60 m wide along the river is under Council management and the rest of the floodplain located in the Murray River Reserve is managed by Parks Victoria (Sunraysia Environmental 2010). The sites are directly or indirectly managed or used by a range of stakeholders (Table 4).

Table 4 - Stakeholders for the Johnsons and Chaffey Bend sites

Group	Role
Parks Victoria	Land Manager
Mallee Catchment Management Authority (MCMA)	Regional environmental management
The Department of Energy, Environment and Climate Action (DEECA)	State level environmental management
Lower Murray Water Authority	Water management
Mildura Rural City Council (MRCC)	Riverfront management
Apex River Holiday Park	Riverfront Management (license holder)
Aboriginal Communities	Indigenous Representation
Murray Darling Basin Authority (MDBA)	River Murray operations
Goulburn-Murray Water	Mildura Merbein Salt Interception Scheme and Lock 11 operators
Landowners	Landowners
Recreational users	Land user
General community	Land user
First People of the Millewa-Mallee Aboriginal Corporation	Indigenous representation

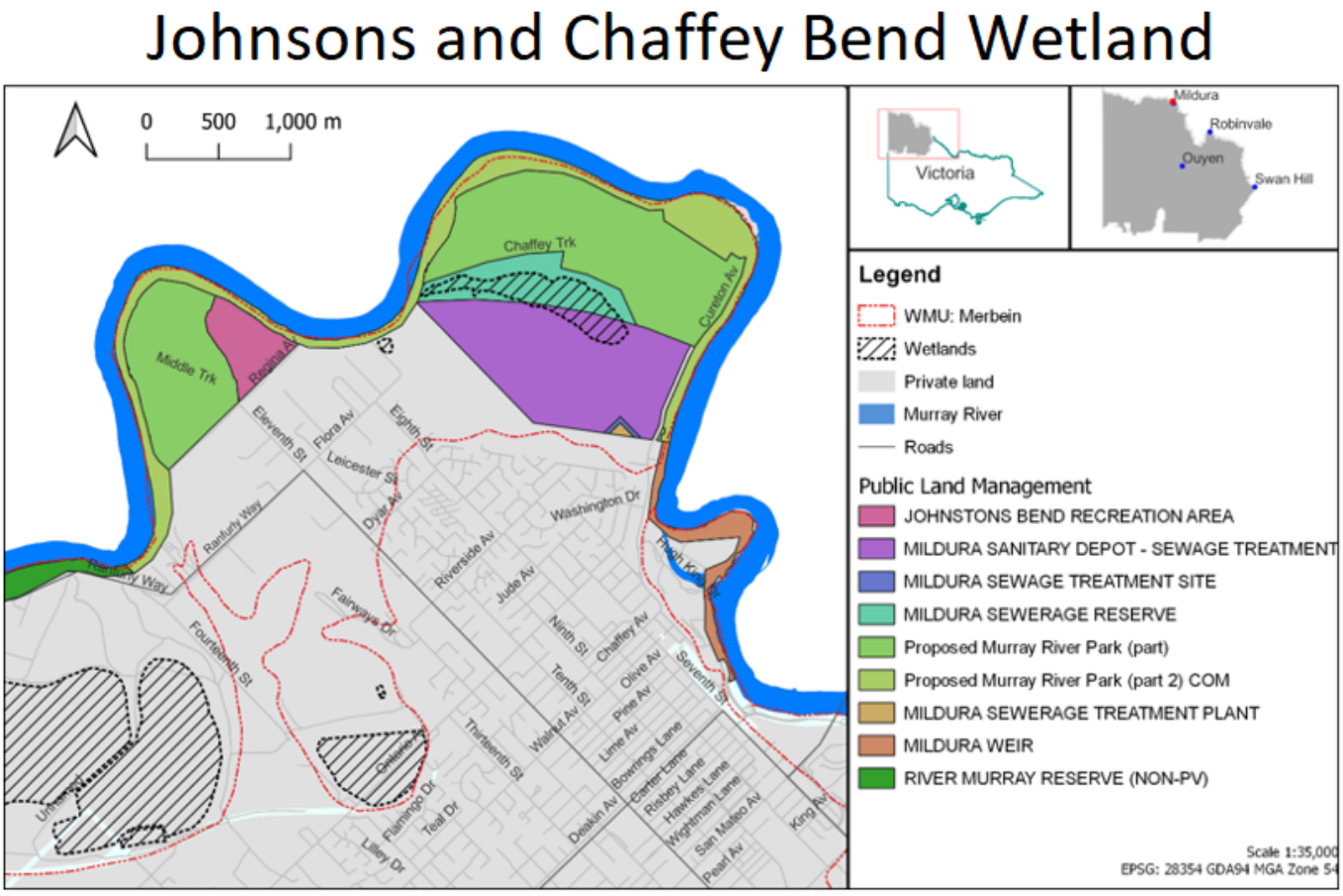


Figure 3. Land Management boundaries in the Johnsons and Chaffey bend target area

3.3 Asset characteristics

Johnsons and Chaffey Bend falls within the Murray Scroll Belt bioregion, in the Merbein WMU. Johnsons and Chaffey Bend contains a large vegetated area with predominantly River red Gum and black Box communities. The Mildura Wastewater

Treatment Plant (WWTP) is located in Chaffey Bend. The plant and its associated irrigation area are located on 150 ha, 2 km north of the city of Mildura. Treated effluent from the WWTP is stored in a 25ha lagoon on site. The lagoon is classified as permanent open freshwater according to the Corrick classification. The lagoon supports bird life and a diverse population of native fish and high numbers of turtles, and leakage from the lagoon provides water to surrounding remnant vegetation (Lower Murray Water 2011). A small proportion in the south and south-west of Chaffey Bend is private land which is used mainly for agricultural and horticultural purposes. Johnsons Bend contains a large proportion of land used for horticulture, recreation and waste disposal, and includes the Bob Corbould stormwater wetland. Native vegetation is distributed mainly along the river and in the northern side of the WMU.

This EWMP focuses only on the vegetated area of the floodplain within Johnsons and Chaffey Bend (Figure 1). The excluded area consists of mainly private ownership and/or non-vegetated area. Also, the Bob Corbould wetland is not included in this EWMP as it forms part of the stormwater network and is managed to achieve stormwater management outcomes.

The Target Area is located between a groundwater mound caused by extensive irrigation and the River Murray. The groundwater hydraulic gradient indicates that saline groundwater is generally flowing from the Mildura irrigation mound through the floodplain towards the river. The average salinity in the Parilla Sand Aquifer (below 25 m AHD) ranges from 50000 to 100000 µS/cm and the shallower water salinity (above 25 m AHD) ranges from 2000 to 50000 µS/cm.

The lower salinity groundwater is mostly located around the Treated Wastewater (TWW) lagoon and is derived from leakage from the lagoon and irrigation drainage from the associated woodlots and agricultural land watered from the lagoon. The recreational areas in the southeast of the Johnsons Bend are also irrigated with TWW lagoon water. The groundwater heads are influenced by infiltration from the TWW lagoon and its associated irrigation. Groundwater modelling also indicates elevated recharge rates occur beneath the pond/irrigation area (AWE 2013). Approximately 30m of freshwater occurs underneath the TWW lagoon and extends southward from the site. The freshwater lens gets thinner further away from the lagoon. It also shows that there is not much freshwater available for vegetation use near the river.

Table 5 - Wetland characteristics at Johnson and Chaffey Bend

Characteristics	Description
Name	Johnson and Chaffey Bend
Mapping ID (Wetland Current layer)	Chaffey Sewage Farm: #11434
Area of wetlands in target area	25 ha
Bioregion	Murray Mallee
Conservation status	Not listed on the Directory of Important Wetlands in Australia
Land status	Crown Land (delegated management reserve)
Land manager	LMW, Parks Victoria, DEECA, MRCC
Surrounding land use	Services and utilities (water and sewage), Residential, Horticulture, Recreation
Water supply	Lower Murray Water supply
Wetland category (Wetland Current layer)	Unknown

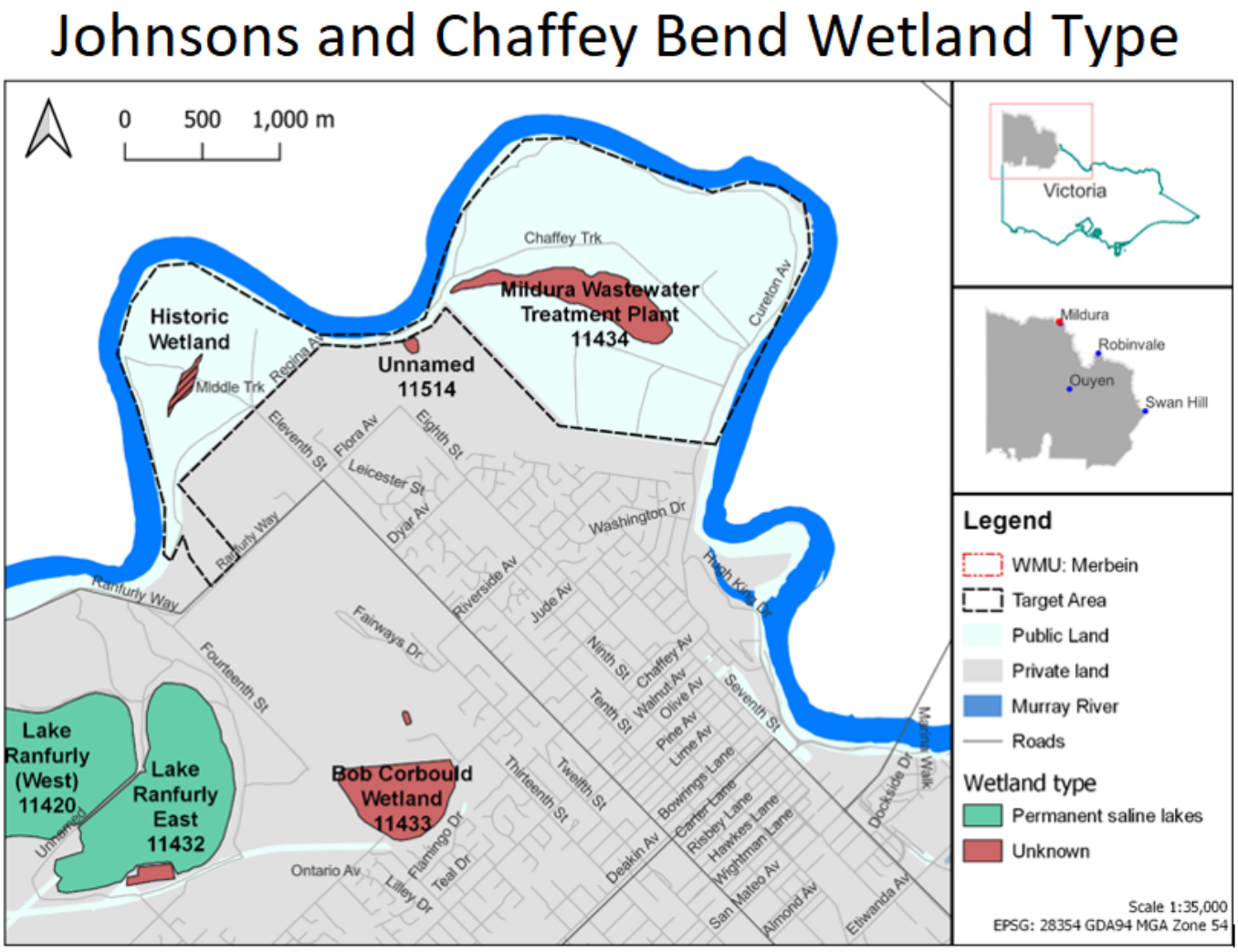


Figure 4. Wetland locations and classification at Johnsons and Chaffey Bend

3.4 Environmental water sources

Water delivered to Johnsons and Chaffey Bend will be made available by the VEWH under the Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999 held by the VEWH. This may include water held by the CEWO and donated water.

Other sources of water may become available through water trading or changes in water entitlements.

4. Current/historical hydrological regime and system operations

FMU Hydrology, Water Management and Delivery

Pre-regulation

With the effects of major storages and river regulation on the Murray River, the frequency, duration and magnitude of most flood events have decreased compared to natural conditions. Prior to river regulation, floodplain inundation would have occurred more frequently. In order to inundate low floodplain terraces and many wetlands, the flood peak has to be in the order of 20,000 to 60,000 ML/d. These high flow events occurred more often, with longer duration and at higher frequency compared to current conditions (EA 2007). Much of the floodplain does not get inundated by flows less than 120,000 ML/d.

Prior to irrigation development and locking, it is likely that losing stream conditions would have prevailed along this section of river and the floodplain aquifer would have been recharged by fresh River Murray water under most flow regimes. Prior to locking, river and groundwater levels would have fallen significantly lower than current levels during times of drought. Regional groundwater flow would have been driven by rainfall and occurred in a broadly east to west direction (AWE and SKM 2003).

Post-regulation

Since 1922, 13 weirs and locks across the Murray River have been constructed. The hydrology of the region has been altered significantly. River regulation and increased consumptive water use have reduced overbank flows that stimulate flora and fauna (Sunraysia Environmental 2008). The flooding regime has also been affected by local works such as changes to anabranches and wetland sills, which prevent or reduce inflows to flood-dependent ecosystems (EA 2007).

Groundwater Trend

Construction of Lock 11 at the upstream end of Chaffey Bend created a weir pool that is held above the pre-development groundwater level in the adjacent floodplain (AWE and SKM 2003). Since irrigation development, significant additional recharge to the groundwater system has occurred which has created a large irrigation mound to the south of Johnsons and Chaffey Bend. The mound influences the flow of groundwater within the site; elevated groundwater levels have created a radial flow pattern away from the mound and towards the river (AWE 2009). Groundwater heads are also elevated in bores adjacent the TWW lagoon in comparison to the surrounding floodplain providing the opportunity for TWW water to drain from the lagoon into the aquifer, and across the floodplain.

The Johnsons and Chaffey Bend floodplains can be considered gaining floodplains (AWE 2013) where the regional groundwater system (Parilla Sand) is discharging to the floodplain alluvium. The groundwater is sourced from regional groundwater flux and from irrigation induced groundwater recharge. The elevated heads have increased the rate of groundwater (and salt) movement to the river (AWE 2013) and much of the river would be a gaining stream without the implementation of the SIS.

Groundwater levels on the floodplain are affected by a combination of factors including flood events, floodplain surface water features, river flow regime, SIS pumping, rainfall, and irrigation.

Mildura Wastewater Treatment Plant (WWTP)

The Mildura Wastewater treatment plant (WWTP) and associated farm is located on 150 hectares of land adjacent the Chaffey Bend floodplain (Lower Murray Water 2011). A lagoon is also located within the site, which has an area of 30 hectares. The lagoon has a total capacity of 507 ML but volume varies from 34 ML (in March) up to 480 ML (July to October). It was previously used for wet weather storage but has not held water in recent years. The plant receives approximately 1,150ML of wastewater per year and discharges treated water via flood irrigation to a tree plantation (59.7 hectares) and pasture plantation (56 hectares). Treated water is also used for irrigation of the Aerodrome Ovals and Recreation Complex located adjacent the study area.

4.1 Environmental watering

An initial emergency watering program was carried out to maintain the health of River red gum over three years from 2005 to 2007 (Sunraysia Environmental 2008). According to Kelly (2006), the Department of Sustainability and Environment (now DEECA) had led a program to attempt to resurrect the health of the river red gums, Eucalyptus camaldulensis, along the Victorian Murray River floodplain. A total of 13,005 ML of water was delivered to the River Channel sites which are along the Murray River from Swan Hill to Lock 10 in Wentworth during the three-year period. Among these sites, Johnsons Bend State

Forest and Chaffey Bend received 277 ML and 212 ML respectively. The water was pumped directly from the river into flood runners (Sunraysia Environmental 2008). Details of the watering events in the Target Area during 2005-2006 are presented in Table 6. No other active environmental watering has occurred at these sites.

Table 6: Watering events at Johnsons and Chaffey Bend (Sunraysia Environmental 2008)

Site	Year	Volume (ML)	Area (ha)	Distance (km)
Johnsons Bend	2005	88	10	2
	14-18/6/2006	52	10	2
Chaffey Bend	2005	151	13	2
	13-18/6/2006	61	13	2

In 2006, environmental water allocated for Johnsons and Chaffey Bend came from 5,578 megalitres of donated water from Victorian Mallee Irrigators. The amount of donated water was used to water 16 selected sites along the Murray River including Johnsons Bend (52 ML) and Chaffey Bend (61 ML). The water was able to reach the severely stressed communities including River red gums, Black box and Lignum with only three runners (Kelly 2006).

Currently, the main sources for environmental water delivered to Johnsons and Caffey Bend are unregulated flows from the Murray River, a Salt Interception Scheme, groundwater recharge, irrigation drainage and the adjacent wastewater treatment plant. Any potential future environmental watering will be undertaken with a priority for River red gums and Black box.

5. Water-dependant values

Wetlands and waterways on the floodplain are a vital component of the landscape and support flora and fauna which vary with the type of wetland/waterway system. The habitat provided by vegetation communities around wetlands is essential for maintaining populations of water dependent fauna species. 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 vital services are maintained.

Johnsons and Chaffey Bend provide a range of shelter and food resources for indigenous fauna, flora and vegetation communities. Data from the Victorian Biodiversity Atlas, Mallee CMA and Naturekit exports from May 2023 have been referenced. 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

The wetlands in this area are a mix of Permanent Open Freshwater and Semi-permanent Saline wetlands. Present vegetation communities include Chenopod Mallee, Grassy Riverine Forest, Intermittent Swampy Woodland, Lignum Swampland, Lignum Swampy Woodland, Low Chenopod Shrubland, Riverine Chenopod Woodland, Semi-arid Chenopod Woodland, Semi-Arid Woodland and Shrubby Riverine Woodland.

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

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

Creation and maintenance of vital habitat for threatened/endangered species

Wetlands act as refugia for frogs, native fish and waterbirds during periods of extended drought in an arid landscape. Inundation of areas of the wetland woodland mosaic provides a diversity of feeding, breeding and nursery sites for native water-dependent biota including waterbirds.

Maintenance of River red gums and Black box at Johnsons and Chaffey Bend will provide extensive habitat for a wide range of native flora and fauna.

Diversity of habitat for feeding, breeding and nursery

Seasonal fluctuations in water levels in the wetlands increase the availability of specific habitat niches for feeding, breeding and nursery areas. Permanent and semi-permanent water bodies provide a source of food, refuge from predators and nesting sites and materials (Kingsford and Norman, 2002).

Wetland filling and water recession increases the extent of the band of sedges, rushes and semiaquatic forbs surrounding wetlands. Areas of deeper, permanent water support submerged aquatic macrophytes, and promote high levels of aquatic productivity and high habitat value for frogs, fish, and waterbirds.

Variable flooding is required to promote River red gum growth (Roberts and Marston 2011), while drier and less frequently flooded conditions, Black box trees have a twisted shape with dead limbs and hollows providing refuge, breeding holes and crevices for birds, lizards and small mammals (Roberts and Marston 2011). With tolerance to prolonged drought, Black box woodlands occur higher on the floodplain than River red gum communities. Promoting diversity in River red gum and Black box communities at Johnsons and Chaffey Bend therefore enhances the potential for diversity of habitat for native flora and fauna.

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

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 riverine food chain (Young, 2001).

Wetland inundation transports nutrients and carbon into the water column, which then becomes available for consumption by bacteria, algae and macroinvertebrates. On re-wetting, decomposition accelerates and becomes more efficient. Carbon and nutrients are released from the soil and enter the water and are available for aquatic plants and animals. The release of energy and nutrients results in increased productivity, with an increase in bacteria and invertebrates (Ecological Associates, 2013). This results in abundant food for fish, birds and other animals.

Fluctuations in water levels allows exposure of substrates such as large wood and plant stems through a drying cycle, which increases the diversity of the biofilms grazed by macroinvertebrates and fish.

5.1.2 Flora and Fauna

There are 11 EVCs modelled in the Johnsons and Chaffy Bend target area, described in Table 7.

Table 7. EVCs modelled at Johnsons and Chaffey Bend

EVC number	EVC Name	Bioregional conservation status	EVC Extent (ha)
EVC 993	Bare Rock/Ground	N/A	11.05
EVC 158	Chenopod Mallee	Vulnerable	3.44
EVC 106	Grassy Riverine Forest	Depleted	19.97
EVC 813	Intermittent Swampy Woodland	Depleted	41.5
EVC 808	Lignum Shrubland	Vulnerable	14.82
EVC 823	Lignum Swampy Woodland	Vulnerable	76.78
EVC 102	Low Chenopod Shrubland	Depleted	92.13
EVC 103	Riverine Chenopod Woodland	Depleted	82.28
EVC 98	Semi-arid Chenopod Woodland	Vulnerable	8.51
EVC 97	Semi-arid Woodland	Vulnerable	2.42
EVC 818	Shrubby Riverine Woodland	Least Concern	68.13

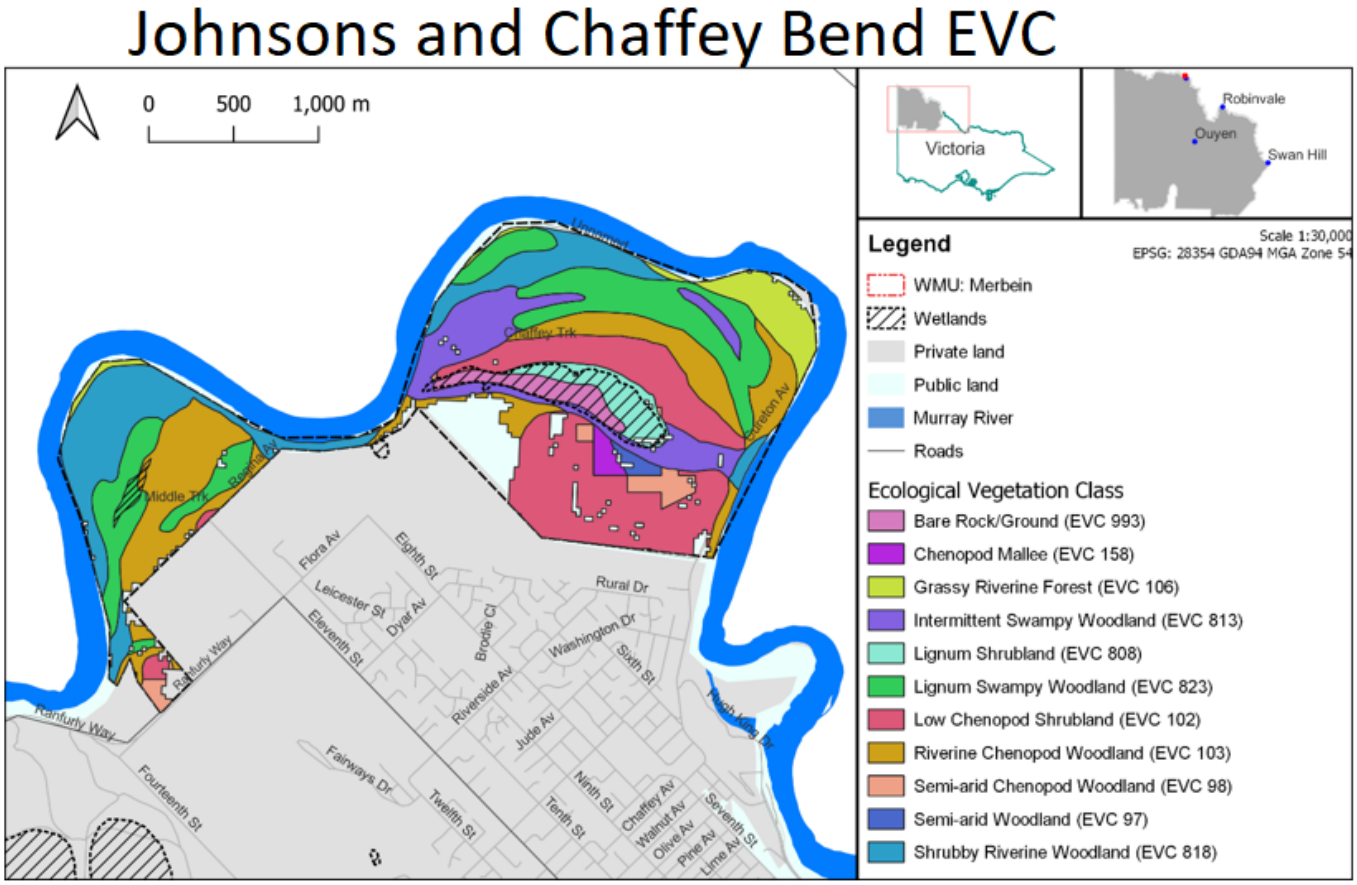


Figure 5. EVCs modelled within the target area of Johnsons and Chaffey Bend.

Semi-Arid Woodland (EVC 97) is characterised by non-eucalypt woodland or open forest up to 12m tall, on light textured loamy sands or sandy loams. Where wetlands and woodlands are combined in close proximity, conservation significance is high. Woodlands provide habitat and grazing opportunities for fish through snags and debris deposited in the water. They also provide important refuges for birds, reptiles and mammals, such as perches and nesting hollows. When flooded, the woodland

floor becomes an extension of the wetland habitat, thereby extending food and shelter opportunities for aquatic fauna (EA 2007).

Chenopod Mallee (EVC 158) is described as 'open to very open mallee woodland up to 12m tall (almost invariably dominated by *Eucalyptus gracilis*)" and is characterised by the dominance of saltbushes and semi-succulent understorey shrubs.

Low Chenopod Shrubland (EVC 102) is present at the perimeter of the Mildura Wastewater Treatment Plant wetland; it is characterised by succulents and a suite of annual herbs and does not rely on inundation events for persistence across the landscape.

Lignum Swampy Woodland (EVC 823) is modelled as present within the bed of the Historic Wetland and north of the Mildura Wastewater Treatment Plant wetland. Lignum Swampy Woodland has an understorey dominated by Lignum, typically of robust character and relatively dense (at least in patches), in association with a eucalypt or acacia woodland to 15m tall. Lignum dominates this EVC, but it also supports Eucalypt or Acacia woodland with River red gum and Black box being the dominant trees species. Black box woodlands provide strong habitat links from the riverine corridor to the surrounding Mallee landscape in this region. 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 conditions from wet to dry and saline to fresh (Roberts & Marston 2011).

Riverine Chenopod Woodland (EVC 103) is modelled as present within the bed of the Historic Wetland and north of the Mildura Wastewater Treatment Plant wetland. Riverine Chenopod Woodland is comprised of a eucalypt woodland up to 15m tall with a diverse shrubby and grassy understorey occurring on most elevated riverine terraces and is naturally subject to only extremely infrequent incidental shallow flooding from major events if at all flooded.

Semi-Arid Chenopod Woodland (EVC 98) is described as sparse, low non-eucalypt woodland to 12m tall of the arid zone with a tall open chenopod shrub-dominated understorey to a treeless, tall chenopod shrubland to 3m tall.

Grassy Riverine Forest (EVC 106) 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. At Johnsons and Chaffey Bend, Grassy Riverine Forest is modelled as present on the banks of the Murray River. It is described as River red gum forest to 25 m tall with a ground layer dominated by graminoids, with occasional tall shrubs present.

Intermittent Swampy Woodland (EVC 813) is modelled as present on the perimeter of the Mildura Wastewater Treatment Plant wetland. It is described as 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.

Lignum Shrubland (EVC 808) is modelled as present in the bed of the Mildura Wastewater Treatment Plant wetland. It is described as 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. Lignum Shrubland is characterised the open and even distribution of relatively small Lignum shrubs, and occupies heavy soil plains along Murray River, low-lying areas on higher-level (but still potentially flood-prone) terraces.

Shrubby Riverine Woodland (EVC 818) is modelled as present at the banks of the Murray River and is described as 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.

Water Dependent Fauna

182 species have been recorded at Johnsons and Chaffey Bend, six of which are introduced. Of special management interest and responsibility are the 22 species that are listed in legislation, agreements or conventions. For a full species list of native fauna, see Appendix 2 – Flora and fauna species list. For a full species list of exotic fauna, see Appendix 3 – Exotic Flora and Fauna Species Lists.

Johnsons and Chaffey Bend supports 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 8).

These records are drawn from Naturekit (incidental and targeted surveys); however, it is fair to assume that more listed species are likely to occur due to the availability of habitat and nearby sightings.

Table 8. Listed water-dependant fauna at Johnsons and Chaffey Bend

Scientific Name	Common Name	FFG Act	EPBC Act Status
Calidris ferruginea	Curlew sandpiper	CE	CE
Burhinus grallarius	Bush stone-curlew	CE	
Falco subniger	Black falcon	CE	
Ardea intermedia plumifera	Plumed egret	CE	
Stictonetta naevosa	Freckled duck	E	
Climacteris affinis	White-browed treecreeper	E	
Ptilotula plumula	Grey-fronted honeyeater	E	
Tringa stagnatilis	Marsh sandpiper	E	
Tringa nebularia	Common greenshank	E	
Varanus varius	Lace monitor	E	
Falco hypoleucos	Grey falcon	V	V
Polytelis anthopeplus monarchoides	Regent parrot	V	V
Litoria raniformis	Growling grass frog	V	V
Grantiella picta	Painted honeyeater	V	V
Spatula rhynchotis	Australasian shoveler	V	
Ardea alba modesta	Eastern great egret	V	
Aythya australis	Hardhead	V	
Oxyura australis	Blue-billed duck	V	
Hieraaetus morphnoides	Little eagle	V	
Hydroprogne caspia	Caspian tern	V	
Biziura lobata	Musk duck	V	
Struthidea cinerea	Apostlebird		

Lifeform type: Amphibian (A), Bird (B), Fish (F), Reptile (R)

EPBC threatened status/Victorian Status - FFG: VU = Vulnerable, EN = Endangered, CE = Critically Endangered, NL = Not Listed

The above listed species are directly dependent on water due to food, shelter or breeding requirements.

Fish

Both the Western carp gudgeon (*Hypseleotris klunzingeri*) and the Flatheaded gudgeon (*Philypnodon grandiceps*) have been recorded at Johnsons and Chaffey Bend. A protected matter search found that there are 2 fish species listed under the EPBC Act in the Johnsons and Chaffey Bend area; Silver perch (*Bidyanus bidyanus*; critically endangered), Murry cod (*Maccullochella peelii*; vulnerable),

Frogs

Johnsons and Chaffey Bend supports habitat for several frog species, including the Growling grass frog (*Litoria raniformis*), the Eastern sign-bearing froglet (*Crinia parinsignifera*), the Spotted marsh frog (*Limnodynastes tasmaniensis*), the Southern bullfrog (*Limnodynastes dumerilii*), Peron's tree frog (*Litoria peronii*) and the Barking marsh frog (*Limnodynastes fletcheri*).

Waterbirds

Waterbird diversity and abundance are influenced by wetland habitat diversity, with different species and feeding guilds using different habitats for breeding and foraging (Haig, Mehlman and Oring, 1998). Water depth in particular influences waterbird diversity due to the specific feeding behaviours of different species (Bancroft, Gawlick and Rutchey, 2002). Managing wetlands to provide diverse habitats such as variable water depth, mud flats, inundated vegetation and areas of deep water increases the likelihood of increased waterbird diversity (Taft, Colwell, Isola and Safran, 2002).

Significant waterbirds such as the Curlew sandpiper, Bush stone-curlew, Black falcon, Plumed egret, Grey falcon, Regent parrot and Painted honeyeater have been recorded at Johnsons and Chaffey Bend. The River red gum and Black box communities support habitat for many of these species.

Bats

A bat survey (Gee 2002) at the treatment area was conducted on 26th November 2002. During the survey period, five different species of micro chiropteran bats were either caught or detected including Gould's wattle bat (*Chalinolobus gouldii*), Little broad-nosed bat (*Scotorepens greyii*), Long-eared bat (*Nyctophilus spp.),* Forest bat (*Vespadelus spp.)* and Little pied bat (*Chalinolobus picatus*). The Greater long-eared bat is a rare species. Even though no Greater long-eared bats were caught during the survey, experts believe it is quite feasible for it to be at the study site. The number of species found or detected was expected to be higher if the weather had been in better condition during the survey time.

Reptiles

Another highly significant wildlife species the Carpet python (*Morelia spilota variegata*) may also occur at the Mildura Wastewater Treatment Plant. Carpet python is considered to be endangered within Victoria. Currently, based on available information, its existence has not been confirmed (Sluiter 2006).

Eastern hooded scaly-foot is listed as a threatened taxon under the Victoria Flora and Fauna Guarantee Act 1988. In Victoria, this species has been found in areas of clay and clay-loam soils dominated by Black box. A study on an SIS site adjacent to Johnsons Bend suggested that even though no Eastern hooded scaly-foot were found in the survey area, the study site is still considered as high potential habitat for this species. Curl snake was found at the survey site which is known to have similar habitat requirement to the Eastern hooded scaly-foot. Therefore, Johnsons Bend also has high potential for providing habitat for the Eastern hooded scaly-foot species (GHD 2012).

Flora

47 flora species have been recorded at Johnsons and Chaffey Bend, five of which are introduced. Ten flora species that have been recorded at Johnsons and Chaffey Bend are listed under the FFG Act (Table 9. 9). For a full species list of native flora, see Appendix 2 – Flora and fauna species list. For a full species list of exotic flora, see Appendix 3 – Exotic Flora and Fauna Species Lists.

Table 9. Listed flora at Johnsons and Chaffey Bend

Scientific Name	Common Name	FFG Act	EPBC Act Status
Dianella porracea	Riverine flax-lily	CE	
Acacia oswaldii	Umbrella wattle	CE	
Carpobrotus aff. rossii (N.W. Victoria)	Mallee pigface	CE	
Acacia victoriae subsp. victoriae	Bramble wattle	E	
Eragrostis lacunaria	Purple love-grass	E	
Calotis cuneifolia	Blue burr-daisy	E	
Eremophila divaricata subsp. divaricata	Spreading emu-bush	V	
Bergia trimera	Small Water-fire	E	
Calotis cuneifolia	Blue Burr-daisy	E	
Cullen tenax	Tough Scurf-pea	E	

Victorian Status - FFG: VU = Vulnerable, EN = Endangered, CE = Critically Endangered, R = Rare, NL = Not Listed

The Johnsons and Chaffey Bend Target Area contains River red gum and Black box dominant forest woodland and shrubland communities in varied condition.

River Red Gum (*Eucalyptus camaldulensis Dehnh*.)

River red gum is the most widespread species on the Murray River floodplain in Victoria. River red gum communities are an important part in the nutrient cycling between floodplains and rivers and provide extensive habitat for a wide range of plants and animals (such as Carpet python, White-bellied sea eagle and Regent parrot). It also provides a good source of timber. River red gum forests can be used extensively for grazing and recreation (Cunningham et al. 2006, Roberts & Marston 2011). Flooding is one of the three sources of water for riparian trees including River red gums, the others being groundwater and rainwater (Roberts and Marston 2011). River red gum communities receive more regular flooding than Black box woodlands (MDBA 2009).

According to Roberts & Marston (2011), River red gum communities require flooding every two to four years with duration of two to four months. Tree growth is greatest when flooded under warm conditions such as summer and wood production increases with increasing flood duration. Spring-summer floods followed by summer recession provide suitable condition for germination. Regeneration is optimised if the flood recession is in spring-early summer (Roberts & Marston 2011). The relationship between River red gum health and soil salinity has not been thoroughly investigated. River red gum can be observed to have growth reduction when root-zone soil salinities of an extract from a saturated soil paste (ECe) range from 2 to 5 dS/m, but survival is likely to be affected at soil ECe > 15 dS/m (MDBA 2003). Another study cited in MDBA 2003 suggested that soil salinity threshold for River red gum is around 25 dS/m as total absence of River red gum stands were observed beyond that value.

Black Box (*Eucalyptus largiflorens F.Muell.)*

Black box is also a dominant tree species on the Murray River floodplain. Black box forests play an important role in nutrient cycling between floodplains and rivers (Baldwin, 1999) and provide valuable habitat for plants and animals (Mac Nally et al. 2001). Under drier and less frequently flooded conditions, Black box trees have a twisted shape with dead limbs and hollows providing refuge, breeding holes and crevices for birds, lizards and small mammals (Roberts and Marstons 2011). With tolerance to prolonged drought, Black box woodlands occur higher on the floodplain than River red gum communities. Black

box can effectively exclude salt from its root system, but the tree health can be affected by the additional effect of reducing transpiration (Roberts & Marston 2011).

Research on Black box woodlands has found that Black box is ecologically flexible and opportunistic in water use. However, Black box trees are at their healthiest when they were flooded for 4-6 months every 4-5 years but flooding duration should not exceed 12 months (Roberts & Marston 2011).

In the Mildura WWTP, a biodiversity audit of the lagoon site commissioned by Lower Murray Water (2011) found the dominant vegetation community to be Riverine Chenopod Woodland, which is considered to be a 'depleted' community type in the region. The audit detailed a significant stand of Black box trees and a number of rare and vulnerable flora species including Tall kerosene grass (Aristida holathera var.holathera), Sarcozona (Sarcozona praecox), Silky umbrella grass (Digitaria ammophila) and Purple plume grass (Triraphis mollis) (Lower Murray Water 2011). A number of threatened plant species were also identified including Spreading emu bush (species name), Umbrella wattle (species name) and Purple love grass (species name) (Table 9). The vegetation community was considered to be in good to very good condition and is located on an elevated floodplain terrace on the northern side of the lagoon (Lower Murray Water 2011). In 2023, Mallee CMA identified a large amount of Tough scurf pea (*Cullen tenax*) present at the site.

Tangled Lignum (*Muehlenbeckia florulenta*)

Lignum is also a common species in these floodplains. It is known as a high drought and salinity tolerant plant and can rapidly expand and regenerate following floods or high rainfalls. Tangled lignum is an important understorey component in River red gum and Black box communities (MCMA 2012). It provides habitat and nesting sites for migratory waterbirds and helps prevent erosion (Roberts & Marston 2011). It is observed that the distribution of lignum is mainly in areas with a flood frequency of every three to 10 years and Lignum cover is greatest in high flood frequency zones. However, prolonged flooding (>12 months) will cause lignum to die under anoxic conditions (Rogers & Ralph 2011).

River Coobah (*Acacia stenophylla*)

River Coobah is also known as river myall and can be found in Intermittent Swampy Woodland. It is adapted to swampy conditions which occur on the heavy, brackish soils on the low elevation areas of the riverine terraces (MCMA 2012). There is little information about water requirements for the survival and maintenance of River coobah. River coobah is thought to have water requirements that fall within the ranges for River red gum and Black box, as it is usually between zones occupied by River red gum and Black box. River coobah is somewhat salt-tolerant but growth might be reduced when soil salinity of 10-15 dS/m and survival is limited at salinities greater than 15 dS/m (Rogers & Ralph 2011)

5.1.3 Current condition

Along the Murray River, surveys of River red gum forest have shown an apparently substantial decline in tree condition over the past 20 years. For example, in the late 1980s the degradation of tree canopies increased dramatically below the Wakool Junction in the Mallee. Survey of River red gum condition in 2006 indicates 70% of these forests across the Victorian Murray River floodplain were in stressed condition (Cunningham et al. 2010) Stressed trees are usually found away from the banks of the Murray River and permanently inundated anabranches on the floodplain (Cunningham et al., 2006).

Cunningham et al. 2006 indicates that the River red gum condition in Johnsons and Chaffey Bend area is generally ranging from declining to severely degraded.

Similar to the condition of River red gum communities, Black box woodlands are also under severe stress. Kelly (2006) stated that in Johnsons Bend, both River red gum forest and Black box woodland were degraded.

The exception is vegetation communities around treated wastewater lagoon in Chaffey Bend. Vegetation was considered to be in good to very good condition due to the accessibility to freshwater source from the lagoon and freshwater lens beneath (Lower Murray Water 2011, AWE 2013).

Previous inspections of both floodplains showed that River red gum stands were generally only one tree deep along the banks of the Murray, with rapid declines in health inland and extensive tree death at distances of 100m or more from the river. Similarly, Black box health is generally poor with significant death, except around the TWW lagoon and at the inland fringes of the vegetated floodplain areas.

The vegetation is considered to be Possibly Groundwater Dependent as described in the previous section. It is observed that vegetation health appears to be correlated with the presence of a freshwater lens. The available data, although sparse, supports a working hypothesis that tree health will decline where the groundwater salinity exceeds a threshold salinity value. Roberts and Marsden suggest threshold salinities based on data from the Murrumbidgee, however similar data is not readily available for the Lower Murray, and the threshold where the salinity is exceeded for a decade or more may be lower than where it exceeds it for only one year.

Due to a persistent La Nina and the associated high rainfall and flooding across the Murray-Darling Basin at the time this EWMP is being updated (2022-2023), Johnsons and Chaffey Bend are experiencing very wet conditions, which has resulted an extensive and long flooding event. The condition of the site following the 2022/23 flooding was not well understood at the time this plan was updated.

Index of Wetland Condition

One method for assessing the current condition of a wetland is the Index of Wetland Condition (IWC) developed by DEECA. The IWC defines wetland condition as the state of the biological, physical, and chemical components of the wetland ecosystem and their interactions. The IWC has five sub-indices based on the catchment of the wetland and its fundamental characteristics: physical form, hydrology, water properties, soils and biota.

Johnsons and Chaffey Bend have not been assessed using the IWC criteria.

5.2 Shared benefits

While the primary requirement of environmental watering is to achieve environmental objectives and outcomes, environmental water can provide benefits beyond environmental objectives. Shared benefits will arise from improving the condition of an asset by using environmental watering, which in turn may contribute to benefits or outcomes for other water users and values, including for cultural outcomes and increased recreation and amenity value (DEECA EWMP Guidelines 2022, pg. 16).

In addition to its significant environmental values, Johnsons and Chaffey Bend has significant social and economic values. Water-dependant values that were identified for Johnsons and Chaffey Bend are detailed in Table 10.

Table 10. Water-dependent values at Johnsons and Chaffey Bend

Value	Value theme (category)
Exercise, especially walking/running and swimming	Recreational
Boating	Recreational
Fishing	Recreational
Nature appreciation (unique landscape features and natural beauty)	Recreational
Work or education opportunities	Economic
Irrigated horticulture, cropping, vine fruits, grazing, firewood collection, and forest production	Economic
Eco-system function – supporting the health of the river and wetlands	Environmental
Creation and maintenance of vital habitat for threatened/endangered species	Environmental
Diversity of habitat for feeding, breeding and nursery	Environmental
Transportation and dilution of nutrients and organic matter and increase in macroinvertebrate productivity and biofilm diversity	Environmental
European cultural heritage	Cultural
Traditional Owner values	Cultural

The above water-dependant values are reflected in or are closely tied to the ecological values of the site. Environmental watering decisions at Johnsons and Chaffey Bend will have direct impacts on the social, cultural and environmental values identified. Improved environmental watering will therefore have broader positive impacts for a wider range of community values at Johnsons and Chaffey Bend.

5.2.1 Aboriginal cultural values

The Mallee region has been occupied by hundreds of generations of 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 and enduring connection Traditional Owners have with the Mallee's natural landscapes.

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 Murray River and its associated waterways continue to be culturally significant habitation 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) confirms that all of the target area at Johnsons and Chaffey Bed is defined as an area of cultural heritage sensitivity.

The current Registered Aboriginal Party (RAP) for the area is the First People of the Millewa-Mallee Aboriginal Corporation (FPMMAC). Their Action Plan and Country and Water Plan "seek to repair the natural environment and our people's place in the environment" (Mallee CMA, 2022). The Mallee CMA have engaged with the FPMMAC about this EWMP and are committed to working with FPMMAC to ensure that tangible and intangible Aboriginal culture and heritage is protected, and that Traditional Owner led practices are imbedded in the management and healing of Country (Mallee RCS, 2022).

Cultural heritage

The Johnsons and Chaffey Bend Target Area is an important cultural site for the local indigenous people. A search of the Department of Primary Industries GeoVic Database shows that large areas in the WMU around the River Murray and the flood runners are areas of Cultural Heritage Sensitivity. As is the case for most of the Murray River floodplain and beyond, it is recognized that waterways and floodplains are highly significant for the indigenous culture but the true extent of the number and types of sites present is still unknown.

Frontages to the River Murray from Robinvale to Merbein hold important European heritage value, which is reflected through homesteads, grave sites and historic markers from the early settlement of the region. The area was first explored by Major Thomas Mitchell and Captain William Sturt in the 1830s with much of it developed for large grazing runs. Closer settlement was established after the success of the Mildura Irrigation Colony in the early 1900s and the Red Cliffs and Robinvale Soldier Settlement Scheme of the 1920s and 1940s. A notable heritage site in this study area is Chaffey Grave Sites at Chaffey Bend (MCMA 2003).

5.2.2. Recreational values

Johnsons and Chaffey Bend is popular for boating, camping, fishing and picnicking. Community members use the area predominately for exercise (walking/running), and many use Johnsons and Chaffey Bend for boating purposes (cite community survey data). These activities are supported with a wide range of facilities, i.e. Motorbike club, Mildura lifesaving club, Gun club, boat ramp, caravan parks and Mildura walking trails. For examples, the northern portion of the Old Mildura Homestead Reserve connects to Chaffey Bend Reserve and contains a well-maintained shared path, a picnic setting and is adjacent to the Chaffey graves and memorial site. Along the Chaffey Bend reserve's length, there are a large number of picnic tables and scenic locations (Sunraysia Environmental 2010).

Johnsons and Chaffey Bend has also been identified to provide recreation and tourism opportunities. As Johnsons and Chaffey Bend is of high biodiversity value and provides habitat for many threatened species, there is great potential in Johnsons and Chaffey Bend being utilised for citizen science (flora and fauna surveying).

5.2.3. Trajectory of change

Most of the River red gum (including the remnant River red gums along the river side) and Black box communities are in poor condition and without any effective management plan, vegetation health at Johnsons and Chaffey Bend will continue to decline. The correlation between the presence of "fresh" groundwater beneath the wastewater lagoon and good tree health in this area supports the idea that allowing these communities to get access to freshwater supports tree growth. Therefore, maintaining the freshwater lens is also a crucial part in maintaining/improving vegetation health in the Target Area.

If the irrigated disposal area was decommissioned, the freshwater lens beneath the wastewater lagoon will be eventually replaced by the saline groundwater causing the current healthy vegetation communities there to gradually degrade in condition. Therefore, without any strategies emplaced, the vegetation condition at Johnsons and Chaffey Bend is expected to be worsen with time.

Previous watering programs and floods have shown only a small beneficial response in vegetation health at the Johnsons and Chaffey Bend Target Area compared to other places (Louise Searle pers comm.). Where natural flooding and environmental watering has occurred in these sites, both Black box and occasionally River red gum show evidence of epicormic growth. However, the longevity of any beneficial effect of the flooding/watering is still ambiguous. These effects are constrained to the inundated areas. The current trajectory, particularly for Black box, is continued decline in condition.

Continued decline in vegetation health, and changes in vegetation community to more salt tolerant species, will lead to the decline in valuable habitat and associated environmental, social and economic values.

It is likely that Johnsons and Chaffey Bend will be subject to more extreme wetting and drying cycles under a changing climate. It is important to ensure that climate change adaptation is considered in environmental watering management decisions for Johnsons and Chaffey Bend, in order to preserve and enhance their significant environmental values.

6. Managing water-related threats

The values for the Johnsons and Chaffey Bend target area are described in section 5. Some of the threats which may have an impact on the values at Johnsons and Chaffey Bend include:

- **Groundwater inputs;** Leakage from the irrigated disposal area, SIS decommissioning, Reductions in Irrigation Drainage, Caravan Park Watering
- **Altered River flow regimes**
- **Poor Surface Water Quality**

Groundwater Inputs

Changes in groundwater conditions are expected to be a major controller of long-term trends in vegetation health.

Leakage from the irrigated disposal area

Decreases in the volumes of water irrigated on the adjacent land of the Treated Wastewater lagoon will decrease the recharge of fresher water into the aquifers. This may have an adverse effect on vegetation health in the long term. The timing and magnitude of the impact are not possible to predict with current information.

Salt Inception Scheme (SIS) decommissioning

The Mildura-Merbein SIS construction commenced in the late 1970s targeting the interception of saline groundwater from the Monoman and Parilla Sand Aquifers. However, all the production bores have been decommissioned except two bores located on the western area of the Chaffey floodplain.

The changes in operation of the Mildura-Merbein SIS have resulted in a reduction of groundwater pumping from the Chaffey floodplain, north of the Waste Water Treatment Plant lagoon. The pumping has been progressively reduced over the last two decades. An immediate effect is that groundwater water levels will be higher immediately adjacent the borefield, resulting in less leakage from the lagoon on that northern side. Conversely, the bores are no longer extracting the fresher lagoon recharge, so the lagoon leakage may extend further northward into the floodplain. Groundwater analysis is required to identify if the “freshwater lens” will increase or decrease in extent northward from the lagoon under future SIS operations.

The Buronga SIS may be contributing to beneficial outcomes, through pulling the freshwater lens across the floodplain toward the borefield.

Reductions in Irrigation Drainage

Changes in irrigation volumes and improvements in irrigation efficiency will have reduced the groundwater flux into the floodplains, and the salinity is likely to be trending slowly downward in the incoming groundwater due to progressive dilution of the saline native groundwater by fresher irrigation recharge.

The correlation of good vegetation health around the TWW lagoon with better quality groundwater suggests that improvements in groundwater quality coming into the floodplain should support improvement of floodplain vegetation health.

Some additional work needs to be undertaken to derive salinity thresholds that might be expected to affect improvements in vegetation health, and the time lag between changes in groundwater salinity and improvements in vegetation health.

Caravan Park watering

Watering for amenity improvement at the Caravan Park will have provided fresh water in the unsaturated zone and may have contributed to emplacement of a (thin) layer of fresh groundwater. Remnant River red gum health may be better where this irrigation occurs.

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Altered River flow regimes

The altered surface water regime also poses threats for the Johnsons and Chaffey Bend sites. Flow modification of the Murray River system has occurred to satisfy the increasing demand in navigation, irrigation and urban water use. River regulations cause changes in the frequency, magnitude and duration of flows and flood events. The construction of locks, weirs and dams has altered the wetting and drying periods on river frontage and associated wetlands, consequently causing significant impacts on River red gum, Black box communities, fish populations, nutrient cycling, riparian vegetation, biodiversity, water quality, channel shape and form and aquatic macrophytes (MCMA 2006).

Poor Surface Water Quality

The key water quality parameters include salinity, turbidity, pH, toxicity, temperature and dissolved oxygen. These parameters are controlled by catchment activities and adjacent land use. Low water quality can have an adverse effect on river capacity for productive use (MCMA 2006).

Assessing risks.

Consideration of risk provides a link between recognition of system threats and key management processes, including decade and seasonal planning. Risk assessments are composed of both likelihood and consequence components.

From a seasonal watering perspective, prioritisation of watering actions will be based on consequence. 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 MDB.

Not all consequences can be identified as readily and so we have provided a process that can be followed in Appendix 5.

7. Management goal

7.1 Management Goal

The overall goal proposed for Johnsons and Chaffey Bend target area has been developed through consultation with various experts and stakeholders including DEECA, Parks Victoria, and local residents. The goal considers the values the wetland supports and the potential threats that need to be managed. This includes consideration of the values the wetland has historically supported and the likely values it could support into the future.

To support healthy ecosystems across the floodplains.

They are strongly linked to the goals of the Mallee Waterway Strategy 2014-22 (Mallee CMA 2014)

- To maintain or improve habitat within waterways and on surrounding riparian land;
- To manage all land tenures for water quality benefits and respond appropriately to threatening events (both natural and pollution based);
- To restore appropriate water regimes and improve connectivity;
- To protect the extent and condition of Cultural Heritage (Indigenous and non-Indigenous) sites associated with waterways; and
- To 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 outlined in the Water Dependent Values section. 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 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 Johnsons and Chaffey Bend can be found in Section 5.7.1 of Butcher et al. (2020).

The numbering of the environmental objectives in this EWMP have been adopted directly from the Butcher et al (2020) assessment. The changes were made to align the language used with the Basin Plan and are shown in Table 11.

Table 11. Change in Environmental Objectives in the Johnsons and Chaffey Bend EWMP

Old Environmental Objective	New environmental objective
JCB1: Preserve remnant old River red gums along the riverfront and promote recruitment of River red gums (i.e. germination and retention of seedlings).	**JCB1:** By 2030, improve condition and maintain extent from baseline levels of River red gum (Eucalyptus camaldulensis) to sustain communities and processes reliant on River red gum woodland at the Johnsons & Chaffey Bend asset.
JCB2: Preserve extent and support health of Black box across the floodplains and promote recruitment of Black box (i.e. germination and retention of seedlings).	**JCB2:** By 2030, improve condition and maintain extent from baseline (2006) levels of Black box (Eucalyptus largiflorens) to sustain communities and processes reliant of such communities at the Johnsons & Chaffey Bend asset.

Table 12. Updated Environmental Objectives for Johnsons and Chaffey Bend

Environmental objective	Target
JCB1 Objective: **By 2030, improve condition and maintain extent from baseline levels of River red Gum (*Eucalyptus camaldulensis)* to sustain communities and processes reliant on River red gum woodland at the Johnsons & Chaffey Bend asset.**	JCB1 Target**:** By 2030, a positive trend in the condition score of River red gum dominated EVC benchmarks the Johnsons & Chaffey Bend asset at 80% of sites over the 10 year period. OR By 2030, at stressed sites (see Wallace et al. 2020) the Johnsons & Chaffey Bend asset: 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 trees at Johnsons & Chaffey Bend needs to be established.
JCB2 Objective: **By 2030, improve condition and maintain extent from baseline (2006) levels of Black box (*Eucalyptus largiflorens*) to sustain communities and processes reliant of such communities at the Johnsons & Chaffey Bend asset.**	JCB2 Target**:** A positive trend in the condition score of Black Box dominated EVC benchmarks at the Johnsons & Chaffey Bend asset at 50% of sites over the 10-year period. OR By 2030, at stressed sites (see Wallace et al. 2020) at the Johnsons & Chaffey Bend asset: 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 Black Box trees needs to be established to ensure TCI good is achievable - may need to rewrite target and adaptively manage this as condition improves.

7.3 Regional significance

Johnsons and Chaffey Bend supports a range of environmental values of local, regional and Basin significance as described in section 5. Johnson and Chaffey Bend supports habitat for many species listed under the Environment Protection and Biodiversity Conservation Act (EPBC Act).

The environmental values listed in Section 5 are linked to the management goals and environmental objectives and targets described in Section 7. Details of the links between the environmental objectives and environmental outcomes at a regional/Basin scale are provided in Appendix 4.

The management goals and environmental objectives and targets are aligned with the goals of the Mallee Waterway Strategy as described in Section 7.1

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 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 Johnsons and Chaffey Bend EWMP environmental objectives to the Basin Plan are provided in Appendix 4. The Environmental Objectives for Johnsons and Chaffey Bend have been updated to improve consistency with the Basin Plan. Further details of these linkages and the rationale behind the updates for each objective is provided in Appendix 4.

Table 13 – Mapping updated Johnsons and Chaffey Bend EWMP objectives to Basin Plan Environmental Watering Plan (EWP) objectives

EWMP Objective	Alignment with Basin Plan		
	8.05 Ecosystem and biodiversity	8.06 Ecosystem function	8.07 Ecosystem resilience
JCB1: By 2030, improve condition and maintain extent from baseline levels of River red Gum (*Eucalyptus camaldulensis)* to sustain communities and processes reliant on River red gum woodland at the Johnsons & Chaffey Bend asset.	3 (b)	6 (b)	
JCB2: By 2030, improve condition and maintain extent from baseline (2006) levels of Black box (*Eucalyptus largiflorens*) to sustain communities and processes reliant of such communities at the Johnsons & Chaffey Bend asset.	3 (b)	6 (a)	

8. Environmental water requirements and intended water regime

8.1 Watering requirements and intended watering regimes

It is not currently possible to actively deliver environmental water to this site. Widespread watering of the site is reliant on flooding events. However, for future planning a wetland watering regime has been derived from the ecological and hydrological objectives and is limited by these specific objectives. To allow for adaptive and integrated management, the watering regime is framed using the seasonally adaptive approach. This means that a watering regime is identified for optimal conditions, as well as the minimum tolerable watering scenario.

The surface watering regime has been derived using the ecological and hydrological objectives described above. A surface watering regime is provided for optimal conditions as well as the maximum and minimum tolerable watering scenarios.

Table 14. Target Watering Regime – Maintain Johnsons and Chaffey Bend and improve aquatic habitat

Target Watering Regime
Minimum watering regime Inundate River red gum communities along the river three times in ten years with a maximum interval of three years between events. Extend the inundation area to include Black box communities at least once every seven years. Allow ponding on the floodplain for at least three months to maintain River red gum and Black box communities. Timing is not critical in terms of mature tree health but flooding during spring may produce best results.
Optimal watering regime Inundate River red gum communities along the river every one to three years with a maximum interval of three years between events. Extend the inundation area to include Black box communities three times in ten years with a maximum interval of seven years between events. Allow ponding on the floodplain for five months to improve River red gum and Black box communities. Timing is not critical in terms of mature tree health but flooding during spring may produce best results.
Maximum watering regime Inundate the River red gum communities along the river every one to three years with a minimum interval of six months between events. Extend the inundation area to include Black box communities every three years with a minimum interval of one year between events. Allow ponding for up to 6 months (variability in flood duration is encouraged) to improve River red gum and Black box communities. Timing is not critical in terms of mature tree health but flooding during spring may produce best results.

Table 15. Hydrological Objectives for Johnsons and Chaffey Bend EWMP

Ecological Objective	Water Management Area	Mean frequency of events (number per 10 years)			Tolerable interval between events (years)		Duration of ponding (months)			Preferred timing of inflows
		Min	Opt	Max	Min	Max	Min	Opt	Max	
Preserve remnant old River Red Gums along the riverfront	Floodplain	3	4	5	1	3	3	5	6	Spring to Summer.
Improve health of River Red Gum communities		2	8	10	0	2	3	5	6	Spring to Summer. Flood recession during spring or later
Preserve extent of Black Box communities		1	2	3	3	10	2	4	6	Spring to Summer.
Improve health of Black Box communities		2	3	5	1	7	2	4	6	Spring to Summer. Flood recession during spring or summer

8.2 Expected watering effects

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

Table 16 – Environmental objectives and the watering actions required to achieve them

Objective Code	Environmental objective	Potential watering action	Expected watering effects
JCB1	By 2030, improve condition and maintain extent from baseline levels of River red gum *(Eucalyptus camaldulensis)* to sustain communities and processes reliant on River red gum woodland at the Johnsons & Chaffey Bend asset.	Environmental watering should take place between September and February, to provide inflows at the optimal time for River red gum communities. Water should pool in the target area for about 5 months. Maintain a salinity threshold of <15d/Sm to support growth of River red gums.	Condition and extent of River red gum is improved/maintained from baseline levels.
JCB2	By 2030, improve condition and maintain extent from baseline (2006) levels of Black box (Eucalyptus largiflorens) to sustain communities and processes reliant of such communities at the Johnsons & Chaffey Bend asset.	Environmental watering should take place between September and February, to provide inflows at the optimal time for Black box communities. Water should pool in the target area for about 4 months.	Condition and extent of Black box is improved/maintained from baseline levels.

8.3 Seasonally adaptive approach

Victoria has adopted an adaptive and integrated management approach to environmental management. A key component of this approach for environmental watering is the 'seasonally adaptive' approach, developed through the Northern Region Sustainable Water Strategy and incorporated into the Victorian Waterway Management Strategy.

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

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

The broad approach for Johnson's and Chaffey Bend wetlands is summarised in Figure 6**Error! Reference source not found.**. During drought and dry periods, long-lived trees rely on groundwater to maintain condition. Within this context, the risk to tree condition during dry and drought periods, maintaining the condition of long-lived vegetation requires effective management of the risk that groundwater salinity levels exceed tree tolerances. During median and wet conditions, environmental flows can be used to inundate areas of River red gum and Black box which would be expected to lead to improvements in condition and, less reliably, flowering which is important for resident animals.

During drought conditions, foraging habitat for waterbirds is important to sustaining waterbird populations regionally. Depending on the regional context, there may be situations where the allocation of environmental flows to Johnsons and Chaffey may contribute to the provision of foraging habitat in the region.

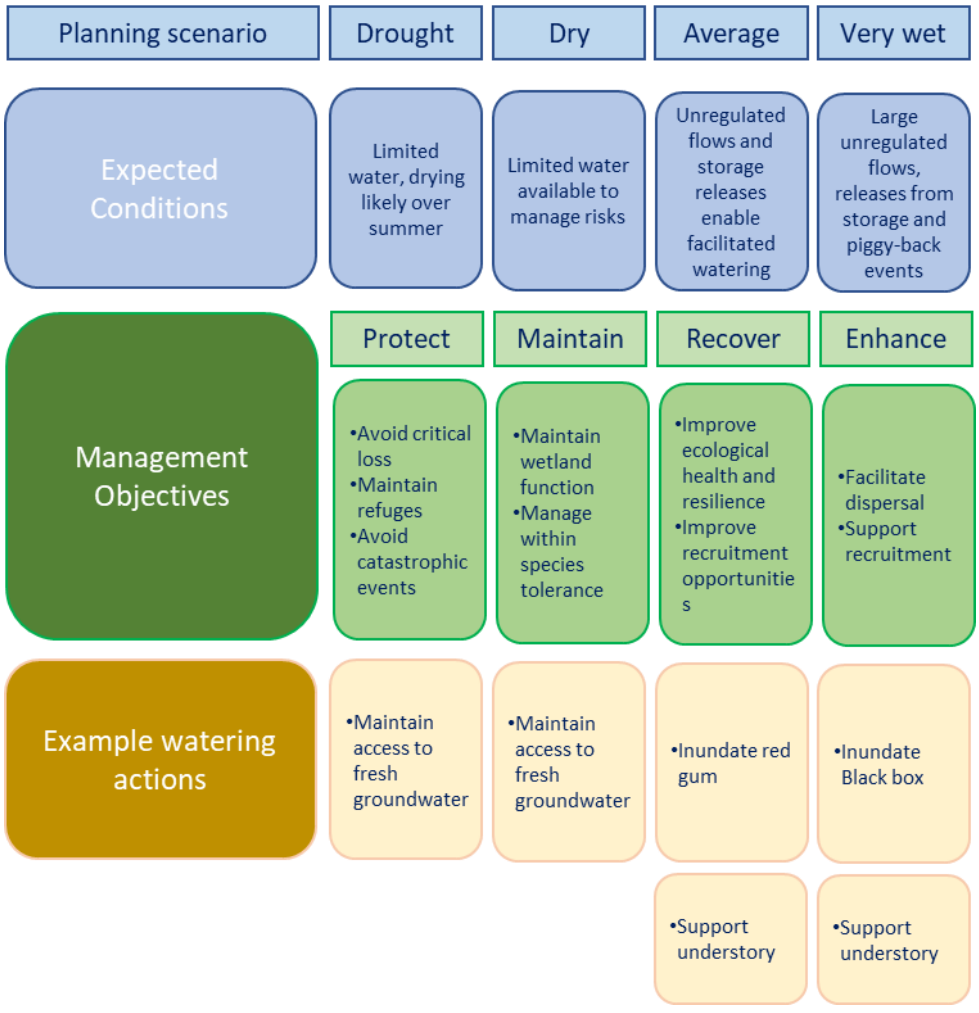

Figure 6. Seasonally adaptive approach for Johnsons and Chaffey Bend

9. Demonstrating outcomes – monitoring and assessment

9.1 Environmental Monitoring

The watering program at Johnsons and Chaffey Bend has been designed to optimise ecological outcomes based on environmental water requirements.

Table 17. Links between environmental objectives, monitoring questions and survey methods

Objective	Monitoring focus	Monitoring question	Method	When
JCB1	Improving condition and maintaining extent of River red gum	Is the condition of River red gum improving? What is the extent compared to the baseline?	TSC tool, field assessments	Annual
JCB2	Improving condition and maintaining extent of Black box	Is the condition of River red gum improving? What is the extent compared to the 2006 baseline?	TSC tool, field assessments	Annual

9.2 Monitoring priorities at the asset

Ecological monitoring is required to demonstrate the effectiveness of environmental watering in achieving ecological objectives, to help manage environmental risks and to identify opportunities to improve the efficiency and effectiveness of the program. The broad program logic for the lake is:

- Objectives (Section 7.2)
- Environmental flows to provide:
    - Vegetation habitat
- Outcomes
    - River red gum condition
    - Black box condition

The highest priorities for monitoring at Johnsons and Chaffey Bend are the monitoring questions that most strongly influence watering decisions and the evaluation of watering effectiveness.

All these priorities align with the following long-term outcomes of the Mallee Regional Catchment Strategy Waterway theme:

- 3.2.1 The condition of high value aquatic and riparian habitat is improved
- 3.2.2 Appropriate water regimes are restored to priority waterways and connectivity is improved.

Table 18. Monitoring priorities at Johnsons and Chaffey Bend

Monitoring priority	Reason for priority
Groundwater bores	To identify salinity and water table levels, and to confirm that watering will abate the leaching of highly saline groundwater through the Parilla Sands aquifer into the wetlands. If groundwater monitoring suggests there is a risk of increased salinity, monitoring of surface water quality should be initiated.
Remote sensing of the distribution and condition of long-lived trees (River red gum and Black box)	Target species for management objectives Provides important ecological functions (e.g. habitat)
Photo point monitoring be conducted before and after watering events.	To measure the success of environmental water in improving wetland and riparian vegetation communities.
Index of Wetland Condition assessments should be undertaken every 5 years	To monitor the health of the vegetation communities in response to the implementation of the EWMP.

10. Adaptive Management

Mallee CMA uses an adaptive management approach in planning, delivering 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 the goals of the activity are being reached 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 13 shows an illustration of the adaptive management cycle for environmental water delivery.

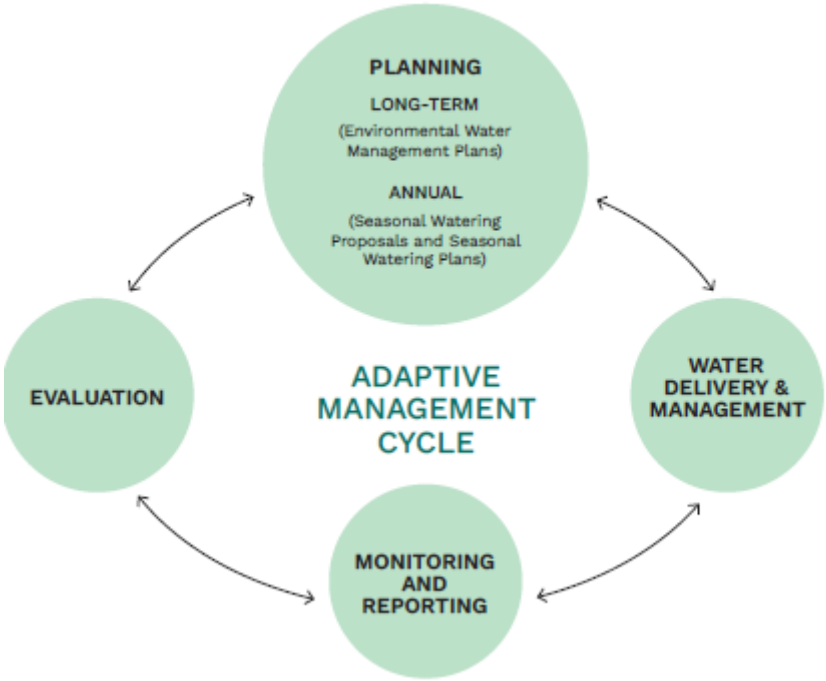

Figure 7. The adaptive management cycle for environmental water delivery and management.

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.

In 2022, Mallee CMA further refined its adaptive management approach, implementing the Environmental Watering Adaptive Management Framework (MCMA, 2022).

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.

Mallee CMA's 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. In this way, we iteratively improve 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.

11. Knowledge gaps and recommendations

Vegetation health has not responded well to surface water inundation, and the vegetation is classified as being of "High potential for groundwater interaction". It seems likely that soil and groundwater salinities are hostile to good tree health. If the vegetation communities are groundwater dependent, and where groundwater and soil conditions are hostile to long-term sustenance of the existing vegetation or recruitment of new vegetation, new models of water management for ecological benefit need to be developed that go beyond surface water inundation. Groundwater management needs to be considered.

The floodplains contain a complex hydrogeological system, and their groundwater salinity regimes are influenced by many factors including SIS bore operation, TWW and irrigation drainage as well as the more traditional rainfall and surface water inundation drivers. It is likely that the existing TWW freshwater lens will be modified by changes to the SIS pumping regime, which may also affect the condition of floodplain vegetation. The extent and thickness of the lens may also be influenced by the management of the wastewater lagoon, the frequency of flood events, and changes in the water table elevation and salinity. This relationship between the surface water inputs, the groundwater factors and vegetation health have not yet been adequately analysed or documented at this site, which remains a major knowledge gap.

Implementing trials to evaluate the effectiveness of direct groundwater manipulation for preservation of remnant old River red gums is suggested. These trials could support the development of concept designs to identify the most appropriate methodologies and locations.

Table 19. Knowledge gaps and recommendations for the target area

Knowledge gaps and data	Action recommended	Responsibility
Impacts of nearby irrigation on wetland health	Investigation of surface water, groundwater and irrigation water interaction	MCMA
Flora and fauna surveys	Data collection and monitoring	MCMA
Impacts of climate variability	Data collection and monitoring	MCMA
Assessment of salinity impacts on the Murray River under proposed watering regimes	Engage consultants to carry out investigations and report	MCMA
Continue to build understanding of the optimal salinity conditions for Johnsons and Chaffey Bend, including the long-term interactions with groundwater, irrigation and drainage.	Ongoing investigation of surface water groundwater and irrigation water interaction.	MCMA

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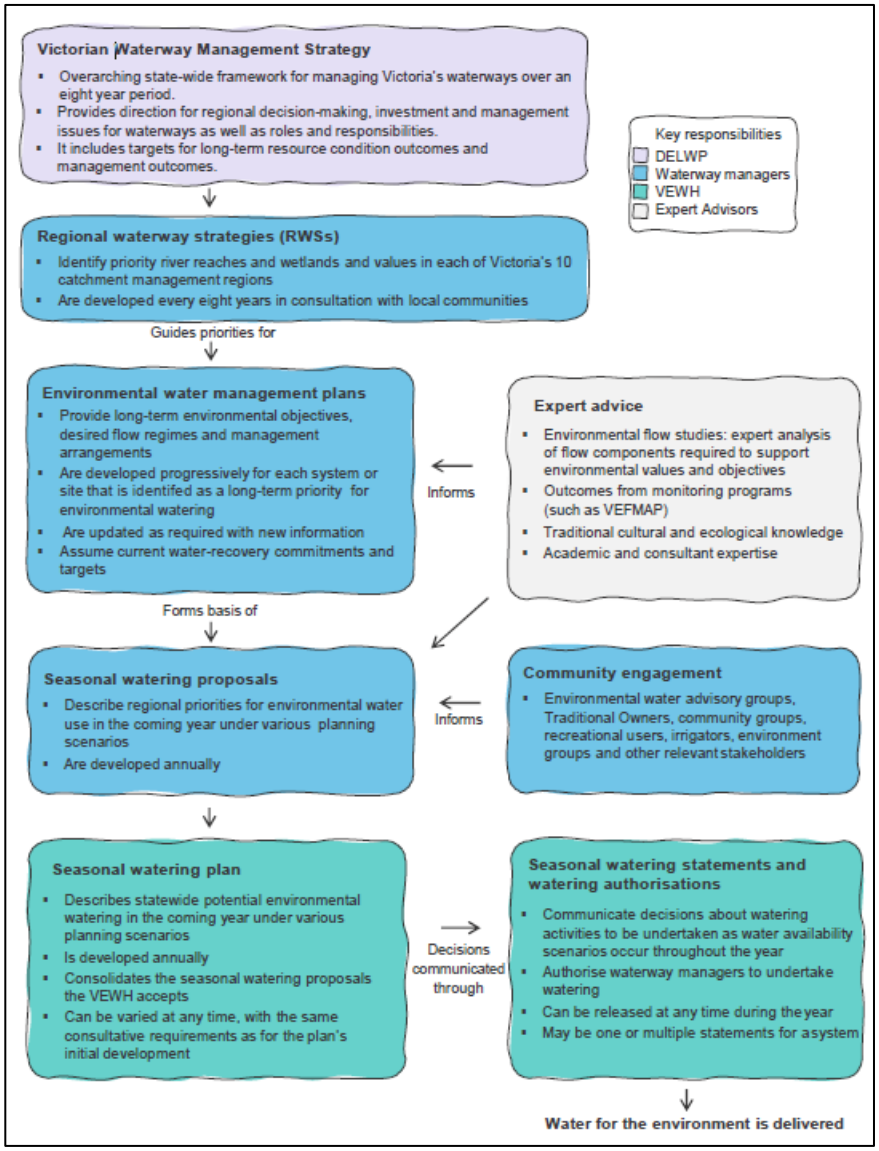
Appendix 1 – Framework for Environmental Water Management

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 below). 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 Johnsons and Chaffey 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 Johnsons and Chaffey 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 Johnsons and Chaffey Bend.



Mallee Catchment Management Authority (MCMA), the Department of Energy, Environment and Climate Action, 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.

Appendix 2 – Flora and fauna species list

Flora and fauna species lists were sourced from Naturekit records, extracted May 2023, and Mallee CMA.

Fauna – Native

Scientific Name	Common Name	Record Number
Acanthagenys rufogularis	Spiny-cheeked honeyeater	35
Acanthiza apicalis	Inland thornbill	1
Acanthiza chrysorrhoa	Yellow-rumped thornbill	10
Acanthiza nana	Yellow thornbill	10
Acanthiza uropygialis	Chestnut-rumped thornbill	16
Accipiter cirrocephalus	Collared sparrowhawk	2
Accipiter fasciatus	Brown goshawk	3
Acrocephalus australis	Reed-warbler	9
Anas castanea	Chestnut teal	16
Anas gracilis	Grey teal	54
Anas spp. (Dabbling ducks)	Dabbling ducks	1
Anas superciliosa	Pacific black duck	62
Anhinga novaehollandiae	Australasian darter	22
Anthochaera carunculata	Red wattlebird	39
Anthus australis	Australian pipit	1
Aphelocephala leucopsis	Southern whiteface	1
Aquila audax	Wedge-tailed eagle	1
Ardea alba	Great egret	12
Ardea alba modesta	Eastern great egret	3
Ardea intermedia plumifera	Plumed egret	2
Ardea pacifica	White-necked heron	5
Artamus cyanopterus	Dusky woodswallow	9
Artamus leucorynchus	White-breasted woodswallow	4
Aythya australis	Hardhead	33
Barnardius zonarius zonarius	Port lincoln parrot	5
Biziura lobata	Musk duck	16
Bubulcus coromandus	Eastern cattle egret	1
Burhinus grallarius	Bush stone-curlew	1
Cacatua galerita	Sulphur-crested cockatoo	4
Cacatua sanguinea	Little corella	10
Cacomantis flabelliformis	Fan-tailed cuckoo	2
Cacomantis pallidus	Pallid cuckoo	8
Calidris acuminata	Sharp-tailed sandpiper	2
Calidris ferruginea	Curlew sandpiper	2
Ceyx azureus	Azure kingfisher	1
Charadriidae spp.	Plovers, dotterels and lapwings	1
Chenonetta jubata	Australian wood duck	45
Chlidonias hybrida	Whiskered tern	3
Chroicocephalus novaehollandiae	Silver gull	32

Scientific Name	Common Name	Record Number
Chrysococcyx basalis	Horsfield's bronze-cuckoo	4
Chrysococcyx osculans	Black-eared cuckoo	1
Cincloramphus cruralis	Brown songlark	2
Cincloramphus mathewsi	Rufous songlark	1
Circus approximans	Swamp harrier	6
Cladorhynchus leucocephalus	Banded stilt	1
Climacteris affinis	White-browed treecreeper	2
Climacteris picumnus	Brown treecreeper	5
Colluricincla harmonica	Grey shrike-thrush	42
Coracina novaehollandiae	Black-faced cuckoo-shrike	18
Coracina papuensis	White-bellied cuckoo-shrike	1
Corcorax melanorhamphos	White-winged chough	21
Corvus bennetti	Little crow	4
Corvus coronoides	Australian raven	28
Corvus mellori	Little raven	4
Corvus spp.	Ravens and crows	4
Cracticus nigrogularis	Pied butcherbird	32
Cracticus torquatus	Grey butcherbird	10
Crinia parinsignifera	Eastern sign-bearing froglet	6
Cryptoblepharus pannosus	Carnaby's wall skink	1
Cygnus atratus	Black swan	44
Dacelo novaeguineae	Laughing kookaburra	34
Daphoenositta chrysoptera	Varied sittella	1
Dicaeum hirundinaceum	Mistletoebird	14
Egretta novaehollandiae	White-faced heron	24
Elanus axillaris	Black-shouldered kite	1
Elseyornis melanops	Black-fronted dotterel	21
Entomyzon cyanotis	Blue-faced honeyeater	14
Eolophus roseicapilla	Galah	21
Epthianura albifrons	White-fronted chat	1
Erythrogonys cinctus	Red-kneed dotterel	8
Falco cenchroides	Nankeen kestrel	4
Falco hypoleucos	Grey falcon	1
Falco longipennis	Australian hobby	1
Falco peregrinus	Peregrine falcon	2
Falco subniger	Black falcon	1
Falcunculus frontatus	Eastern Shrike-tit	1
Fulica atra	Eurasian coot	35
Gallinula tenebrosa	Dusky moorhen	6
Gavicalis virescens	Singing honeyeater	6
Gehyra variegata	Tree dtella	1
Geopelia placida	Peaceful dove	35
Gerygone fusca	Western gerygone	1
Grallina cyanoleuca	Magpie-lark	39

Scientific Name	Common Name	Record Number
Grantiella picta	Painted honeyeater	1
Gymnorhina tibicen	Australian magpie	41
Haliastur sphenurus	Whistling kite	40
Hieraaetus morphnoides	Little eagle	6
Himantopus leucocephalus	Pied stilt	21
Hirundo neoxena	Welcome swallow	22
Hydroprogne caspia	Caspian tern	12
Hypotaenidia philippensis	Buff-banded rail	1
Hypseleotris klunzingeri	Western carp gudgeon (species complex)	1
Lalage tricolor	White-winged triller	2
Limnodynastes dumerilii	Southern bullfrog (ssp. Unknown)	1
Limnodynastes fletcheri	Barking marsh frog	5
Limnodynastes tasmaniensis	Spotted marsh frog (race unknown)	7
Litoria peronii	Peron's tree frog	2
Litoria raniformis	Growling grass frog	1
Malacorhynchus membranaceus	Pink-eared duck	34
Malurus assimilis	Purple-backed fairywren	21
Malurus cyaneus	Superb fairy-wren	38
Malurus lamberti	Variegated fairy-wren	1
Malurus leucopterus	White-winged fairy-wren	2
Malurus spp.	Fairywrens	2
Manorina flavigula	Yellow-throated miner	2
Manorina melanocephala	Noisy miner	42
Melithreptus brevirostris	Brown-headed honeyeater	4
Melopsittacus undulatus	Budgerigar	1
Merops ornatus	Rainbow bee-eater	17
Microcarbo melanoleucos	Little pied cormorant	21
Milvus migrans	Black kite	15
Myiagra inquieta	Restless flycatcher	2
Ninox boobook	Southern boobook	3
Northiella haematogaster	Blue bonnet	4
Nymphicus hollandicus	Cockatiel	1
Ocyphaps lophotes	Crested pigeon	40
ord. Podicipediformes fam. Podicipedidae	Grebes	1
Oxyura australis	Blue-billed Duck	18
Pachycephala pectoralis	Golden whistler	1
Pachycephala rufiventris	Rufous whistler	29
Pardalotus punctatus	Spotted pardalote	8
Pardalotus striatus	Striated pardalote	33
Pelecanus conspicillatus	Australian pelican	41
Petrochelidon ariel	Fairy martin	2
Petrochelidon nigricans	Tree martin	14
Petroica goodenovii	Red-capped robin	18
Phalacrocoracidae spp.		2

Scientific Name	Common Name	Record Number
Phalacrocorax carbo	Great cormorant	29
Phalacrocorax sulcirostris	Little black cormorant	24
Phalacrocorax varius	Pied cormorant	7
Phaps chalcoptera	Common bronzewing	6
Philemon citreogularis	Little friarbird	21
Philemon corniculatus	Noisy friarbird	1
Philypnodon grandiceps	Flatheaded gudgeon	1
Platalea flavipes	Yellow-billed spoonbill	16
Platycercus elegans	Crimson rosella	35
Platycercus elegans flaveolus	Yellow rosella	7
Plectorhyncha lanceolata	Striped honeyeater	8
Podargus strigoides	Tawny frogmouth	1
Podiceps cristatus	Great crested grebe	3
Podicipedidae spp.	Grebes	6
Poliocephalus poliocephalus	Hoary-headed grebe	28
Polytelis anthopeplus monarchoides	Regent parrot	1
Pomatostomus ruficeps	Chestnut-crowned babbler	2
Pomatostomus superciliosus	White-browed babbler	26
Poodytes gramineus	Little grassbird	15
Porzana fluminea	Australian spotted crake	1
Porzana tabuensis	Spotless crake	2
Psephotellus varius	Mulga parrot	1
Psephotus haematonotus	Red-rumped parrot	39
Ptilotula ornata	Yellow-plumed honeyeater	1
Ptilotula penicillata	White-plumed honeyeater	53
Ptilotula plumula	Grey-fronted honeyeater	1
Purnella albifrons	White-fronted honeyeater	6
Recurvirostra novaehollandiae	Red-necked avocet	6
Rhipidura albiscapa	Grey fantail	13
Rhipidura leucophrys	Willie wagtail	52
Smicrornis brevirostris	Weebill	32
Spatula rhynchotis	Australasian shoveler	37
Stictonetta naevosa	Freckled duck	14
Strepera versicolor	Grey currawong	3
Struthidea cinerea	Apostlebird	2
Tachybaptus novaehollandiae	Australasian grebe	25
Tadorna tadornoides	Australian shelduck	51
Taeniopygia guttata	Zebra finch	3
Threskiornis molucca	Australian white ibis	39
Threskiornis spinicollis	Straw-necked Ibis	12
Todiramphus pyrrhopygius	Red-backed kingfisher	1
Todiramphus sanctus	Sacred kingfisher	5
Tribonyx ventralis	Black-tailed native-hen	14
Trichosurus vulpecula	Common brush-tailed possum	1

Scientific Name	Common Name	Record Number
Tringa nebularia	Common greenshank	1
Tringa stagnatilis	Marsh sandpiper	5
Vanellus miles	Masked lapwing	33
Varanus varius	Lace monitor	1
Zosterops lateralis	Silvereye	2

Flora – Native

Scientific Name	Common Name	Record Number
Acacia oswaldii	Umbrella wattle	2
Acacia victoriae subsp. victoriae	Bramble wattle	1
Atriplex nummularia	Old-man saltbush	1
Calotis cuneifolia	Blue burr-daisy	1
Carpobrotus aff. rossii (N.W. Victoria)	Mallee pigface	1
Chenopodium curvispicatum	Cottony saltbush	1
Chenopodium nitrariaceum	Nitre goosefoot	1
Dianella porracea	Riverine flax-lily	1
Dodonaea viscosa subsp. angustissima	Slender hop-bush	1
Enchylaena tomentosa var. tomentosa (shrubby form)	Ruby saltbush (shrubby inland form)	1
Eragrostis lacunaria	Purple love-grass	1
Eremophila divaricata subsp. divaricata	Spreading emu-bush	1
Eucalyptus camaldulensis	River red-gum	2
Eucalyptus largiflorens	Black box	2
Hakea leucoptera subsp. leucoptera	Silver needlewood	1
Potamogeton sulcatus	Furrowed pondweed	1
Acacia stenophylla	River myall	
Alternanthera denticulata	Lesser joyweed	
Alternanthera nodiflora	Common joyweed	
Atriplex lindleyi subsp. Inflata	Flat-topped saltbush	
Bergia trimera	Small water-fire	
Calotis hispidula	Hairy burr-daisy	
Centipeda cunninghamii	Common sneezeweed	
Centipeda minima subsp. minima	Spreading sneezeweed	
Cullen tenax	Tough scurf-pea	
Dysphania glomulifera subsp. glomulifera	Pigweed	
Dysphania pumilio	N/a	
Einadia nutans subsp. nutans	Nodding saltbush	
Glinus lotoides	Hairy Carpet-weed	
Glinus oppositifolius	Slender Carpet-weed	
Laphangium luteoalbum	Jersey cudweed	
Medicago sp.*	Medic	
Oxalis perennans	Grassland Wood-sorrel	
Paspalidium jubiflorum	Warrego Summer-grass	
Persicaria decipiens	Slender knotweed	
Salsola tragus subsp. tragus	N/a	

Sclerolaena diacantha	N/a	
Sclerolaena tricuspis	Three-spined Bassia	
Sisymbrium erysimoides	Smooth mustard	
Solanum nigrum*	Black nightshade	
Sonchus oleraceus*	Sow thistle	
Sphaeromorphaea littoralis	N/a	
Stemodia florulenta	Bluerod	
Verbena officinalis s.l.	Common verbena	
Verbena supina s.l.*	Trailing verbena	

Appendix 3 – Exotic Flora and Fauna Species Lists

Flora – Exotic

Scientific Name	Common Name	Record Number
Datura stramonium	Common thorn-apple	1
Echium plantagineum	Paterson's curse	1
Euphorbia terracina	Terracina spurge	2
Lepidium draba	Hoary cress	5
Lycium ferocissimum	African box-thorn	1

Fauna – Exotic

Scientific Name	Common Name	Record Number
Turdus merula	Common blackbird	7
Passer domesticus	House sparrow	6
Sturnus vulgaris	Common starling	17
Columba livia	Domestic pigeon	3
Anas platyrhynchos	Mallard	1
Gambusia holbrooki	Eastern gambusia	1

Appendix 4 – Johnsons and Chaffey Bend EWMP Updated Environmental Objectives, Further Information (From Butcher et al 2020).

JOHNSONS AND CHAFFEY BEND EWMP UPDATED ENVIRONMENTAL OBJECTIVES, FURTHER INFORMATION (FROM BUTCHER ET AL 2020)

Johnsons and Chaffey Bend EWMP – Information describing rationale behind updated environmental objectives and targets (from Butcher et al 2020)

SMARTness and rationalisation

Site-specific environmental objectives for the Johnsons and Chaffey Bend EWMP (DSE 2010b).

EWMP objectives
JCB1: Preserve remnant old Red Gums along the riverfront and promote recruitment of Red Gums (i.e. germination and retention of seedlings)
JCB2: Preserve extent and support health of Black Box across the floodplains and promote recruitment of Black Box (i.e. germination and retention of seedlings)

Assessment of SMARTness of current Johnsons and Chaffey 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
JCB1	0	0	1	1	1	0	1	1	1	0	0
JCB2	0	0	1	1	1	0	1	1	1	0	0

Rationalised environmental objectives for the Johnsons and Chaffey Bend EWMP (Mallee CMA 2016b).

Objective	Issue	Outcome
JCB1	No issue with objective other than its not fully SMART and no baseline data	Objective updated to align with Basin Plan language
JCB2	Incudes multiple aspects - extent and recruitment. Options are to split or consolidate to a measure of condition.	Simplify to focus on condition with the assumption that this will be a surrogate for recruitment

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, DSE Listed **5:** High level of ecological communities which would support high level of biodiversity as a result of environmental watering	**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):** Condition of priority ecosystem function – prevention of decline in native biota

Updated objectives for Johnsons and Chaffey Bend

Current objective	JCB1: Preserve remnant old Red Gums along the riverfront and promote recruitment of Red Gums (i.e. germination and retention of seedlings)
Comments	Focus of the objective is the condition of mature RRG – if condition is good assumes that recruitment will occur under the right conditions.
EWP objective(s)	8.05,3(b) 8.06,6(b)
Schedule 7 targets	Condition of priority asset – prevention of decline of native biota Recruitment and populations 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) Condition of priority ecosystem function – prevention of decline in native biota
BEWS QEEO	B2.9 By 2024 improve recruitment of trees within river red gum and Black Box communities
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 reliant on River Red Gum woodland at the Johnsons & Chaffey Bend asset.
2020 Targets:	By 2030, a positive trend in the condition score of River Red Gum dominated EVC benchmarks the Johnsons & Chaffey Bend asset at 80% of sites over the 10 year period.
	OR By 2030, at stressed sites (see Wallace et al. 2020) the Johnsons & Chaffey Bend asset: 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 trees at Johnsons & Chaffey Bend needs to be established.

Current objective	JCB2: Preserve extent and support health of Black Box across the floodplains and promote recruitment of Black Box (i.e. germination and retention of seedlings)
Comments	Simplify to focus on condition with the assumption that this will be a surrogate for recruitment
EWP objective(s)	8.05,3(b) 8.06,6(b)
Schedule 7 targets	Condition of priority asset – prevention of decline of native biota Recruitment and populations 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) Condition of priority ecosystem function – prevention of decline in native biota
BWS 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 Black Box dominated EVC benchmarks at 50% of sites over the 10 year period to 2025
2020 Objective:	By 2030, improve condition and maintain extent from baseline (2006) levels of Black Box (*Eucalyptus largiflorens*) to sustain communities and processes reliant of such communities at the Johnsons & Chaffey Bend asset
2020 Targets:	A positive trend in the condition score of Black Box dominated EVC benchmarks at the Johnsons & Chaffey Bend asset at 50% of sites over the 10 year period. OR By 2030, at stressed sites (see Wallace et al. 2020) at the Johnsons & Chaffey Bend asset: 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 Black Box trees needs to be established to ensure TCI good is achievable - may need to rewrite target and adaptively manage this as condition improves.

Appendix 5 – Assessing Risks

When prioritizing wetland watering, it is often difficult because there is no framework by which you can compare the fate of different species. To support prioritization, 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 14, with a more detailed explanation provided in Tables 20 and 21.

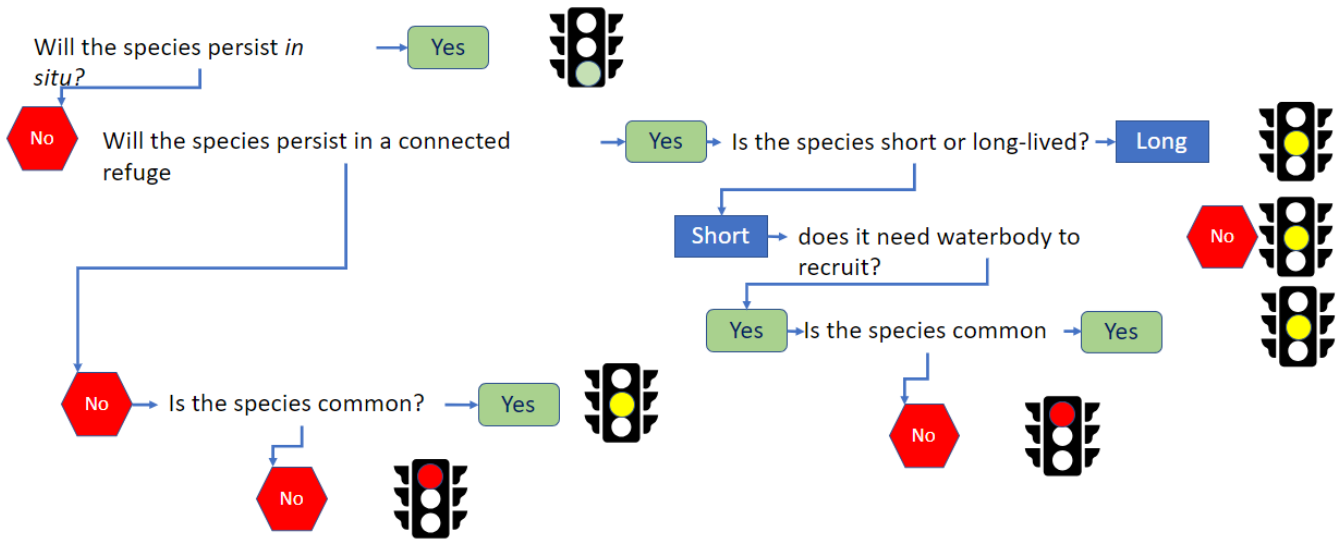


Figure 17. Risk decision tree

Table 20. Risk decision tree

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 2
			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 21. Risk decision tree

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	

Appendix 6. Community Engagement 2023 Summary.

To update the community values present at Johnsons and Chaffey Bend, Mallee CMA engaged with the local community through an online survey. This survey requested information from participants about which wetland area was most important or meaningful, how they used that area, additional water dependent values of the area, a ranking of the importance of values, as well as demographic information from survey participants. This engagement exercise represented the 'Consult' activity in the IAP2 Public Participation Spectrum.

Twelve of forty-seven respondents identified Johnsons and Chaffey Bend as the most important site (of all eight sites), although only 7 completed surveys were received. Four participants identified as residents, two participants identified as visitors to the region, and two participants identified as recreational users. Over 40% of respondents (4/7 respondents) visit Johnsons and Chaffey Bend every few months, with almost 30% (2/7 respondents) visiting Johnsons and Chaffey Bend on a weekly basis. Almost 30% (2/7 respondents) visit Johnsons and Chaffey Bend less than once a year. Respondents visit Johnsons and Chaffey Bend in all seasons, with 100% of respondents visiting during Summer. All respondents use Johnsons and Chaffey Bend for walking/running, and almost 60% of respondents (4/7) visit Johnsons and Chaffey Bend for boating. Over 40% (3/7 respondents) used Johnsons and Chaffey Bend for swimming. 1 survey participant used Johnsons and Chaffey Bend for fishing and nature appreciation. No respondents identified that Johnsons and Chaffey bend is used for birdwatching, education or tourism purposes.

Table 22 - Community Values rankings

Community Value	Use and Value ranking
Exercise, especially walking/running and bike riding	100% of survey participants use Johnsons and Chaffey Bend for walking/running. Exercise was ranked very important (scores of 4.4/5 and 5/5) for survey participants.
Boating	Almost 60% of respondents (4/7) visit Johnsons and Chaffey Bend for boating
Unique landscape features and natural beauty	Respondents for the Historic Wetland (Johnsons Bend) ranked this value as very important (a score of 4.6/5)
Fishing	A respondent to the survey identified fishing as value.
Nature appreciation	A respondent to the survey identified nature appreciation as a value
Traditional Owner Values	Respondents for the Johnsons and Chaffey survey ranked this value as important (a score of 4.2/5).

The Historic Wetland (Johnsons Bend) The Historic Wetland (Johnsons Bend) was the area most visited by survey respondents (6/7 respondents visit these areas), followed by Mildura Wastewater Treatment Plant (Chaffey Bend) (3/7 respondents visit this area), and the 'River track and through woodlands' (1 respondent). The majority of survey participants (5/7 respondents) identified that the Historic Wetland (Johnsons Bend) was the most important/meaningful to them at Johnsons and Chaffey Bend, with 2/7 respondents identifying that the Mildura Wastewater Treatment Plant (Chaffey Bend) was the most important/meaningful.

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