Lake Carpul, by Mallee CMA

Section 1

Introduction

1.1 The Victorian environmental watering program

The Victorian environmental watering program is the ongoing collaborative management of water available under environmental entitlements and used to improve the health of Victoria's rivers and wetlands and the native plants and animals that depend on them.

This seasonal watering plan previews the potential environmental watering that may be delivered across Victoria under the program in the coming year.

In this section ...

1.1.1 Who is involved in the Victorian environmental watering program?

The Victorian environmental watering program involves a range of people and organisations. Relationships between local communities, waterway managers, storage managers, environmental water holders and land managers are the foundation of the program.

Many public authorities collaborate to deliver the program. These authorities are referred to as program partners.

Waterway managers (CMAs and Melbourne Water) are the linchpin of the program. In consultation with local communities, waterway managers develop proposals for environmental watering in rivers and wetlands in their region. Waterway managers also order environmental water from storage managers and monitor the outcomes.

Storage managers (some water corporations) deliver water for all water users, including waterway managers and environmental water holders.

Environmental water holders (the Victorian Environmental Water Holder [VEWH], Commonwealth Environmental Water Holder [CEWH] and the Murray–Darling Basin Authority [MDBA]) commit environmental water to different rivers and wetlands. They work together to ensure the coordinated delivery of water available under different environmental entitlements and often have to prioritise across large regions (such as northern Victoria).

Public land managers (such as Parks Victoria, Department of Environment, Land, Water and Planning and Traditional Owner land management boards) are closely involved in environmental water planning and delivery for public land such as state forests or national parks. They may have a variety of responsibilities including controlling infrastructure (such as pumps, outlets, gates and channels) and ensuring appropriate public signage. Some environmental watering also occurs on private land, in partnership with landholders or corporations.

To effectively manage environmental water, it is important to understand the environmental values of Victoria's rivers and wetlands. This understanding draws on the knowledge of local communities and scientists.

Local communities help to identify the important environmental values in each region and help to monitor the success of environmental watering. Their input is important because they are often actively involved with local rivers and wetlands and bring a range of environmental, cultural, social and economic perspectives to the program.

Scientists provide indispensable advice about how environmental water will support native plants and animals in the short and long terms and work with waterway managers to monitor, evaluate and report on the outcomes of environmental watering.

1.1.2 What is the program aiming to achieve?

The Victorian environmental watering program seeks to collaboratively manage environmental water to improve the environmental values and health of water ecosystems, including their biodiversity, ecological functioning, water quality and other uses that depend on environmental condition.

Barwon River at Fyansford, by Saul Vermeeran, Corangamite CMA

1.1.3 What is the role of the VEWH?

The VEWH is an independent statutory authority set up under the Victorian *Water Act 1989* to manage Victoria's environmental water entitlements to achieve environmental benefits for Victoria's rivers, wetlands and floodplains.

The role of the VEWH is to:

- make decisions about the most effective use of the environmental water entitlements, including for use, carryover and trade (see section 1.4.2)
- commit water and authorise waterway managers to implement watering decisions (see section 1.3.2)
- work with storage managers and other water holders to coordinate and optimise environmental outcomes from the delivery of all water (see section 1.4)
- commission projects to demonstrate the ecological outcomes of environmental watering at key sites and to help improve environmental water management
- publicly communicate environmental watering decisions and outcomes.

The VEWH consists of three part-time commissioners, supported by a small team.

The commissioners are Denis Flett (Chairperson), Geoff Hocking (Deputy Chairperson) and Chris Chesterfield (Commissioner). Commissioners were appointed by the Governor in Council on the recommendation of the Minister for Environment, Climate Change and Water.

1.1.4 Where can I find more information about the Victorian environmental watering program?

More information about the program can be found on the VEWH website at www.vewh.vic.gov.au or by contacting the VEWH on (03) 9637 8951 or by email to general.enquiries@vewh.vic.gov.au.

More detailed information about environmental watering in your region can be obtained by contacting your local waterway manager using the contact details in section 6.3.

Environmental watering fact sheets

The VEWH has produced fact sheets to answer questions people have about environmental watering. They are:

- What is environmental water?
- Why is environmental watering important?
- What does environmental watering aim to achieve?
- What does environmental watering involve?
- How do we know if environmental watering is successful?
- What is environmental water trading?

These fact sheets can be found on the VEWH website. Hard copies can be requested by email to general.enquiries@vewh.vic.gov.au.

1.2 The seasonal watering plan

The seasonal watering plan is a statewide plan that guides environmental watering decisions in Victoria. It provides program partners, stakeholders and communities with a sense of what to expect during the water year.

In this section ...

- **What does 'seasonal' mean?**
- **How does the seasonal watering plan fit into the planning process?**
- **Who contributes to the seasonal watering plan?**
- **Can the seasonal watering plan be changed?**
- **What kinds of changes don't require a formal variation of the plan?**

The plan previews the potential environmental watering that could be implemented using water available under all environmental water entitlements held in Victoria. This includes water available under the VEWH's environmental water entitlements and water held by other environmental water holders (see section 1.4.1).

The plan for the upcoming water year is released by 30 June each year. The 2016–17 plan and any variations are valid for this water year (1 July 2016 to 30 June 2017) or until the subsequent seasonal watering plan is released.

1.2.1 What does 'seasonal' mean?

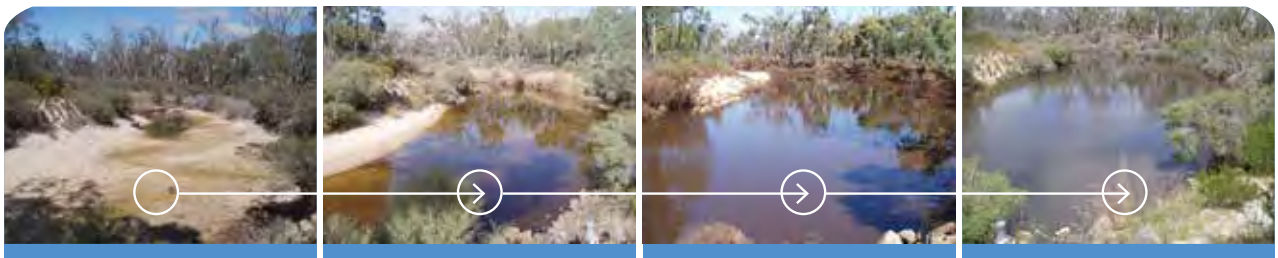
'Seasonal' refers to the variability of climatic conditions in a given year. Environmental watering objectives and water availability may differ depending on seasonal conditions, so it is important that environmental water planning considers the range of potential seasonal condition or water availability scenarios that may unfold, ranging from drought to wet (see Figure 1.2.1). This scenario planning provides a guide for the VEWH and waterway managers throughout the year when it comes to deciding what environmental watering to go ahead with.

For each river and wetland system, the potential environmental watering under each water availability scenario is captured in the Scenario planning section of the relevant chapter.

1.2.2 How does the seasonal watering plan fit in the planning process?

Each year, waterway managers scope the potential environmental watering actions for their regions for the coming year in seasonal watering proposals. The proposals draw on environmental flow studies and on longer-term plans (such as environmental water management plans and regional waterway strategies). The proposals incorporate information and advice from local communities.

Figure 1.2.1 Examples of environmental watering objectives under different planning scenarios



Drought

Main objective: PROTECT

- Avoid critical loss
- Maintain key refuges
- Avoid catastrophic events

Dry

Main objective: MAINTAIN

- Maintain river functioning with reduced reproductive capacity
- Maintain key functions of high-priority wetlands
- Manage within dry-spell tolerances

Average

Main objective: RECOVER

- Improve ecological health and resilience
- Improve recruitment opportunities for key animal and plant species

Wet to very wet

Main objective: ENHANCE

- Restore key floodplain and wetland linkages
- Enhance recruitment opportunities for key animal and plant species

This seasonal watering plan is a collated summary of the seasonal watering proposals.

The different stages of environmental water planning, including the different strategies and plans, are shown in Figure 1.2.2. More information about each of these strategies and plans can be found at www.vewh.vic.gov.au.

1.2.3 Who contributes to the seasonal watering plan?

Stakeholder engagement on potential environmental watering actions occurs during the development of regional seasonal watering proposals. The level and method of engagement varies across the state, reflecting the differing systems, watering actions and stakeholders. In some regions, formal environmental water advisory groups provide the opportunity for waterway managers and interested community members to discuss potential

Figure 1.2.2 Victorian environmental watering program planning framework

environmental watering in their system or locality for the coming year. In other systems, engagement occurs one-on-one between waterway managers and interested stakeholders.

Land managers and storage managers also consider and endorse the seasonal watering proposals to ensure that planned watering aligns with land and storage management objectives and can feasibly be delivered through planned system operations.

The engagement activities undertaken by waterway managers during the development of the seasonal watering proposals are summarised in sections 2 to 5 of this plan.

1.2.4 Can the seasonal watering plan be changed?

Under the Victorian *Water Act 1989*, the VEWH can only authorise use of environmental water where it is consistent with a seasonal watering plan. This is to ensure transparency about what environmental watering is planned and how it is managed.

However, to also ensure flexibility to adapt to changing conditions, under the Act the VEWH can vary any section of a seasonal watering plan. This could be to incorporate new knowledge or to address any circumstances not identified before the start of the water year.

All variations are made publicly available at www.vewh.vic.gov.au as separate attachments to the original seasonal watering plan. Printed copies can be requested by emailing general.enquiries@vewh.vic.gov.au.

1.2.5 What kinds of changes don't require a formal variation to the seasonal watering plan?

Changes that do not require a variation to the seasonal watering plan include:

- minor operational adjustments to specific environmental watering actions
- environmental water being used for environmental emergency management situations
- small volumes of environmental water being used for technical investigations
- facilitating the delivery of water held by other water holders for downstream objectives
- environmental watering actions that continue beyond the year of the plan (even if there are unforeseen delays releasing the following year's plan).

As it is not possible to anticipate the specifics of these changes, it is not possible to include details about them in this plan.

Minor operational adjustments

Minor operational adjustments to environmental watering actions may occur from time to time and do not require a formal variation to the seasonal watering plan. For example, the targeted river reaches, flow rates, timing and durations detailed in sections 2 to 5 may need to be adjusted slightly due to changes in predicted rainfall or other water orders, or delivery infrastructure constraints. In all cases, environmental watering actions will still aim to optimise the environmental outcomes achieved.

Environmental emergency management situations

Environmental water may be needed for an environmental emergency management situation. This may include reducing the impact of natural blackwater or bushfire events, preventing fish deaths or mitigating the effects of blue-green algae blooms. It could also include smoothing the transition to or from a high natural flow event (for example, supplementing natural flows with environmental water to provide a more gradual rise and fall to minimise the threat of river banks slumping).

Small technical investigations

There may be instances where a small volume of environmental water may be used for research and development purposes or small-scale infrastructure testing. Such instances are considered on a case-by-case basis. The project must aim to enhance knowledge and improve environmental water management. It must not compromise the potential to achieve the environmental objectives in the seasonal watering plan.

Facilitating the delivery of water held by other water holders for downstream objectives

Some water held by other water holders is stored in Victorian storages and is sometimes called on to meet downstream demands beyond the scope of this plan (such as for the Coorong, Lower Lakes and Murray Mouth area in South Australia). Delivery of this water is sometimes needed at a time and flow rate that was not scoped in the seasonal watering plan. The VEWH facilitates and authorises such deliveries, provided the risk of adverse impacts on Victoria's rivers, wetlands and floodplains and other risks are appropriately managed.

Environmental watering actions that continue beyond the year of the plan

Nature doesn't keep to strict timelines, so some potential environmental watering scoped in a seasonal watering plan may begin before, or continue beyond, the year of the plan. This means environmental watering actions that start either before July 2016 or continue after June 2017 are still consistent with the plan, especially if there turn out to be unforeseen delays releasing the *Seasonal Watering Plan 2017–18*.

1.3 Implementing the seasonal watering plan

The seasonal watering plan scopes potential environmental watering for the coming year, but many factors influence decisions about what environmental water is actually committed and delivered.

These factors include:

- seasonal conditions, weather forecasts and catchment conditions
- river and system operations (such as unregulated flows, catchment inflows, storage levels, other water users' needs and potential delivery constraints)
- ecological or biological factors and triggers (such as plant and animal responses to natural flows or temperature)
- water availability
- risks associated with an environmental watering action (such as declining water quality).

It is important that there is flexibility to respond to these different factors, as they can significantly influence the environmental outcomes that can be achieved.

In this section ...

1.3.1 How do program partners decide which watering actions are delivered?

As the season unfolds, many of the uncertainties associated with seasonal conditions, water availability and operational context become clearer and this clarity informs decisions about what environmental watering should proceed. Many on-ground factors do not become clear until very close to the anticipated time of water delivery.

To guide environmental watering decisions, a flexible and adaptive approach is adopted that includes the range of stakeholders in environmental water management. This process of review and adjustment ensures that environmental water is used in an efficient and seasonally appropriate manner to optimise ecological outcomes across the state.

Waterway managers, environmental water holders, storage managers and land managers all play a role in deciding which watering actions are or can be delivered during the year. These decisions are often made collaboratively, as each program partner has a role in approving the delivery of environmental water (as explained in section 1.3.3).

If decisions are required as a result of unforeseen or consequential changes to planned watering during the season, further scientific or community input may be sought to inform decision-makers.

Regularly updated information about current and anticipated environmental watering actions is published on the VEWH website at www.vewh.vic.gov.au.

Lisa Duncan from Goulburn Broken CMA at Top Lake, by Keith Chalmers, Victorian Environmental Water Holder

1.3.2 When does the VEWH commit and authorise its water for use?

The VEWH aims to commit as much water as is sensibly possible, as early as possible, to provide waterway managers with as much certainty as possible to enable them to proceed with the planned environmental watering actions.

The VEWH (like other environmental water holders) can commit its water at any point before or during the water year. The VEWH commits water via seasonal watering statements which authorise waterway managers to use environmental water. Seasonal watering statements are published on the VEWH website at www.vewh.vic.gov.au.

A seasonal watering statement can be made at any time of the year. Depending on the nature of the system and the entitlement being used, there may be one or multiple statements made for a particular system. Before issuing a seasonal watering statement, the VEWH must be sure that the required delivery arrangements (including any risk management measures) are in place and that any costs to be met by the VEWH are acceptable.

Where many environmental watering actions planned across different systems require access to the same environmental water entitlement, decisions to commit water to particular actions may require more thorough consideration. This may require one river or wetland to be prioritised over another. Section 1.3.3 has further information about how prioritisation decisions are made.

In some instances, the VEWH may commit water very close to the anticipated delivery time. This may be necessary because the water demand arises at short notice due to environmental, operational or weather conditions triggering the need for environmental water. For example, if colonial waterbirds start nesting in Barmah Forest, this may trigger a need for environmental water to maintain shallow flooding long enough for the birds to breed and fledge.

There may also be instances where no environmental water is committed to a particular site. For example, there could be an ecological trigger or seasonal conditions that show watering should not proceed, or insufficient water to achieve the planned watering action.

The CEWH and MDBA (through the Living Murray program) commit water for use in Victoria with similar logic to that outlined above. The VEWH then formally authorises the use of that water through seasonal watering statements.

Can environmental water holders change their minds after a seasonal watering statement has been issued?

The VEWH may withdraw a seasonal watering statement at any point during the year. Such an action is undertaken in consultation with the waterway manager and storage manager for that river or wetland system. This may occur due to factors such as emerging risks or changes in operating conditions or water availability.

Similarly, a waterway manager or storage manager may decide, in consultation with the VEWH, not to proceed with an environmental watering action after a seasonal watering statement has been issued. This could occur as a result of environmental triggers indicating the water was no longer required, resourcing constraints or new information that the potential environmental or public risk of watering was too high.

1.3.3 How does the VEWH prioritise different watering actions when not enough water is available?

In any given year, the need for environmental water as outlined in the seasonal watering plan can be higher than the water available to use, so it is important to consider where water is most needed and how it can be used most efficiently to achieve the best environmental outcomes.

A shortfall in supply might arise because of:

- significant, high-value environmental water demands
- drought or low water availability.

To meet this deficit the VEWH may look at using tools such as carryover and trade (as explained in section 1.4.2). If there is still a shortfall of water, the VEWH, in collaboration with waterway managers and other water holders if relevant, must prioritise environmental watering actions.

Prioritisation decisions are influenced by many factors such as the previous watering history in that river or wetland, environmental or public risk considerations and seasonal conditions in that region. Prioritisation decisions can be extremely difficult and often involve trading off one watering action against another.

In making the decision to prioritise one environmental watering action and site over another, the VEWH always seeks to optimise environmental outcomes across the state.

What criteria are used to guide prioritisation decisions?

Figure 1.3.1 shows the criteria considered when making the trade-off decisions and prioritising the range of potential environmental watering actions. Information about how different watering actions meet these criteria are provided by the waterway managers in their seasonal watering proposals.

Who is involved in the prioritisation process?

Waterway managers, environmental water holders, storage managers and communities all have a role in prioritising environmental watering actions, depending on the nature and scale of the decision being made.

Waterway managers are best placed to advise about the extent and significance of an environmental watering action and the highest priorities in their region.

The VEWH and other environmental water holders determine the highest watering priorities across regions and have a mandate to commit environmental water to particular watering actions and sites over others. The VEWH's decisions are intended to provide the best-possible environmental outcomes for the state. The VEWH makes these decisions in consultation with waterway managers as the primary environmental watering representatives of their regions and with other program partners as relevant.

Advice from storage managers is generally the key to understanding the feasibility of delivering a watering action, including the flexibility of delivery timing and operational constraints.

Land managers provide consent to environmental water delivery on their land and will advise on delivery feasibility in light of land management activities, public access and the risks and benefits of the environmental watering action.

The annual prioritisation process is informed by longer-term site prioritisation by waterway managers in consultation with their communities. This prioritisation is in plans such as regional waterway strategies and environmental water management plans. These plans draw on community and scientific knowledge and prioritise sites for environmental watering (and other river health activities) that have high environmental, cultural, social and economic value to the community.

Additional input from the community about prioritisation of environmental watering is provided annually where needed.

Figure 1.3.1 Criteria for prioritising watering actions

Prioritisation criteria	Types of factors considered
Extent of benefit	▸ Size of the area being watered ▸ Expected ecological outcomes ▸ Expected scale of response ▸ Conservation status of the species that will benefit
Likelihood of success	▸ Evidence to support the desired outcomes will be achieved ▸ External threats that may affect getting the desired results
Longer-term benefits	▸ Value added to previous watering investment at the site ▸ Longer-term environmental benefits expected ▸ Ability to sustain these values into the future
Urgency of watering needs	▸ History of watering at the site ▸ Potential for irreversible damage if the watering does not occur ▸ Potential for species loss at a local or greater scale ▸ Risks associated with not delivering the water
Feasibility of the action	▸ Capacity of infrastructure to meet the delivery requirements ▸ System or operational constraints ▸ Flexibility in the timing of delivery ▸ Feasibility of management actions in mitigating external threats
Environmental or third-party risks	▸ Adverse environmental outcomes that may arise ▸ Third-party risks associated with the event ▸ Effectiveness of actions to manage third-party and environmental risks
Costs of the watering action	▸ Costs to deliver and/or manage water ▸ Costs of interventions for managing external threats and risks
Efficiency of water use	▸ Volume of water needed to achieve the desired outcomes ▸ Volume and timing of return flows that may be used at downstream sites (see section 1.4.2) ▸ Alternative supply options such as use of consumptive water en route or augmenting natural flow events ▸ Risks of spills from storages in the upcoming water year and any carryover water (see section 1.4.2) that may be available

1.3.4 Do seasonal conditions affect how environmental water is used?

In the same way rainfall patterns influence how people water their gardens or paddocks, different climatic conditions influence how environmental water is managed.

Seasonal conditions drive what water will be available during the water year and the environmental watering objectives to be pursued (as explained in section 1.2.1). Waterway managers take seasonal conditions into account when prioritising the environmental water needed at each particular site. These are known as planning scenarios and describe the range of watering actions that may occur under drought to very wet climatic conditions.

Waterway managers work with a range of program partners to decide how to optimise the ecological outcomes that can be achieved using environmental water by considering factors including:

- the environmental objectives under each climatic scenario, including consideration of any essential environmental water needs
- how rainfall, natural flooding or the delivery of water for consumptive users may contribute to the achievement of the environmental objectives
- how environmental water may be used to build on natural flows or irrigation deliveries to meet the environment's needs
- natural climatic cues that might occur that increase the likelihood of achieving a particular ecological outcome.

Planning scenarios are presented in the seasonal watering plan and provide the basis for the adaptive management of environmental water as the season unfolds. They also provide an early indication of the amount of water that may be used at different sites and whether the VEWH may need to trade water that season to meet the identified environmental need (as explained in section 1.4).

Figure 1.3.2 provides an example of how different planning scenarios may influence decisions about how environmental water may be managed in a given year.

Figure 1.3.2 Example planning scenarios for a river system under a range of climatic conditions

Planning scenario	Drought	Dry	Average	Wet to very wet
EXPECTED CATCHMENT CONDITIONS	No unregulated flows	One or two brief unregulated flow peaks in winter/spring	One to three unregulated flow peaks plus extended low flows in winter/spring	Extended unregulated high flows with some overbank flooding in winter/spring
ENVIRONMENTAL OBJECTIVES	Protect critical refuge habitat for native fish	Maintain native fish habitat	Encourage fish movement and spawning Improve habitat for water bugs Support the establishment and maintenance of bank vegetation	Encourage movement and spawning of native fish Enhance condition and extent of bank vegetation Where possible, provide opportunities for the exchange of nutrients and carbon between the river and floodplain
POTENTIAL ENVIRONMENTAL WATERING	Provide low flows and trigger-based freshes to maintain water quality in deep refuge pools	Provide summer/autumn low flows to manage water quality and maintain connectivity Extend the duration of flow peaks to freshen water quality in deep pools	Provide year-round baseflows to maintain habitat connectivity and support fish movement Extend the duration and/or magnitude of peaks to provide spawning cues for fish Provide seasonal freshes to support the establishment of bank vegetation	Maintain year-round low flows and seasonal freshes to encourage the recovery of in-stream and bank vegetation and trigger the spawning and movement of native fish Where possible, maintain connectivity and the exchange of nutrients between the river and floodplain Slow the recession of natural peaks to avoid bank slumping and erosion Top up natural flows if needed, to meet targets for winter base flows and spring peaks

1.3.5 How are recreational, cultural and economic benefits considered in environmental watering?

Environmental water is essential for maintaining and improving the health of rivers, wetlands and floodplains. The plants, animals and broader health of these waterways provide shared benefits for recreation, cultures and economies. For example, environmental watering can improve conditions for fishing, camping and canoeing; sustain healthy Country and totem species for Aboriginal communities with a continuing connection to rivers, wetlands and floodplains; and improve water quality which can deliver economic benefits for irrigators.

In planning for environmental watering, the primary purpose is to maximise environmental benefits. However, where consistent with this purpose, program partners also consider whether additional social, cultural and economic benefits can be achieved.

These shared benefits of environmental water can sometimes be actively maximised by making decisions around the storage, delivery and use of environmental water, such as holding water in weirs at particular times to support waterskiing activities.

When planning for and delivering environmental water, the VEWH and program partners look for opportunities to achieve these shared benefits, where environmental outcomes are not compromised. The VEWH and waterway managers are interested in seeking and developing robust methods to better incorporate these values in the watering prioritisation process.

Waterway managers work with communities to identify the environmental, social, cultural and economic values of waterways through regional waterway strategies, environmental water management plans and seasonal watering proposals. These values for each system are summarised in sections 2 to 5. Program partners will continue to work with stakeholders to look for opportunities to achieve shared benefits from environmental watering.

1.3.6 How are risks managed?

Risk management is an integral part of environmental watering and is considered by program partners throughout environmental water management (that is, during long-term and annual planning, implementation and review).

The seasonal watering proposals, on which this *Seasonal Watering Plan 2016–17* is based, identify potential risks associated with the specific watering actions proposed for the coming water year. They assess risks and identify mitigating actions. Often, the management of risks associated with environmental watering is shared between program partners as it requires a collaborative risk management approach.

Table 1.3.1 shows the main shared risks of environmental watering. Program partners consider and reassess these and other potential risks as the season unfolds and planned watering actions are due to commence.

Some risks may only eventuate at the time of delivery. For example, if there is significant rain forecast, there is a risk that this could cause nuisance flooding if combined with a scheduled environmental watering action. To avoid this, risks are always reconsidered by program partners within the specific environmental and operational contexts of a watering action to inform decisions about whether delivery should proceed. Any measures or actions required to mitigate the risks identified are implemented as agreed by the responsible program partner. Watering actions will not be implemented if an unacceptable risk to the public or the environment is identified.

Even with best-practice risk management controls in place, there may be unintended impacts from environmental watering or situations where environmental watering cannot occur as planned. In these situations, it is essential that partners work together to respond to risks and then learn and adapt their management of risks. An agreed approach to incident management has been developed by the VEWH to help program partners report, investigate and respond to risks.

Table 1.3.1 Main shared risks of environmental watering

Type of risk	Example mitigating actions
Environmental watering contributes to third-party impacts	• Identify and understand water system capacities and monitor water levels at key locations to inform daily water release decisions and ensure impacts do not eventuate. • Consider potential catchment run-off from forecast rainfall before deciding on the timing of environmental water releases. • Implement a communication strategy including media releases, public notices and signage before environmental watering, to ensure people are informed of significant environmental water deliveries and can adjust their behaviour accordingly. This includes early liaison with potentially affected stakeholders. • Restrict access by closing gates and tracks.
Inability to achieve or demonstrate ecological outcomes from environmental watering	• Undertake intervention monitoring within available resources to identify the ecological response. • Conduct research to better understand environmental watering responses. • Communicate the outcomes of monitoring and incorporate learnings into future environmental watering.
Environmental watering has negative effects on the environment (for example blackwater, bank erosion and the spread of weeds)	• Monitor outcomes of environmental watering and reassess future deliveries and/or scientific recommendations if necessary. • Plan the timing, frequency, duration and variability of environmental watering to limit conditions that are favourable to non-native plants and animals or which have negative effects.

1.4 Managing available environmental water

Environmental water entitlements are held in 15 water supply systems across Victoria. Sections 2 to 5 detail where the water made available under these entitlements may be delivered in 2016–17.

In this section ...

- **How much water is available to use as part of the Victorian environmental watering program?**
- **What options are available to effectively and efficiently manage environmental water?**

To the extent possible, the VEWH and other environmental water holders attempt to avoid water supply shortfalls through the efficient use of environmental water and by using tools such as carryover and trade. However, if there is still a shortfall of water despite these measures, the VEWH, in collaboration with waterway managers (and other water holders if relevant), must prioritise environmental watering actions.

1.4.1 How much water is available to use as part of the Victorian environmental watering program?

VEWH environmental water entitlements

Environmental water is made available under the environmental water entitlements held by the VEWH. Table 1.4.1 shows the entitlements held by the VEWH as at 30 June 2016, including those held in trust for the Living Murray program. The VEWH's environmental water entitlements can be viewed at http://waterregister.vic.gov.au/water-entitlements/bulk-entitlements.

The water available to use under these entitlements varies from year to year, depending on entitlement rules, seasonal conditions (including rainfall and run-off in the catchments) and the water already available in storages.

Murray crayfish, by Keith Ward, Goulburn Broken CMA

Table 1.4.1 Environmental water entitlements held by the VEWH (as at 30 June 2016)[1]

System	Entitlement	Volume (ML)	Class of entitlement
Gippsland Region			
Latrobe	Latrobe River Environmental Entitlement 2011	N/A[2]	Unregulated
	Blue Rock Environmental Entitlement 2013	18,737[3]	Share of inflow
Thomson	Bulk Entitlement (Thomson River – Environment) Order 2005[4]	10,000	High
Macalister	Macalister River Environmental Entitlement 2010	12,461 6,230	High Low
Central Region			
Yarra	Yarra Environmental Entitlement 2006[4]	17,000 55	High Unregulated
Tarago	Tarago and Bunyip Rivers Environmental Entitlement 2009	3,000[3]	Share of inflow
Werribee	Werribee River Environmental Entitlement 2011	N/A[3]	Share of inflow
Moorabool	Moorabool River Environmental Entitlement 2010[4]	7,086[3]	Share of inflow
Barwon	Barwon River Environmental Entitlement 2011	N/A[2]	Unregulated
Western Region			
Wimmera and Glenelg	Wimmera and Glenelg Rivers Environmental Entitlement 2010[4,5]	40,560 1,000	Pipeline product Wetland product
Northern Region			
Murray	Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999	29,782 3,894 40,000	High Low Unregulated
	Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999 – Barmah-Millewa Forest Environmental Water Allocation	50,000 25,000	High Low
	Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999 – Living Murray	9,589 101,850 34,300	High Low Unregulated
	Environmental Entitlement (River Murray – NVIRP Stage 1) 2012	22,376	High
	Bulk Entitlement (River Murray – Snowy Environmental Reserve) Conversion Order 2004	29,794	High
	Water shares – Snowy Environmental Reserve	14,671 6,423	High Low
Goulburn	Goulburn River Environmental Entitlement 2010	8,851 3,140	High Low
	Environmental Entitlement (Goulburn System – Living Murray) 2007	39,625 156,980	High Low
	Environmental Entitlement (Goulburn System – NVIRP Stage 1) 2012	32,805	High
	Bulk Entitlement (Goulburn System – Snowy Environmental Reserve) Order 2004	30,252 8,156	High Low
	Water Shares – Snowy River Environmental Reserve	8,321 17,852	High Low
	Silver and Wallaby Creeks Environmental Entitlement 2006[4]	0	Passing flow only
Campaspe	Environmental Entitlement (Campaspe River – Living Murray Initiative) 2007	126 5,048	High Low
	Campaspe River Environmental Entitlement 2013	20,652 2,966	High Low
Loddon	Bulk Entitlement (Loddon River – Environmental Reserve) Order 2005[5]	10,970 2,024	High Low
	Environmental Entitlement (Birch Creek – Bullarook System) 2009[4,5]	100	N/A[7]
	Water Shares – Snowy River Environmental Reserve	470	High

1 While the VEWH does not hold any entitlements in the Maribyrnong system, water allocation was purchased in this system (together with Melbourne Water) in 2015–16.
2 Use of these entitlements depends on suitable river heights, as specified in both the Latrobe and Barwon environmental entitlements.
3 Water is accumulated continuously according to a share of inflows (Blue Rock 9%, Tarago system 10.3%, Werribee system 10%, Moorabool system 11.9%) and this volume represents the maximum that can be stored at any time. The actual volume available in any year varies according to inflows.
4 In addition to volumetric entitlement, the entitlement also includes passing flows.
5 In addition to volumetric entitlement, the entitlement also includes unregulated water.
6 This entitlement volume is equal to one-third of the total water savings from the Goulburn-Murray Water Connections Project Stage 1, as verified in the latest audit (including mitigation water).
7 Allocation against this entitlement is made subject to specific triggers, as specified in the entitlement.

Water donations

The VEWH may receive water donations from individuals, community groups and other organisations. This water could be used for environmental watering in the water year it was donated (including for actions identified in the seasonal watering plan), or it could be carried over for use in the future (see section 1.4.2 for more information about carryover). Some donors may identify a specific use for the water they donate (such as environmental watering in a specific wetland or using environmental water to protect a certain tree species). The costs and benefits of each donor proposal is considered by the VEWH. These donations may be authorised by the VEWH if considered environmentally beneficial.

Water available from other environmental water holders

In northern and western Victoria, the VEWH coordinates with other environmental water holders to deliver environmental outcomes at the broader Murray–Darling Basin scale. One of the VEWH's important roles is to coordinate with Murray–Darling Basin environmental water holders (the CEWH, MDBA and program partners in New South Wales and South Australia) to maximise the benefits of all environmental water delivery in Victorian waterways. The seasonal watering plan considers the use of all water holders' water held in Victorian river systems.

Usually, when Commonwealth or Living Murray water is to be delivered in Victoria, the CEWH and MDBA transfer the agreed amount of water to the VEWH. That amount then becomes part of the Victorian environmental water entitlements until used or transferred back.

Table 1.4.2 shows the environmental water entitlements held by the CEWH and MDBA in Victoria. The CEWH and MDBA also hold water in New South Wales and South Australia, which could potentially be made available for environmental watering in Victoria.

Table 1.4.2 Environmental water entitlements held in Victoria by other water holders (as at 31 March 2016)

System	Volume (ML)	Class of entitlement
Living Murray entitlements (held by MDBA)		
Murray	12,267	High-reliability water share
Goulburn	5,559	High-reliability water share
Commonwealth Environmental Water Holdings		
Ovens	70	High-reliability water share
Murray	320,431 25,489	High-reliability water share Low-reliability water share
Broken	253 4	High-reliability water share Low-reliability water share
Goulburn	275,979 29,435	High-reliability water share Low-reliability water share
Campaspe	6,547 395	High-reliability water share Low-reliability water share
Loddon	3,356 527	High-reliability water share Low-reliability water share
Wimmera-Mallee	28,000	Low-reliability product

1.4.2 What options are available to effectively and efficiently manage environmental water?

Other water sources

Environmental water is not the only type of water that can support river, wetland and floodplain health. Waterway managers and environmental water holders, in consultation with storage managers, consider the potential for environmental watering objectives to be met by other types of water. Timing environmental releases can also be combined with other types of water to achieve greater benefits than an environmental release alone could produce.

Other sources of water can include:

- **system operating water** (including passing flows) which maintains a baseflow in many rivers to which environmental water can be added
- **heavy rainfall** (resulting in unregulated flows) which can naturally meet an environmental objective, so water available under environmental water entitlements is not needed
- **alterations to the timing and route for delivery of consumptive water** which, if possible without detriment to consumptive water users, can achieve environmental objectives.

These types of water are considered in the development and implementation of the seasonal watering plan to ensure effective system operations and efficient use of environmental water, and to achieve the maximum benefit to the environment.

Return flows

In some systems, environmental water delivered through upstream sites can be used again downstream. This helps to ensure environmental water is used efficiently and effectively to achieve optimal environmental benefits, as the Goulburn River example below illustrates.

This reuse policy, known as return flows, is available in many systems across northern Victoria. It increases the efficiency of environmental water use and helps reduce the volume of water needed to be recovered for the environment from consumptive water users.

The VEWH's access to return flows is enabled through rules in its environmental water entitlements. Reuse of return flows is also available to the CEWH and MDBA when the VEWH delivers water on their behalf.

Where possible, return flows are reused to provide benefits at Victorian environmental sites. If not needed in Victoria, the VEWH, Living Murray and CEWH return flows will continue to flow across the border to South Australia where they will be used to provide environmental benefits at sites such as the Coorong, Lower Lakes and Murray Mouth area.

Goulburn River: reusing return flows

Environmental water is delivered in the Goulburn River to provide environmental benefits such as stimulating fish to breed and promoting the growth of vegetation on river banks. The water flows down the Goulburn River and into the River Murray. The VEWH can apply to the resource manager (Goulburn-Murray Water) to have the volume of environmental water that reached the River Murray re-credited in its accounts as a return flow. This water can then be reused at a priority environmental site in Victoria (such as at Hattah Lakes near Mildura) or used for River Murray environmental outcomes in South Australia. If the water is to be reused in South Australia, the VEWH trades the re-credited return flow volume to environmental water holders in South Australia.

Carryover

Some entitlements allow the VEWH to carry over unused water to the following water year. This means that water allocated in one year can be kept in storages for use in the following year, subject to certain conditions.

Carryover provides flexibility and enables environmental water to be delivered at a time that is of the greatest value to the environment. For example, carryover can help ensure environmental water holders can meet high winter and spring demands when there is a risk there will be little water available under entitlements at the beginning of the water year.

Carryover can also be used to set water aside to maintain key refuge areas and avoid catastrophic events in drought periods, as the Wimmera and Glenelg systems example below illustrates.

Using carryover to manage risks in dry periods

Inflows to waterways and storages in the Western Region were extremely low in 2014–15. Weather forecasts suggested that conditions would remain very dry leading into 2015–16, with a high likelihood of low water availability.

As a result, program partners weighed up the opportunity cost of carrying water over for future use against using it in that season. They decided to reduce, and in some waterways temporarily cease, environmental watering in the Wimmera and Glenelg systems in autumn 2015 to ensure there was sufficient water available to meet essential needs in 2015–16, through carryover.

Although there were environmental risks associated with ceasing deliveries, they were preferable to the risk of not being able to provide flows in the following summer, when risks to native fish and other animals from poor water quality were expected to be much more significant.

This proved to be a good decision. By summer 2015–16, low inflows to the system meant there was insufficient allocation available to provide refuge habitat for fish and other aquatic biota. Waterway managers were however able to call on the water carried over to meet these needs.

Although there was a decline in water quality, the waterway managers were able to provide habitat at critical times and to minimise the risk of fish kills.

Conservative use of water in 2015–16, coupled with an ongoing dry climatic outlook, means water will again be carried over to meet critical needs in the Wimmera and Glenelg systems in the 2016–17 year.

Water trading

Water trading allows the VEWH to move water to the systems where it is most needed and to smooth out some of the variability in water availability across systems and across years. The VEWH can trade water allocated to its entitlements by:

- administrative water transfers between the VEWH's entitlements
- administrative water transfers with other environmental water holders
- purchasing water allocation
- selling water allocation.

Administrative water transfers are the most common trades the VEWH undertakes. These occur between the VEWH's entitlements (or accounts) to move water to where it is most needed. Other environmental water holders also transfer their water to the VEWH for delivery in Victoria. These types of water trades are often referred to as administrative water transfers as there is no financial consideration associated with the trade.

The VEWH can also buy or sell water allocation where it is in line with the VEWH's statutory objectives: that is, if it benefits the environment. The VEWH has bought or sold a small amount of water allocation each year since it was established in 2011.

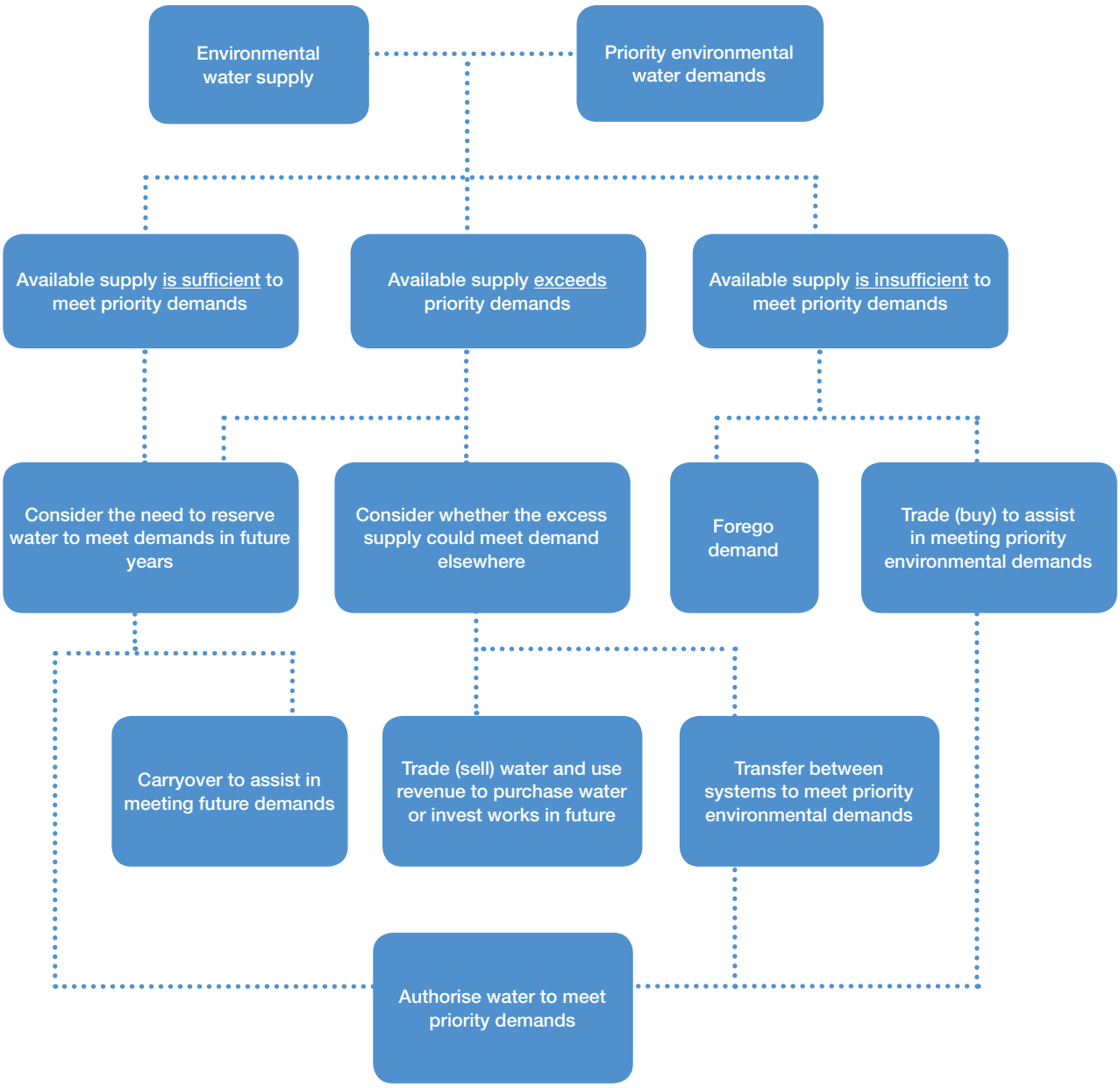
Water has been purchased to enhance environmental outcomes in systems where insufficient environmental water was available, and it has been sold where all foreseeable environmental demands could be met. Revenue raised by selling water allocation can be used to purchase water to meet shortfalls in any Victorian system or to invest in measures such as monitoring, technical or small structural works, or other improvements to the performance of Victoria's environmental watering program.

Subject to the approval of the Minister for Environment, Climate Change and Water, the VEWH can also trade its water entitlements (referred to as a permanent trade). However, no permanent trades have been undertaken to date.

Figure 1.4.1 shows the key considerations guiding the VEWH's use, carryover and trade decisions.

More information about the VEWH's trading activity, including its annual trading strategy, can be found on the VEWH website at www.vewh.vic.gov.au.

Figure 1.4.1 Key considerations guiding use, carryover and trade decisions



Transferring between regions to meet priorities

In 2014 and again in 2015, there was not enough environmental water to provide spring freshes in the Thomson River to encourage the migration of juvenile Australian grayling. In both those years, the VEWH decided to transfer environmental water from the Yarra system to the Thomson system to deliver on this environmental watering priority.

Australian grayling spawn in downstream reaches of coastal river systems. The juvenile fish then spend time in the sea before migrating back upstream. Flows of specific duration and magnitude are required to trigger both the spawning and the returning migration. In recent years, there have been regular spawning opportunities provided for Australian grayling in the Thomson River, and monitoring showed that successful spawning and recruitment of Australian grayling had occurred. However, except for 2014, flows that trigger the return of juvenile Australian grayling to the upstream reaches had been absent since 2010–11.

Unused environmental water had been carried over in the Yarra system from previous years, and there was sufficient water remaining to provide the planned environmental watering in the Yarra system that year. A risk assessment determined that the transfer posed a low risk to achieving environmental outcomes in the Yarra system but would provide benefits in the Thomson system.

These transfers are an example of how water may be prioritised across different regions. It also shows how use, carryover and trade decisions can optimise the value of available water across the state to achieve environmental outcomes.

Water dragon, by East Gippsland CMA

Section 2

Gippsland Region

2.1 Gippsland Region overview

There are four systems in the Gippsland Region that can receive water from the VEWH's environmental entitlements: the Latrobe (including the Latrobe River and lower Latrobe wetlands), Thomson, Macalister and Snowy systems.

The Macalister and Thomson rivers are tributaries of the Latrobe River. The Macalister flows into the Thomson near Sale. The Thomson joins the Latrobe shortly downstream, where it flows past the Latrobe wetlands (Sale Common, Heart Morass and Dowd Morass) before entering Lake Wellington. These waterways and wetlands contain a range of environmental values and support irrigated agriculture, tourism and industry.

The Snowy River flows south from the Snowy Mountains in New South Wales and into Victoria and Bass Strait. Storages in the Snowy Mountains Hydro-electric Scheme are connected to the Murray and Murrumbidgee systems via a network of tunnels, pipelines and aqueducts through which water from the Snowy is transferred to supply irrigated agriculture in the Murray–Darling Basin.

Seasonal outlook 2016–17

Environmental water available for use in the Latrobe, Thomson and Macalister systems is held in Blue Rock Reservoir, Thomson Reservoir and Lake Glenmaggie respectively.

The Thomson system receives a secure annual allocation, which is available on 1 July each year. Water availability in the Thomson system may be bolstered by the recovery of an additional 8,000 ML of environmental water in 2016–17. In the Latrobe and Macalister systems, water availability depends more on seasonal conditions. Most inflows occur in winter and spring, so more will be known early in 2016–17.

Under moderate streamflow forecasts, environmental water is expected to be available to achieve the highest-priority watering actions in the Latrobe, Thomson and Macalister rivers. If necessary, additional water may be sought via transfers from within the Gippsland system or from another region.

The Latrobe wetlands receive most water from natural and unregulated flows. Water can also be actively diverted from the Latrobe River into Sale Common, Heart Morass or Dowd Morass when river levels are appropriate.

Planning and delivery of environmental water in the Snowy system is managed by the New South Wales Department of Primary Industries, which consults the Victorian and Australian governments and stakeholder groups about environmental water released to the Snowy River.

Australian grayling, by David Dawson

2.2 Latrobe system

Waterway manager – West Gippsland Catchment Management Authority

Storage manager – Southern Rural Water

Environmental water holder – Victorian Environmental Water Holder

The Latrobe system (which includes the Latrobe River and lower Latrobe wetlands) is one of the most modified rivers in Victoria, yet it still supports plant and animal species of high conservation significance including several threatened vegetation types and waterbird, fish and frog species. The Latrobe River also provides an essential source of freshwater to the Ramsar-listed Gippsland Lakes site, of which the lower Latrobe wetlands are an important component.

Engagement

Table 2.2.1 shows the partners and stakeholder organisations with which West Gippsland CMA engaged when preparing the Latrobe system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional waterway strategies and environmental flow studies, which include environmental, cultural, social and economic considerations.

Table 2.2.1 Partners and stakeholders engaged in developing the Latrobe system seasonal watering proposal

Partner and stakeholder engagement
• Wetlands Environmental Taskforce, a registered environmental organisation that purchases and restores wetlands in Australia
• Field and Game Australia
• Southern Rural Water
• Parks Victoria
• Victorian Environmental Water Holder

2.2.1 Latrobe River

Environmental values

The Latrobe River contains estuarine and freshwater fish species including the black bream, Australian bass, grayling and short- and long-finned eel. Along the banks in the lower reaches there are intact stands of swamp scrub, an endangered vegetation type that is characterised by dense stands of swamp paperbark and tea tree. The upstream reaches contain some continuous stands of river red gums and a tall shrub layer. Mature river red gums are also adjacent to the lower Latrobe wetlands and provide nesting habitat for birds of prey (such as sea eagles) that hunt in the wetlands.

Social and economic values

The Latrobe Valley is the centre of Victoria's energy industry and water from the Latrobe River is essential for electricity generation. The lower Latrobe River is commercially fished for eel and carp. It also contains black bream and estuary perch, which are favoured by recreational fishers. The waterways in the Latrobe system hold significance for Traditional Owners. Waterways and wetlands in the region are important ceremonial places and for thousands of years the Latrobe River has provided resources such as food and materials to the Gunaikurnai people.

Environmental watering objectives in the Latrobe River	
	Enable formation of in-stream bars to help stabilise the structure and condition of the river channel. This will help to reduce the load of sediment and nutrients flowing into the Gippsland Lakes
	Establish native plants on bars and lower parts of the banks to stabilise the river channel
	Improve habitat for native fish including black bream and estuary perch

System overview

The Latrobe River originates on the Mount Baw Baw Plateau and flows into Lake Wellington, the westernmost point of the Gippsland Lakes. The upper Latrobe River is relatively intact, but the lower Latrobe River that flows through the Latrobe Valley is degraded due to historic river management practices. Most snags have been removed from the river and many sections have been artificially straightened. This reduces the diversity of habitat that aquatic plants and animals depend on.

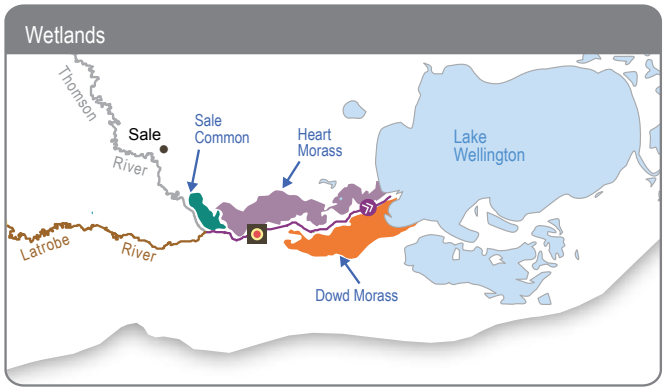
Environmental water is supplied from Blue Rock Reservoir on the Tanjil River. The reservoir also supplies water for other entitlement holders (such as the electricity generators in the Latrobe Valley).

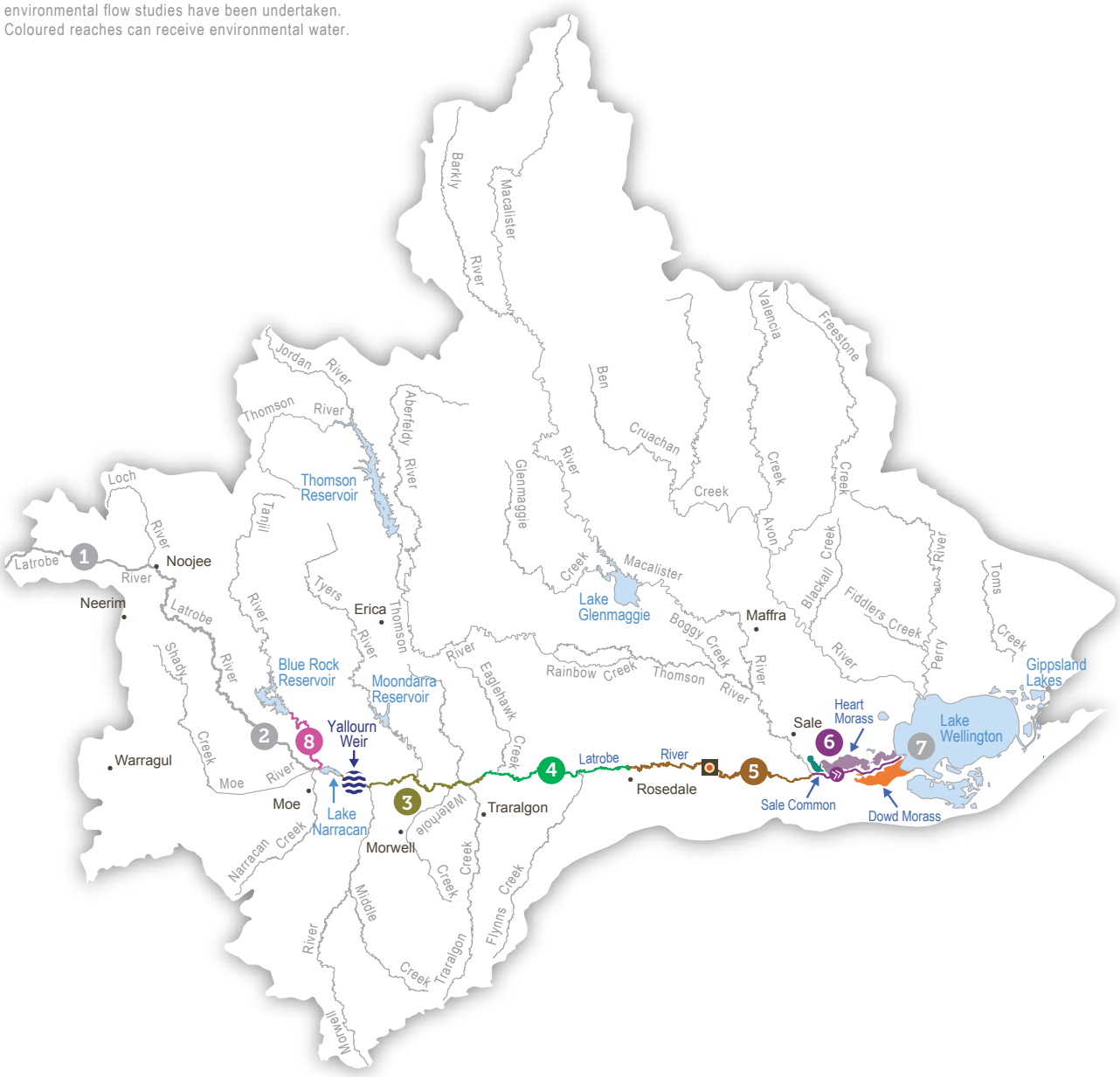
The Latrobe River from Rosedale to the Thomson River confluence (reach 5) is the priority for environmental watering because it contains endangered plant communities that have good potential for recovery. With an appropriate water regime it is possible to improve the quality of riparian vegetation. This in turn stabilises the river banks and provides improved habitat that has been lost due to historic efforts to straighten the channel and remove snags.

Figure 2.2.1 The Latrobe system

Reach 1 Upstream of Willow Grove
Reach 2 Willow Grove to Lake Narracan
Reach 3 Lake Narracan to Scarnes Bridge
Reach 4 Scarnes Bridge to Rosedale
Reach 5 Rosedale to Thomson River confluence
Reach 6 Downstream of Thomson confluence
Reach 7 Lake Wellington
Reach 8 Tanjil River
Water infrastructure
Measurement point
Town
Indicates direction of flow

Grey river reaches have been included for context.
The numbered reaches indicate where relevant environmental flow studies have been undertaken.
Coloured reaches can receive environmental water.





Recent conditions

Rainfall for the Latrobe River catchment was lower-than-average in 2015–16, mostly due to a particularly dry spring. Although winter and spring were relatively dry, Blue Rock Reservoir was full at the start of the water year and spills occurred in winter and spring. The largest flow occurred in September 2015 and this caused minor flooding of the lower Latrobe River.

An autumn fresh of 1,300 ML per day was delivered from Blue Rock Reservoir in April and May 2015. The flow was delivered to improve vegetation condition and channel structure in the Latrobe River, and to improve water quality by flushing a salt wedge that forms in the lower Latrobe in summer and autumn when flows are low.

An exciting finding from 2014–15 was the capture of Australian grayling eggs during an environmental flow in autumn. The eggs were found in a reinstated meander bend. West Gippsland CMA has undertaken work to re-engage several meander bends in the Latrobe River which had flow diverted due to historical channel straightening and widening. The meander where the eggs were found has a gravel river bed, which is favourable habitat for Australian grayling spawning that has been degraded in most of the Latrobe River.

The environmental flow was not intended for Australian grayling spawning and further research is required to determine the significance of the finding and to inform future environmental recommendations for the Latrobe River.

Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 2.2.2.

Table 2.2.2 Potential environmental watering actions and objectives for the Latrobe River

Potential environmental watering	Environmental objectives
Spring/summer freshes (1,300 ML/day for 2–4 days in September–February)	• Improve vegetation diversity, condition and abundance along lower banks and increase recruitment of in-stream vegetation
Autumn/winter freshes (1,300 ML/day for 2–4 days in March–August)	
Winter/spring baseflows (690–1,500 ML/day from June–November)	• Facilitate the formation of in-stream bars (elevated deposits of sediment and gravel in the river channel)
Summer/autumn baseflows (up to 690 ML/day from December–May)	• Provide in-stream habitat for aquatic biota (especially waterbugs, fish and vegetation)

Scenario planning

Table 2.2.3 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

The long-term aim for the Latrobe River is to rehabilitate vegetation and improve the channel structure. Spring freshes are very important to achieve these objectives: they improve the growth of riparian vegetation which stabilises banks and increases habitat.

Climate and rainfall from July to November is therefore an important consideration in deciding when to use environmental water to meet vegetation objectives. In a dry year there is likely to be low natural achievement of spring and early summer freshes, so environmental water will be delivered to supplement flows, to achieve the desired flow rates for riparian vegetation.

If good inflows occur in winter and spring, Blue Rock Reservoir will spill and most spring priorities will be delivered naturally. If natural flows occur then environmental water will not be needed for spring releases and water can be reserved for use in late summer and autumn.

Dowd Morass, by West Gippsland CMA

Table 2.2.3 Potential environmental watering for the Latrobe River under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Small contributions from unregulated reaches and tributaries of the Latrobe River with little opportunity for freshes to occur naturally • Consumptive demand from Blue Rock Reservoir will be very high and regular releases to the Tanjil River will contribute substantially to baseflows	• There will be some unregulated flows that contribute to baseflows and freshes, but extended periods of high flows will be absent and freshes will be infrequent • Consumptive demand from Blue Rock Reservoir will be high and contribute to baseflows	• Unregulated flows will provide baseflows and multiple freshes, most likely in winter and spring • A moderate amount of spills are likely and there will be releases for consumptive users which will partially contribute to baseflows	• Multiple spills from Blue Rock Reservoir will provide extended durations of high flows and overbank flows • No significant releases from consumptive entitlements in Blue Rock Reservoir are likely
Expected availability of environmental water	• 16,200 ML	• 18,200 ML	• 18,700–23,200 ML	• 18,700–31,200 ML
Potential environmental watering	• 1 spring/summer fresh • 1 autumn/winter fresh • Winter/spring baseflows	• Up to 3 spring/summer freshes • Up to 2 autumn/winter freshes • Winter/spring baseflows • Summer/autumn baseflows	• Up to 3 spring/summer freshes • Up to 2 autumn/winter freshes • Winter/spring baseflows • Summer/autumn baseflows	• Up to 4 spring/summer freshes • Up to 4 autumn/winter freshes • Winter/spring baseflows • Summer/autumn baseflows
Possible volume of environmental water required to achieve objectives	• 12,300 ML	• 11,200 ML	• 15,900 ML	• 0–11,000 ML

Risk management

In preparing its seasonal watering proposal, West Gippsland CMA considered and assessed risks, and identified mitigating strategies, relating to implementing environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

2.2.2 Lower Latrobe wetlands

Environmental values

The Latrobe River provides a large source of freshwater to the Gippsland Lakes Ramsar site, of which the lower Latrobe wetlands are an important component. The lower Latrobe wetlands (Dowd Morass, Heart Morass and Sale Common) provide a variety of habitats that suit a range of different birds at different times. For example, colonial waterbirds (such as royal spoonbill and straw-necked and Australian white ibis) find breeding habitat among swamp paperbark trees in spring. Over summer during a drying phase, the mudflats provide feeding habitat for migratory shorebirds (such as sandpipers). Open water is important year-round for waterfowl and fish-eating birds (such as egrets).

In recent years, rare and threatened species (such as the freckled duck and green and golden bell frog) have been found at Heart Morass.

Social and economic values

Sale Common is a state game refuge located close to the town of Sale that provides an excellent opportunity to observe native plants and animals. Dowd Morass is a state game reserve commonly used by hunters, and Heart Morass consists of mostly private landholdings and is also used by hunters. An appropriate water regime in the lower Latrobe wetlands increases waterbird abundance and provide opportunities for bird watching and hunting when the wetlands are in a wet phase.

The lower Latrobe wetlands hold significance for Traditional Owners. Waterways and wetlands in the region are important ceremonial places and for thousands of years the lower Latrobe wetlands have provided resources such as food and materials to the Gunaikurnai people.

Environmental watering objectives in the lower Latrobe wetlands

	Promote dispersal and germination of wetland plants
	Provide habitat for waterbirds
	Control carp abundance, particularly at Sale Common and Dowd Morass

System overview

The lower Latrobe wetlands are Sale Common, Dowd Morass and Heart Morass. The wetlands are on the floodplain of the Latrobe River between its confluence with the Thomson River and Lake Wellington.

River regulation and water extraction from the Latrobe, Thomson and Macalister rivers has reduced the frequency of small- and medium-sized floods that naturally inundate the

wetlands. This problem is worsened by saline water intrusion into Dowd Morass and Heart Morass from Lake Wellington. Construction of levees and drains and the filling in of natural depressions have also altered water movement in and through the wetlands. However, the drainage and flooding regime in all three wetlands can be managed to some extent through the use of regulators connected to the Latrobe River.

Recent conditions

Natural flows to the wetlands were infrequent and small-scale in 2015–16. This resulted in a substantial drawdown of Sale Common and Heart Morass. A partial drawdown of Dowd Morass also occurred, but the extent of the drying was tempered by a small unregulated flow to Dowd Morass in September 2015.

The widespread drying was welcome because in previous years the Latrobe wetlands were continuously inundated, and only partial drawdowns occurred each summer. The drying improved vegetation diversity by allowing plants to germinate on exposed mudflats. It also provided some control of carp.

Waterfowl counts in autumn were lower than in previous years. This was partially attributable to the wetland drying that occurred. It was also a consequence of dryer conditions across all of south-east Australia, meaning that waterfowl were less abundant than usual.

An autumn wetting flow was delivered to Heart Morass in March to June 2016 to provide seed dispersal and support opportunities for waterbirds. This was the first time that water has been actively delivered to Heart Morass using the environmental entitlement for the Latrobe wetlands.

Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 2.2.4.

Table 2.2.4 Potential environmental watering actions and objectives for the lower Latrobe wetlands

Potential environmental watering	Environmental objectives
Sale Common	
Partial, substantial or complete drawdown (primarily August–March)	• Promote oxygenation of surface soils, breakdown of accumulated organic matter and nutrient recycling • Encourage the growth and reproduction of wetland plants across the wetland bed • Reduce the number and size of European carp
Wetting flow (February–May)	• Provide feeding and sheltering habitat for wetland animals, particularly waterbirds and frogs • Discourage the spread of giant rush
Partial wetting flow (August–November)	• Encourage the growth and reproduction of wetland plants, particularly tall marsh, aquatic herbland and aquatic sedgeland • Provide feeding and breeding habitat for wetland animals, particularly waterbirds and frogs
Wetting flow (anytime)	• Mimic the natural inundation regime • Control invasive vegetation
Dowd Morass and Heart Morass	
Partial drawdown (primarily August–March)	• Promote oxygenation of surface soils, breakdown of accumulated organic matter and nutrient recycling • Encourage the growth and reproduction of wetland plants, particularly swamp shrub, tall marsh, aquatic herbland and brackish herbland • Reduce the number and size of European carp
Wetting flow (February–May)	• Provide feeding habitat for wetland animals, particularly waterbirds
Wetting flow (anytime)	• Avoid/mitigate risks to wetland plants and waterbird habitat from adverse salinity and exposure of acid sulphate sediment • Mimic the natural inundation regime
Partial wetting flow (August–November)	• Encourage colonial waterbird breeding • Reduce salinity • Encourage the growth and reproduction of wetland plants, particularly swamp scrub, tall marsh, aquatic herbland and brackish herbland • Provide feeding and breeding habitat for wetland animals, particularly waterbirds and frogs

Scenario planning

Table 2.2.5 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

Natural flows are very influential in the Latrobe wetlands. In a drought and dry year, extensive drawdowns will occur in all three wetlands. Partial drawdowns will occur in an average year, but if conditions are wet the ability to manage drawdown is diminished, and uncontrolled flows will provide widespread inundation throughout the year.

The approach in 2016–17 is to allow water levels to fluctuate according to natural seasonal conditions. At times some selective small-scale flooding and drainage may be managed to amplify the natural conditions and improve environmental outcomes. Short-duration wetting flows may be delivered at any time when water is needed to mitigate risks of salinity and acid sulphate soils or to provide habitat for waterbirds.

Table 2.2.5 Potential environmental watering for the lower Latrobe wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected catchment conditions	• No natural flows from the Latrobe River • Wetlands are likely to dry completely		• Moderate winter and spring flows and flushing flows • Wetlands could be filled or partially filled with a minor drawdown in summer	• Major flows in winter/spring and possibly autumn/winter • Wetlands will be filled naturally with very little drawdown over summer
Sale Common				
Potential environmental watering	• Complete drawdown (July–June) • Wetting flows (anytime)	• Substantial drawdown (August–April) • Wetting flows (anytime) • Wetting flows (February–May)	• Wetting flows (August–November) • Partial drawdown (August–March) • Wetting flows (anytime) • Wetting flows (February–May)	• Flushing/wetting flows (August–November) • Partial drawdown (December–March) • Wetting flows (February–May) • Wetting flows (anytime)
Possible volume of environmental water required to achieve objectives	• 0–1,300 ML	• 0–1,300 ML	• 1,300 ML	• 0 ML
Dowd Morass				
Potential watering actions	• Complete drawdown (July–June) • Wetting flows (anytime)	• Wetting flows (anytime) • Substantial drawdown (August–April) • Wetting flows (February– May)	• Wetting flows (August–November) • Wetting flows (anytime) • Substantial drawdown (August–March) • Wetting flows (February–May)	• Flushing/wetting flows (August–November) • Partial drawdown (December–March) • Wetting flows (February–May) • Wetting flows (anytime)
Possible volume of environmental water required to achieve objectives	• 0–5,800 ML	• 0–5,800 ML	• 5,800 ML	• 0 ML
Heart Morass				
Potential watering actions	• Complete drawdown (July–June) • Wetting flows (anytime)	• Wetting flows (anytime) • Partial drawdown (August–April) • Wetting flows (February–May)	• Wetting flows (August–November) • Partial drawdown (August–March) • Wetting flows (February–May) • Wetting flows (anytime)	• Flushing/wetting flows (August–November) • Partial drawdown (December–March) • Wetting flows (February–May) • Wetting flows (anytime)
Possible volume of environmental water required to achieve objectives	• 0–7,100 ML	• 0–7,100 ML	• 7,100 ML	• 0 ML

Risk management

In preparing its seasonal watering proposal, West Gippsland CMA considered and assessed risks, and identified mitigating strategies, relating to implementing environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

2.3 Thomson system

Waterway manager – West Gippsland Catchment Management Authority

Storage managers – Melbourne Water (Thomson Reservoir), Southern Rural Water (Cowarr Weir)

Environmental water holder – Victorian Environmental Water Holder

Environmental values

Australian grayling are a threatened fish species and the focus of environmental watering in the Thomson River. Australian grayling are known to spawn in response to autumn high flows, and the eggs and juveniles spend time at sea before returning to the freshwater sections of coastal rivers. In addition to Australian grayling a further six migratory fish species are found in the Thomson including the common galaxias, tupong and short-finned eel.

Vegetation is intact and near-natural upstream of Thomson Reservoir in the Baw Baw National Park. Riparian vegetation upstream of Cowwarr Weir is mostly in good condition, but infestations of blackberry and gorse are widespread. Downstream of the Cowwarr Weir, the vegetation is degraded due to stock access and widespread weed invasion.

Social and economic values

Thomson Reservoir is very important because it is the largest storage in Melbourne's water supply system. The system also supplies water to irrigators and towns in Gippsland.

The Thomson River downstream of Thomson Reservoir is popular for canoeing and kayaking. West Gippsland CMA provides flow information before releases so that people can safely take advantage of the improved paddling conditions provided by environmental water.

The waterways in the Thomson system (including the Thomson River) continue to hold significance for Traditional Owners. Waterways and wetlands in the region are important ceremonial places and for thousands of years the Thomson River has provided resources such as food and materials to the Gunaikurnai people.

Environmental watering objectives in the Thomson system

	Protect and boost populations of native fish, specifically Australian grayling, by providing pool habitat and flows for fish to move upstream and downstream, and by encouraging fish to spawn
	Scour silt build-up within the river bed to provide increased and diverse habitat for plants and animals to colonise
	Provide water for plant life to germinate, establish and grow on the river bank

System overview

The Thomson River flows from the slopes of Mt Whitelaw on the Baw Baw Plateau to join the Latrobe River south of Sale. The major tributaries of the Thomson River are the Aberfeldy, Jordan and Macalister rivers, with most unregulated flows originating from the Aberfeldy River.

Environmental water in the Thomson system is held in Thomson Reservoir. Reach 3 of the Thomson River (from the Aberfeldy River confluence to Cowwarr Weir) is the priority for environmental watering due to its heritage river status, relatively intact native riparian vegetation, high-quality in-stream habitat and low abundance of exotic fish species.

At Cowwarr Weir, the Thomson River splits in two and water can move down the old Thomson River course (reach 4a) and Rainbow Creek (reach 4b). The preference is to pass environmental water down the old Thomson course to enable fish migration, as Cowwarr Weir prevents migration through Rainbow Creek.

Recent conditions

In 2015–16 summer rainfall was near-average, but in the important winter and spring inflow periods, rainfall and river flows were well-below-average. Rainfall in autumn was also below-average. Despite the dry conditions there was sufficient environmental water available to deliver water to give Australian grayling and other fish species an opportunity to migrate and spawn. This was supported by a transfer of water from the Yarra system.

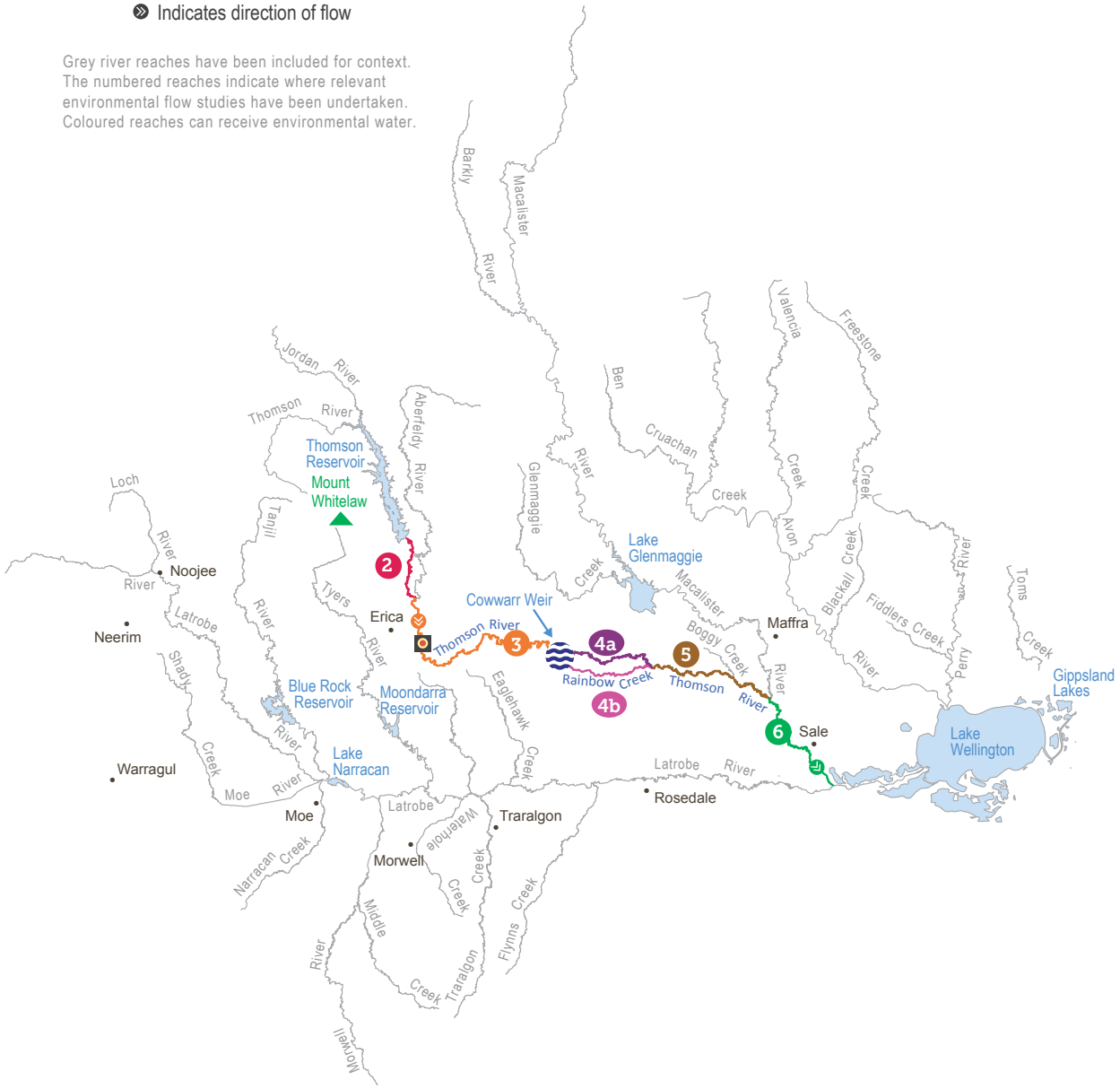
In 2015 the Australian grayling spawning response was the best ever recorded in this system, corresponding to the release of an autumn fresh in the Thomson River. Spawning responses were also observed in the previous three years and there is high certainty that flows of a specific magnitude and duration will elicit a spawning response.

Bankfull flows and winter freshes have not occurred often in recent years because the Thomson Reservoir substantially reduces the duration and frequency of high-volume flows. While these flows are important, there is insufficient water held in the Thomson River entitlement to provide them in addition to the highest-priority flows in spring and autumn.

Figure 2.3.1 The Thomson system

Reach 2 Thomson River: Thomson Dam to Aberfeldy River
Reach 3 Thomson River: Aberfeldy River to Cowwarr Weir
Reach 4a Old Thomson River: Cowwarr Weir to Rainbow Creek
Reach 4b Rainbow Creek: Cowwarr Weir to Thomson River
Reach 5 Thomson River: Rainbow Creek/Old Thomson confluence to Macalister River
Reach 6 Thomson River: Macalister River to Latrobe River
Water infrastructure
Measurement point
Town
Indicates direction of flow

Grey river reaches have been included for context. The numbered reaches indicate where relevant environmental flow studies have been undertaken. Coloured reaches can receive environmental water.



Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 2.3.1.

Table 2.3.1 Potential environmental watering actions and objectives for the Thomson River

Potential watering actions	Environmental objectives
Spring freshes (1–2 freshes of 800 ML/day for 4 days each in September–October)	• Provide a migration cue for juvenile Australian grayling • Inundate and regenerate riparian vegetation • Scour sediment exposing fresh habitat areas
Spring baseflows (230 ML/day from October–November)	
Autumn freshes (1–2 freshes of 600–800 ML/day for 4 days each in April–May)	• Provide a migration and spawning cue for Australian grayling and other aquatic species • Inundate and regenerate riparian vegetation • Scour sediment exposing fresh habitat areas
Autumn/winter baseflows (230 ML/day from May–June)	
Winter freshes (up to 4 freshes of 800 ML/day for 4 days in June–August)	• Maintain/enhance the native fish community structure by providing opportunities for localised fish movement between habitats
Summer/autumn freshes (up to 7 freshes of 230 ML/day for 4 days in December–April)	• Maintain/enhance the native fish community structure by providing habitat availability, large woody debris inundation • Inundate and regenerate riparian vegetation • Scour sediment exposing fresh habitat areas

Scenario planning

Table 2.3.2 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

The highest priority in the Thomson River is to provide flows to promote spawning (in autumn) and recruitment (in spring) of Australian grayling. Australian grayling live for about three years, so it is important to provide optimal spawning conditions at least every two out of three years to maintain their long-term viability. Similarly, it is important to provide spring recruitment flows two out of every three years to attract juvenile Australian grayling into the Thomson River to sustain the local population.

Spawning flows have been delivered successfully for the last seven years in succession and great results have been achieved. Recruitment flows have been provided for the last two years. While the delivery of spawning and recruitment flows in consecutive years reduces the urgency to provide them in 2016–17, recruitment flows in spring are prioritised first because they were infrequent before the last two years.

In drought conditions, releases will focus on the delivery of baseflows in winter and spring to maintain suitable aquatic and riparian habitat. Spawning and recruitment flows are not delivered in a drought scenario.

In dry conditions and subject to water availability, spring freshes will be released along with baseflows to provide conditions for juvenile Australian grayling recruitment. Savings of water under drought and dry conditions will be carried over into 2017–18, by which time spawning and recruitment will be important to maintain the Australian grayling population.

If unregulated river flows are naturally high (such as under the average and wet scenarios), all available water may be used to maximise opportunities for Australian grayling spawning and recruitment. Matching releases with natural high-flow conditions will also improve habitat by scouring sediment and regenerating riparian vegetation.

Walhalla bridge, by West Gippsland CMA

Table 2.3.2 Potential environmental watering for the Thomson system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Unregulated flows very limited • Large volumes of consumptive water released from storage	• Unregulated flows from the Aberfeldy River and other tributaries contribute to baseflows and freshes • Moderate volumes of consumptive water released from storage	• Unregulated flows from the Aberfeldy River and other tributaries contribute to baseflows, freshes and high flows • Some consumptive water released from storage	• Unregulated flows from the Aberfeldy River and other tributaries contribute to baseflows, freshes and sustained high flows • Possible spills from Thomson Reservoir and minimal consumptive water released from storage
Expected availability of environmental water[1]	• 10,000–12,000 ML	• 10,000–14,000 ML	• 10,000–18,000 ML	• 18,000–23,000 ML
environmental watering – tier 1 (high priorities)	• Spring and autumn baseflows	• One spring fresh • Spring and autumn baseflows	• Two spring freshes • Spring and autumn baseflows • One autumn fresh	• Two spring freshes • Spring and autumn baseflows • One autumn fresh • One winter fresh
Potential environmental watering – tier 2 (additional priorities)	• One spring fresh • One autumn fresh • One summer fresh	• One autumn fresh • One summer fresh	• One winter fresh • One autumn fresh • One summer fresh	• One winter fresh • One summer fresh
Possible volume of environmental water required to achieve objectives[2]	• 5,600 ML (tier 1) • 8,900 ML (tier 2)	• 9,400 ML (tier 1) • 5,100 ML (tier 2)	• 18,000 ML (tier 1) • 10,000 ML (tier 2)	• 23,000 ML (tier 1) • 5,300 ML (tier 2)
Priority carryover requirements	• 4,600 to 6,400 ML		• 0 ML	

1 The first 10,000 ML of Thomson Reservoir inflows is allocated to the environment at the beginning of the water year. An additional 8,000 ML may be available in the system, subject to an entitlement amendment being completed to facilitate its use.

2 Environmental water requirements for tier 2 actions are additional to tier 1 requirements.

Risk management

In preparing its seasonal watering proposal, West Gippsland CMA considered and assessed risks, and identified mitigating strategies, relating to implementing environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 2.3.3 shows the partners with which West Gippsland CMA engaged when preparing the Thomson system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional waterway strategies and environmental flow studies, which include environmental, cultural, social and economic considerations.

Table 2.3.3 Partners engaged in developing the Thomson system seasonal watering proposal

Stakeholder engagement
• Southern Rural Water
• Melbourne Water
• Victorian Environmental Water Holder

2.4 Macalister system

Waterway manager – West Gippsland Catchment Management Authority

Storage manager – Southern Rural Water

Environmental water holder – Victorian Environmental Water Holder

Environmental values

There are seven migratory native fish species in the Macalister River that move between freshwater and marine environments to complete their life cycle. These are the Australian grayling, short- and long-finned eel, tupong, Australian bass, short-headed lamprey and common galaxias.

Along the river banks there are some areas of dense woody riparian vegetation dominated by shrubs. Where livestock is excluded, vegetation is in good condition: elsewhere it is degraded. The non-woody plants that colonise the fringes of the river (such as reeds, sedges and rushes) have declined in recent years, as has in-stream vegetation. While the reason for the decline is uncertain, water turbidity, erosion and lack of flow variability are thought to have an effect.

Social and economic values

The Macalister Irrigation District is the major economic driver in the area and water from the Macalister system is highly valued by the local community. As a result, there is a genuine interest in the health of the Macalister River, particularly about water quality, erosion and vegetation condition. People also use the river for recreational fishing and bird watching. The waterways in the Macalister system (including the Macalister River) continue to hold significance for Traditional Owners. Waterways and wetlands in the region are important ceremonial places and for thousands of years the Macalister River has provided resources such as food and materials to the Gunaikurnai people

Environmental watering objectives in the Macalister system

	Protect and boost populations of native fish (including Australian grayling, tupong and Australian bass) prompting fish to move upstream and downstream and between the river and the ocean, and to spawn
	Enable plants to germinate, establish and grow on the river bank
	Restore communities of waterbugs, which break down organic matter, provide a source of food for other animals and support the river's food chain

System overview

The Macalister River flows from Mt Howitt in the Alpine National Park to join the Thomson River south of Maffra. It mostly flows through cleared floodplain that is used for dairy farming. Lake Glenmaggie is the single major storage and supplies water to the Macalister Irrigation District, with flows regulated at Maffra Weir. Environmental water is stored in Lake Glenmaggie.

Before Lake Glenmaggie was built, the Macalister River would regularly receive large floods in winter and spring. Although Lake Glenmaggie regularly spills, floods are now less common. A notable impact from irrigation and water harvesting is reversed seasonality of flows between Lake Glenmaggie and Maffra Weir, where higher-than-natural summer flows occur due to the delivery of irrigation water. In the same reach, flows are lower-than-natural in the water harvesting period in winter. Downstream of Maffra Weir most flows are diverted for irrigation in summer and autumn. The changed hydrology affects the migration of fish as well as the growth and dispersal of aquatic and riparian plants.

Maffra Weir prevents fish passage from upstream and downstream of the weir and the priority reach for fish migration flows is therefore reach 2 which is downstream of Maffra Weir to the confluence with the Thomson River. Non-fish objectives can be achieved in both reaches 1 and 2.

Recent conditions

In 2015-16 inflows to Lake Glenmaggie were lower than the average of the last 10 years. While this reduced the magnitude of spills that typically occur in winter and spring, water allocations were sufficient to provide most of the planned environmental watering.

Winter baseflows were delivered in July 2015 using carryover water. Spills from Lake Glenmaggie in July–August were managed by the storage manager, Southern Rural Water, to align with winter environmental flow recommendations. Multiple autumn freshes, a winter fresh and winter baseflows were delivered in April–June 2016.

Figure 2.4.1 The Macalister system

Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 2.4.1.

Table 2.4.1 Potential environmental watering actions and objectives for the Macalister system

Potential environmental watering	Environmental objectives
Macalister River reaches 1 and 2	
Autumn/winter baseflows (35–90 ML/day in May–July)	• Provide habitat for waterbugs and for local movement of fish • Maintain water quality in pools and connectivity for platypus • Provide slow-moving water for submerged aquatic vegetation
Spring fresh (1,500 ML/day for 3–5 days in September–October)	• Provide variability in water levels and wet the fringing woody vegetation
Macalister River reach 2	
Autumn fresh (350 ML/day for 4–5 days in April–May)	• Promote downstream migration and spawning of Australian grayling
Winter fresh (700 ML/day for 4–5 days in June–August)	• Promote downstream migration and spawning of tupong and Australian bass
Spring/summer fresh (700 ML/day for 5 days in September–December)	• Promote upstream migration opportunities for adults and juveniles of multiple fish species
Summer/autumn fresh (140 ML/day for 3 days in December–May)	• Flush pools to maintain water quality for invertebrates • Provide water-level variability for emergent vegetation

Scenario planning

Table 2.4.2 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

The highest priority in 2016–17 is to provide flows that prompt migration, spawning and recruitment of native fish species that migrate between freshwater and estuarine environments, particularly the Australian grayling, Australian bass and tupong.

In drought conditions an autumn fresh will be provided for Australian grayling and a winter fresh will be provided for tupong, with any remaining water being utilised to continue winter baseflows. It is important to deliver a spawning flow for Australian grayling in a drought year because if conditions are dry a spawning flow may not be delivered in the Thomson River. This will also provide an opportunity to test if Australian grayling will successfully spawn with a release from the Macalister alone.

Autumn flows also remain a high priority when conditions are dry because these are the most impacted flows in reach 2, where most water is diverted for irrigation.

As water availability increases in dry and average conditions, spring and summer freshes will be delivered. The highest-priority spring freshes will provide a cue for juvenile Australian grayling, tupong, adult eels and short-headed lampreys to return upstream from estuarine and marine habitats.

In a wet year water will be available to provide summer freshes that provide connectivity all the way through reach 2. It will also be possible to increase the duration of some releases in line with wet-season flow recommendations.

Carryover of some water into July 2017 is a high priority under all conditions to provide baseflows through reaches 1 and 2 outside the irrigation season.

Macalister River, by West Gippsland CMA

Table 2.4.2 Potential environmental watering for the Macalister system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No unregulated flows • Passing flows at Maffra Weir reduced	• Possible spills from Lake Glenmaggie in spring, minor flood levels may occur • Passing flows at Maffra Weir may be reduced	• Regular spills from Lake Glenmaggie in spring, minor flood levels may occur • Passing flows at Maffra Weir may be reduced, with savings accrued in summer for use in autumn	• Large and frequent spills from Lake Glenmaggie, moderate to major flood levels may occur • Passing flows at Maffra Weir may be reduced, with savings accrued in summer for use in autumn
Expected availability of environmental water	• 9,400 ML	• 13,000 ML	• 14,400 ML	• 22,600 ML
Potential environmental watering – tier 1 (high priorities)	• One autumn fresh • One winter fresh • Autumn/winter baseflows	• One autumn fresh • One winter fresh • One spring fresh • Autumn/winter baseflows	• One autumn fresh • One winter fresh • One spring fresh • Autumn/winter baseflows	• One autumn fresh • One winter fresh • One spring fresh • One summer fresh • Autumn/winter baseflows
Potential environmental watering – tier 2 (additional priorities)	• One spring fresh • One summer fresh	• Increase duration of winter baseflow • One summer fresh	• Increase magnitude of spring fresh • One summer fresh	• Increase duration of spring fresh
Possible volume of environmental water required to meet objectives[1]	• 9,400 ML (tier 1) • 4,600 ML (tier 2)	• 13,000 ML (tier 1) • 1,700 ML (tier 2)	• 13,400 ML (tier 1) • 4,200 ML (tier 2)	• 18,000 ML (tier 1) • 2,900 ML (tier 2)
Priority carryover requirements	• 1,000 to 1,200 ML			

1 Environmental water requirements for tier 2 actions are additional to tier 1 requirements.

Risk management

In preparing its seasonal watering proposal, West Gippsland CMA considered and assessed risks, and identified mitigating strategies, relating to implementing environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 2.4.3 shows the partners, stakeholder organisations and individuals with which West Gippsland CMA engaged when preparing the Macalister system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional waterway strategies, environmental water management plans and environmental flow studies, which include environmental, cultural, social and economic considerations.

Table 2.4.3 Partners and stakeholders engaged in developing the Macalister system seasonal watering proposal

Stakeholder engagement
• Southern Rural Water
• Victorian Environmental Water Holder
• Gippsland Water
• VRFish
• Environment Victoria
• Maffra & Districts Landcare Network
• Native Fish Australia
• Macalister Irrigation District irrigators and diverters
• Gurnaikurnai Land and Waters Aboriginal Corporation
• Wellington Shire Council

2.5 Snowy system

Waterway managers – New South Wales Department of Primary Industries (Water) and East Gippsland CMA

Storage manager – Southern Hydro Limited

Environmental water holder – Victorian Environmental Water Holder and New South Wales Department of Primary Industries (Water)

Environmental values

The Snowy River contains freshwater-dependent fish species in the upper reaches and tributaries (such as the river blackfish and Australian grayling). Fish species that migrate between saltwater and freshwater (such as the estuary perch and Australian bass) occur in the lower reaches. The estuary contains estuarine and saltwater species (such as the flathead, mulloway and black bream). The floodplain wetlands of the Snowy River near Marlo provide feeding and breeding areas for wetland and migratory birds.

Social and economic values

Electricity generation through the Snowy Mountains Hydro-electric Scheme provides substantial economic value and Snowy water supports irrigated agriculture in New South Wales and Victoria. The Snowy River and estuary are a drawcard for the many tourists who enjoy rafting, boating, swimming and recreational fishing.

The waterways of the Snowy system (including the Snowy River) hold significance for the Aboriginal communities in the region. The Snowy River is also an iconic and culturally significant Australian river made famous by Banjo Patterson's poem *The Man from Snowy River*.

System overview

The Snowy River originates on the slopes of Mount Kosciuszko. It drains the eastern slopes of the Snowy Mountains in New South Wales before flowing through the Snowy River National Park in Victoria and emptying into Bass Strait.

There are four major dams and multiple diversion weirs in the Snowy River catchment. The Snowy Mountains Hydro-electric Scheme diverts water to the Murrumbidgee and River Murray valleys and previously resulted in the diversion of 99 percent of the Snowy River's mean annual natural flow at Jindabyne. Travelling downstream, the hydrological effects of the scheme are still substantial but are mitigated by the contribution of flows from tributaries (such as the Delegate River in New South Wales and the Buchan River in Victoria).

While playing an important role in electricity generation and irrigation supply, flow diversion and other activities have affected the river's hydrology and resulted in a significant deterioration in the health of the Snowy River. The Victorian, New South Wales and Commonwealth governments have recovered water (equivalent to 21 percent of the average natural flow) to help restore damage done by decades of limited flow.

Victorian environmental water available for use in the Snowy system is held in the Murray, Goulburn and Loddon systems. This water is made available for environmental flows in the Snowy River via a substitution method, whereby Victorian environmental water replaces water that was earmarked for transfer from the Snowy to Victoria to support irrigation demands.

New South Wales Department of Primary Industries does the planning for environmental flows in the Snowy River, and consults the Victorian and Australian governments and stakeholder groups about environmental water released to the Snowy River.

Recent conditions

In the 2015–16 water year, 147,884 ML of environmental water was released to the Snowy River. The releases aim to rehabilitate the Snowy River below Jindabyne Dam into a smaller but healthy river, recognising that it is not possible to restore the Snowy River to its former size with one-fifth of its former flow volume.

Over time, environmental water releases will improve ecosystem function by scouring fine sediment to improve in-stream habitat and by flushing plant matter and other material into the river to stimulate the food chain. The flows also mix pools in the upper reaches and improve the salinity dynamics in the Snowy Estuary. Repairing these river functions helps the river support healthier aquatic communities.

Recent investigations have shown that high flows delivered to the Snowy River from Lake Jindabyne can mobilise the fine sediment within the channel. This improves habitat quality and increases potential sites for benthic biofilms (for example, algae attached to surfaces) to colonise and increase river productivity. The studies have improved understanding of the required magnitude and frequency of flows and the optimal intervals between events. This knowledge is incorporated into the annual planning for 2016–17.

Figure 2.5.1 The Snowy system

Scope of environmental watering

Environmental water releases are planned to occur every day from May 2016 to April 2017 and aim to mimic the typical flow pattern of a mixed snowmelt/rainfall river system characteristic of the Snowy Mountains. The flow regime provides hourly, daily, seasonal and annual flow variability within the bounds of a natural but smaller Snowy Montane River.

Five high flows are scheduled in winter/spring 2016. A large flushing flow is scheduled for early October 2016 and includes an eight-hour peak of over 8,000 ML per day.

Other peak flows mimic winter rainfall events. These peak flows aim to improve the physical attributes of the river by scouring sediment and limiting the growth of riparian plants (which can block the river channel).

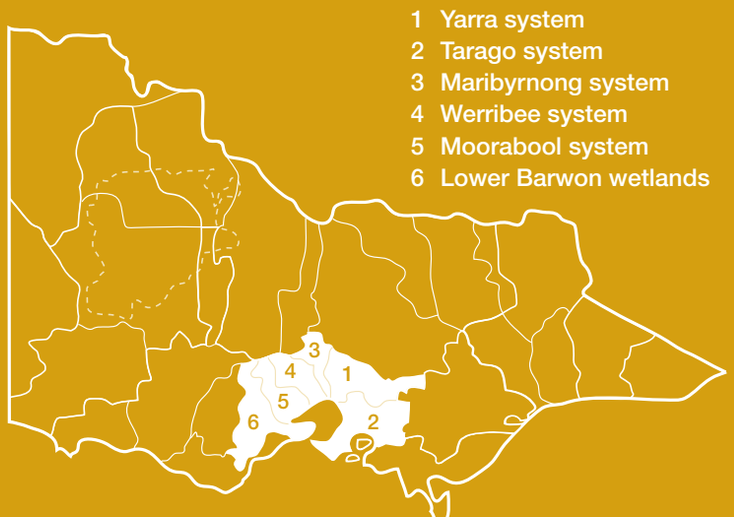
High flows are sustained from July–December to assist with water mixing in the estuary for the benefit of plants and fish (such as Australian bass). Low flows will then be released until the end of the water year in April 2017.

The total volume planned for release in 2016–17 (including contributions from water savings in Victoria and New South Wales) is 131,071 ML.

Moorabool River, by Chloe Wiesenfeld, Victorian Environmental Water Holder

Section 3

Central Region



1 Yarra system
2 Tarago system
3 Maribyrnong system
4 Werribee system
5 Moorabool system
6 Lower Barwon wetlands

3.1 Central Region overview

There are six systems that can receive environmental water in the Central Region of Victoria – the Yarra and Tarago systems in the east and the Werribee, Maribyrnong, Moorabool and Barwon (lower Barwon wetlands) systems in the west.

The waterways in these systems provide drinking water to greater Melbourne, Ballarat and Geelong and support a range of activities including walking, cycling, fishing and camping, as well as areas of irrigated agriculture. Platypus and fish are two examples of animals that attract community interest in the health of the waterways.

Environmental water is held in storage and delivered to support the plants and animals that live in and along the rivers. There are some links between systems in the region, and there are therefore opportunities to move water between systems through trade. Although moving water between systems is possible, most environmental water in these systems is prioritised to provide benefits in the river below where it is stored. While there is no dedicated environmental entitlement in the Maribyrnong system, in the past three years water allocation has been purchased from licence holders in the system for environmental outcomes.

Seasonal outlook 2016–17

The western systems in Central Region are generally drier than those in the east and quite different conditions can exist between them at the same time. Entitlements in some systems (such as the Yarra) are more reliable than others, providing greater certainty of water availability irrespective of catchment conditions. However, systems in the west (such as the Werribee and Moorabool systems) rely on inflows and continuing dry conditions result in a lower water availability: carryover is an important source of water to meet demands in these systems, if conditions remain dry. With most inflows into storages in the Central Region occurring in winter and spring, the likely water availability in these systems should be evident early in 2016–17. Opportunities to optimise the availability and use of environmental water within the region, and between regions, may be considered through trade. This is likely to be the case in the Maribyrnong system, where the VEWH does not hold any environmental water, and so depends on trade to meet demands.

If dry conditions prevail throughout 2016–17, environmental water deliveries will focus on maintaining water quality and protecting habitat for fish, platypus and other water-dependent species, particularly in summer/autumn. If conditions improve, environmental releases will also seek to provide flows that help to improve the health of the environment by providing improved habitat for animals and triggering migration, and sometimes spawning, of native fish.

Platypus, by Healesville Sanctuary

3.2 Yarra system

Waterway manager – Melbourne Water

Storage manager – Melbourne Water

Environmental water holder – Victorian Environmental Water Holder

Environmental values

The Yarra River supports many important environmental values including terrestrial and aquatic vegetation, billabongs, birds, frogs, platypuses and several nationally significant native fish species (such as the Australian grayling and the Macquarie perch).

The upper system (reaches 1–3) provides habitat for a range of native fish species including river blackfish, spotted galaxias and common galaxias and contains good-quality riparian and aquatic vegetation. The lower system (reaches 4–6) contains Australian grayling, Macquarie perch and tupong.

There are several billabongs in the Yarra system which are an important feature of the Yarra River floodplain downstream of Millgrove. The billabongs support a variety of distinct vegetation communities, providing foraging and breeding habitat for waterbirds and frogs. Except in very high flows, the billabongs are disconnected from the Yarra River.

Social and economic values

The upper reaches of the Yarra River are an important water supply catchment for Melbourne. There are more than four million people who live in and travel to greater Melbourne and the river provides social and recreational opportunities such as swimming and kayaking, as well as aesthetic appeal for walkers and cyclists. The waterways of the Yarra system (including the Yarra River) hold significance for Traditional Owners and their Nations in the region.

System overview

Flows through the Yarra system have become highly regulated due to the construction of water storages that capture natural run-off and allow the controlled removal of water for consumptive uses. Over time, the lower Yarra River has been straightened, widened and cleared of natural debris as Melbourne grew around its banks, with the earliest alterations to its course occurring as far back as 1879. Environmental watering aims to reinstate flows that support ecological outcomes throughout the length of the system.

Environmental water can be released from the Upper Yarra, Maroondah and O'Shannassy reservoirs. Priority reaches for environmental watering are reaches 2 and 5 and delivery of water to these reaches is also expected to achieve flow targets in neighbouring reaches. The environmental flow reaches in the Yarra system are shown in Figure 3.2.1. In the upper reaches, the system is influenced by tributaries (such as Woori Yallock Creek, Watts River and Little Yarra River). In the lower reaches, urbanised tributaries (such as Diamond Creek, Plenty River and Merri Creek) provide additional water to the Yarra River.

Environmental watering objectives in the Yarra system

	Rebuild, strengthen and maintain plant life on the river bank and in the channel, as well as on the upper Yarra floodplains and in the river's billabongs
	Protect and boost populations of native fish including threatened species (such as the Australian grayling and Macquarie perch)
	Maintain the form of the river bank and bed Scour silt build-up and clean cobbles in the river to ensure fish, platypus and other water animals have healthy habitat pools and places to shelter
	Restore communities of waterbugs which provide energy, break down dead organic matter and support the river's food chain
	Boost water quality in river pools, ensuring there is plenty of dissolved oxygen in the water to support water animals and bugs

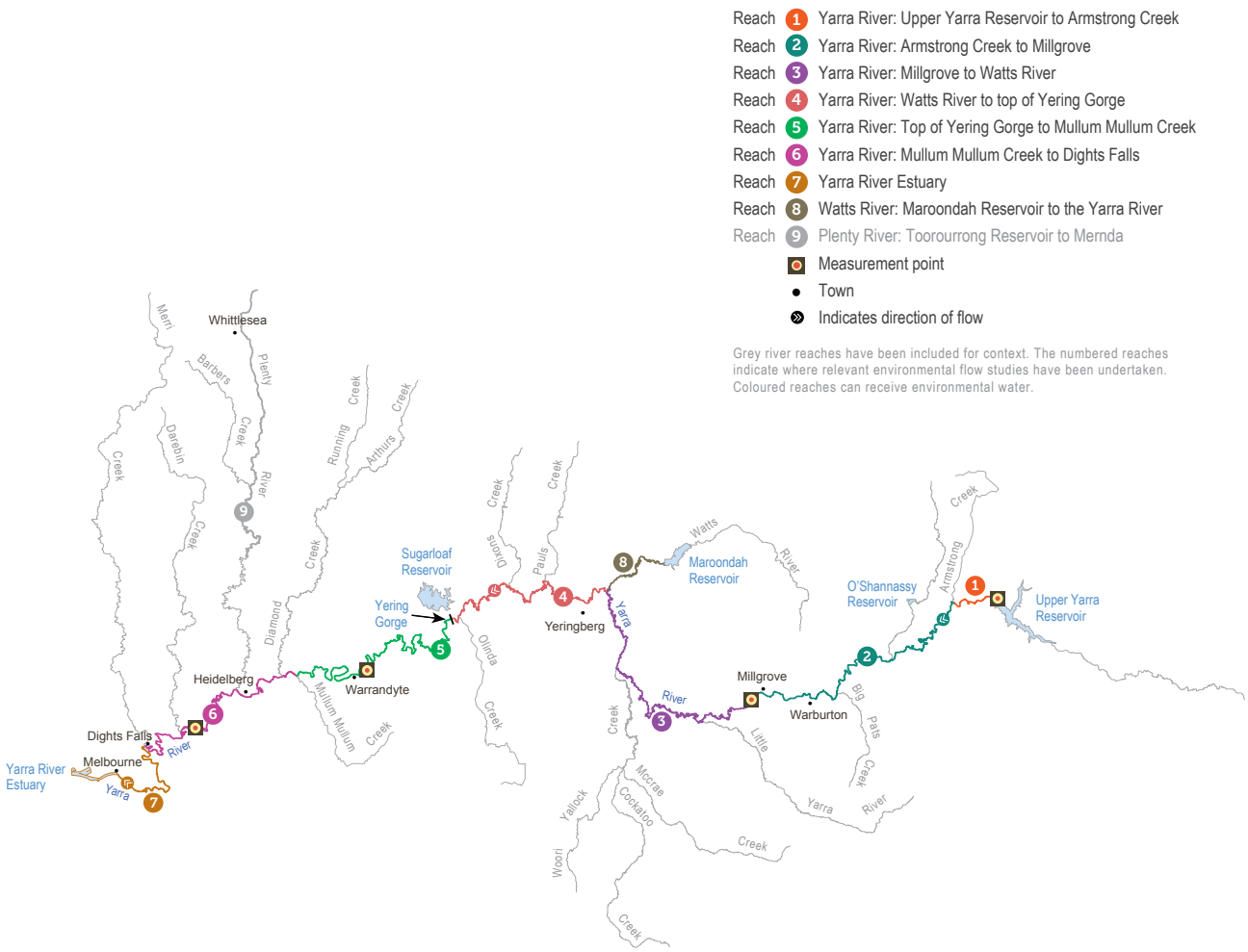
Recent conditions

Dry conditions persisted from 2014–15 into 2015–16 and resulted in low flows falling below target levels at times, as well as an absence of higher unregulated flows in winter/spring. The volume of environmental water required to maintain target low-flow levels was too large, so intermittent freshes were released during the year to maintain habitat and some movement opportunities for animals.

Four freshes were delivered in 2015–16, one in spring and three over summer/autumn. These releases successfully maintained aquatic plants and habitat for waterbugs and fish. Releases over summer were able to maintain water quality (particularly in reach 6) and environmental water also helped allow fish to move up and down the river.

Given the dry conditions and lack of unregulated flows, higher spring and autumn releases primarily targeting fish (Australian grayling) migration and spawning were not delivered. These higher releases were less important in 2015–16 as they had been delivered in previous years.

Figure 3.2.1 The Yarra system



Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 3.2.1.

Table 3.2.1 Potential environmental watering actions and objectives for the Yarra system

Potential environmental watering[1]	Environmental objectives
Year-round low flows[2] (varying rates from 10–350 ML/day)	• Provide sufficient access to riffle habitat • Allow river bank vegetation to dry • Limit the growth of fringing/riparian/terrestrial vegetation into the stream channel • Maintain and/or rehabilitate in-stream vegetation
Summer/autumn freshes (2–5 freshes of varying rates between 60–750 ML/day for 2–4 days each in December–May)	• Maintain habitat by scouring sediments and cleaning cobbles in faster-flowing areas • Provide suitable habitat and migration opportunities for native fish • Promote flood-tolerant vegetation • Improve water quality in pools
Winter/spring freshes (2–3 [or more] freshes of varying rates between 100–2,500 ML/day for at least 2–7 days in June–November)	• Maintain habitat by scouring sediments and cleaning cobbles in faster-flowing areas • Promote flood-tolerant vegetation • Provide suitable habitat and migration opportunities for native fish • Improve water quality in pools
Autumn high flow (1 high flow of varying rates between 560–1,300 ML/day for 7–14 days in April–May)	• Stimulate Australian grayling spawning
Targeted billabong watering	• Support native vegetation and improve habitat availability for wetland plants and animals
Spring high flow (1 high flow of 700–2,500 ML/day for 14 days in October–November)[3]	• Maintain riffle habitat by scouring sediments and cleaning cobbles • Promote flood-tolerant vegetation growth • Promote migration of native fish

1 The magnitude and duration of potential environmental watering depends on the reach being targeted, with the lower range generally occurring in the upper reaches (for example, reach 1) and higher range in the lower reaches (for example, reach 6).

2 Low flows are generally provided by passing flows under the environmental entitlement but during dry conditions it may be necessary to supplement low flows using environmental water.

3 A spring high flow will only be achieved with significant unregulated flow due to release constraints in the upper reaches of the system. However, ceasing harvesting at Yering during a natural high flow may assist in the desired flow being achieved

Scenario planning

Table 3.2.2 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

Watering actions across all scenarios are similar in 2016–17. Given the dry conditions, the autumn high flow and billabong watering did not occur in 2015–16, making them high-priority watering actions in 2016–17, including in dry conditions. Sufficient environmental water will be available to deliver these actions under all planning scenarios, due to the high security of the environmental entitlement in the Yarra system.

Less environmental water is expected to be required under average and wet conditions as natural flows following rainfall contribute significantly to meeting the environmental flow objectives. An additional spring high flow is planned under these conditions. Under wet conditions, priorities such as billabong watering may occur naturally.

A minimum of 3,000 ML carryover into 2017–18 is required (in addition to the 17,000 ML annual entitlement) to deliver the highest-priority flows if dry conditions continue into the following year.

The volumes of environmental water required to meet objectives under dry and average scenarios are similar, with a slightly reduced requirement under an average scenario due to unregulated flows, which are expected to assist in the delivery of additional watering actions. Under a wet scenario, the environmental water requirement reduces as a result of the increased contribution of unregulated flows.

A minimum of 8,000 ML carryover is required to deliver an autumn high-flow event to support Australian grayling in 2016–17, if not met in 2015–16.

Table 3.2.2 Potential environmental watering for the Yarra system under a range of planning scenarios

Planning scenario	Dry	Average	Wet
Expected river conditions	• Low streamflows year-round • Lack of unregulated freshes and high flows • Minimum passing flow requirements not likely to meet low-flow requirements	• High winter flows with small storages likely to spill • Unregulated flows may provide some freshes but duration and/or magnitude will likely be less than target flows	• High winter and spring flows with good variability • Unregulated flows over summer/autumn will provide freshes and possibly high flows • Some natural inundation of billabongs may occur
Expected availability of environmental water	• 22,000 ML carryover • 17,000 ML allocation • 39,000 ML total		
Potential environmental watering	• Summer/autumn low flows • Summer/autumn freshes • Winter/spring low flows • Winter/spring freshes • Autumn high flows • Targeted billabong watering	• Summer/autumn low flows • Summer/autumn freshes • Winter/spring low flows • Autumn high flows • Targeted billabong watering • Winter/spring freshes • Spring high flows	
Possible volume of environmental water required to achieve objectives	• 32,000 ML	• 24,000 ML	• 8,000 ML
Critical carryover into 2016–17	• 3,000 ML		

Risk management

In preparing its seasonal watering proposal, Melbourne Water considered and assessed risks and identified mitigating strategies relating to implementing environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 3.2.3 shows the partners and stakeholder organisations with which Melbourne Water engaged when preparing the Yarra system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term plans such as regional waterway strategies and environmental water management plans. These longer-term plans incorporate a range of environmental, cultural, social and economic perspectives.

Table 3.2.3 Partners and stakeholders engaged in developing the Yarra system seasonal watering proposal

Partner and stakeholder engagement
• Yarra River Environmental Water Advisory Group including representatives of local government, Native Fish Australia, VR Fish, Environment Victoria, Yarra River Keeper, Yarra Valley Water, Melbourne Water and Parks Victoria
• Melbourne Water (Water Supply Operations and Integrated Planning)
• Victorian Environmental Water Holder

3.3 Tarago system

Waterway manager – Melbourne Water

Storage manager – Melbourne Water

Environmental water holder – Victorian Environmental Water Holder

Environmental values

The Tarago system contains several significant and threatened native plant and animal species including the Australian grayling, long pink-bells, tree geebung and swamp bush-pea. The upper catchment has healthy riparian vegetation and in-stream habitat diversity that supports native fish including river blackfish and mountain galaxias. While the lower catchment has been highly modified, it contains good patches of remnant vegetation and healthy populations of Australian grayling and platypus.

Social and economic values

There are several reserves, picnic areas and designated fishing locations along the length of the Tarago system as well as a popular caravan park and public land in the headwaters. These all contribute to the social and recreational value of the Bunyip and Tarago rivers. Many irrigators rely on water from the Tarago system and urban supplies are also provided from the storage.

The Tarago River runs through the traditional lands of the Kurnai and Kulin Nations. The waterways of this region would have been a focus for Aboriginal communities before European settlement due to their permanent water supply and associated resources. Aboriginal people have a continuing connection to the waterways of this region. In recent times the Robin Hood Reserve on the Tarago River has been an important meeting place for Traditional Owners.

Environmental watering objectives in the Tarago system

	Encourage healthy and diverse riverside vegetation
	Protect and boost native fish populations including threatened species (the Australian grayling and river blackfish) by providing habitat and encouraging fish to migrate and spawn
	Provide habitat and nourishment for waterbugs which provide energy, break down dead organic matter and support the river's food chain
	Maintain and improve habitat for platypus

System overview

The Tarago River has its headwaters in the Tarago State Forest and it flows into the Tarago Reservoir at Neerim. Downstream of the reservoir, the river flows close to the town of Rokeby before meeting the Bunyip River (of which it is a major tributary) at Longwarry North. The downstream reach towards Western Port Bay supplies many irrigators in the catchment.

Water available under the Tarago environmental entitlement is stored in and released from Tarago Reservoir. Reach 2 is the target reach as it has high ecological value with a diversity of native fish and patches of native fringing vegetation. Deliveries to reach 2 often result in the desired flows in reach 6.

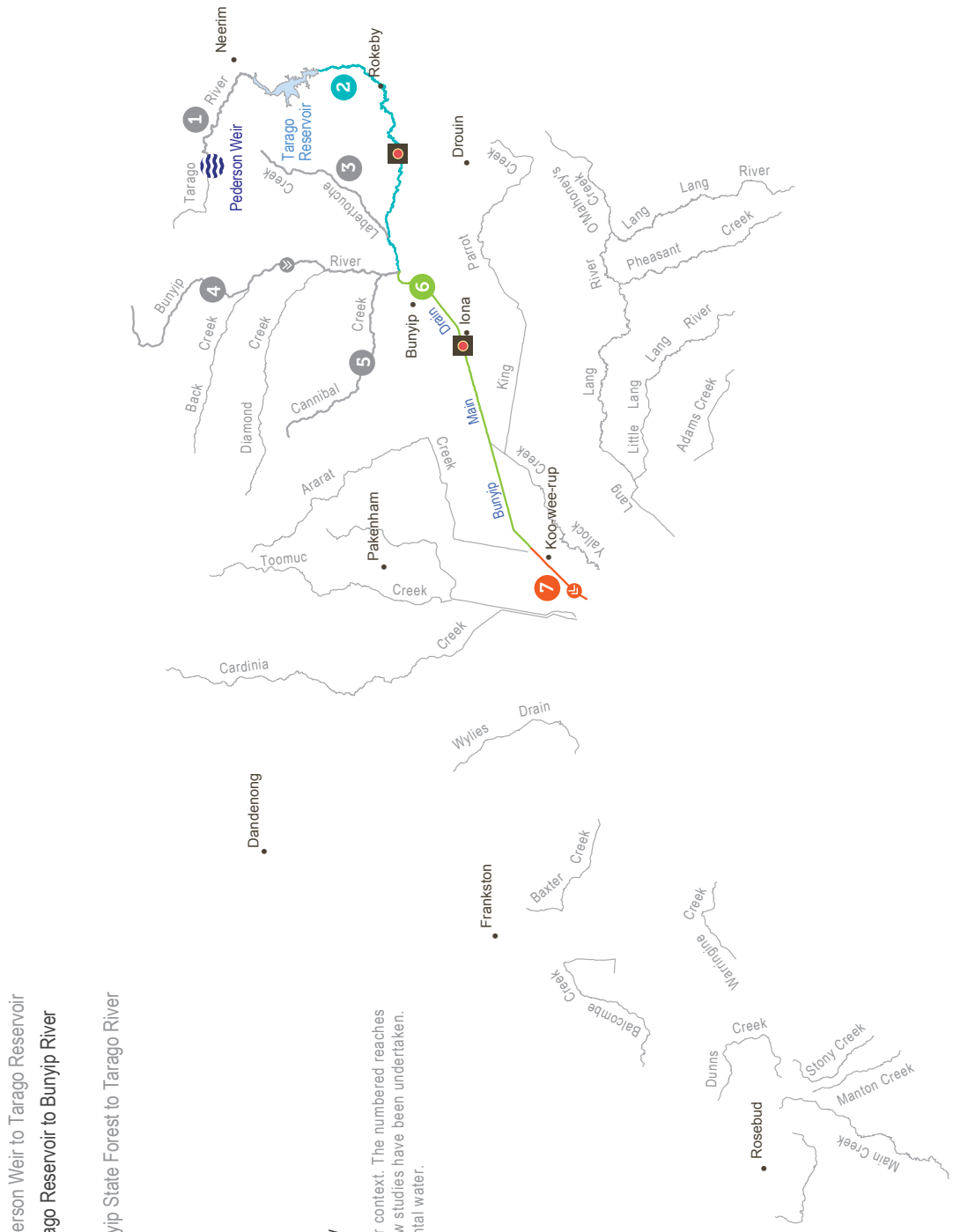
Recent conditions

Spills from Tarago Reservoir between June and November 2015 provided increased flows and variability in the river downstream of the reservoir, resulting in achievement of most of the targeted environmental flows in winter. While small spills occurred into late spring, conditions began to dry due to below-average spring rainfall. The dry conditions continued in summer and autumn.

Environmental water was released to provide two summer freshes, the first in December 2015 and the second in February 2016. These events improved habitat availability for animals and helped clear sand bars of encroaching vegetation. An autumn fresh was delivered in April and piggybacked on some unregulated flows following local rainfall. Initial monitoring results showed that the release was successful in triggering Australian grayling spawning.

Significant monitoring continues to be undertaken in the Tarago system. The results show a clear link between environmental flow pulses and Australian grayling spawning with the length of the pulse being critical to successful spawning. Monitoring of platypus also showed the environmental watering has substantial benefits for this iconic animal including improvements to habitat, increased movement opportunity and more food (in the form of waterbugs).

Figure 3.3.1 The Tarago system



Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 3.3.1.

Table 3.3.1 Potential environmental watering actions and objectives for the Tarago River

Potential environmental watering	Environmental objectives
Summer/autumn freshes (5 freshes of 100 ML/day for 4 days each in December–May)	• Prevent vegetation growing on sand bars, encourage scour hole creation and improve water quality and maintain habitat for aquatic species, particularly fish
Autumn high flow (1 high flow of 100 ML/day for 2 days during April–May)	• Trigger downstream dispersal and spawning of Australian grayling
Spring/summer high flow (1 high flow of 280 ML/day for 4 days during October–December)	• Migration of Australian grayling and inundation of barriers, providing for fish passage
Winter/spring freshes (up to 4 freshes of 280 ML/day for 3 days during June–November)	• Generate habitat variability for waterbugs, prevent sedimentation and provide sufficient depth for fish passage
Summer/autumn low flows (12 ML/day [or natural] during December–May)[1]	• Maintain water quality and provide habitat for river blackfish, Australian grayling, platypus and waterbugs
Winter/spring low flows (100 ML/day [or natural] during June–November)[2]	• Inundate marginal habitats for juvenile fish • Increase riverbed habitat availability for waterbugs • Promote establishment and recruitment of diverse riparian vegetation types and prevent terrestrial vegetation encroachment

1 Summer/autumn low flows are generally provided by passing flows under the environmental entitlement but during dry conditions it may be necessary to supplement these flows using environmental water.
2 Winter/spring low flows are unlikely to be delivered as the volume required would severely affect the ability to provide other environmental flow events.

Scenario planning

Table 3.3.2 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

The highest-priority releases in the Tarago system are summer/autumn freshes (to provide habitat and improve water quality) and an autumn high flow (to provide migration cues for Australian grayling). An autumn high flow is important to deliver in most years as Australian grayling are short-lived (to around three years old) so regular successful breeding is needed. There may not be sufficient water in drought conditions to deliver the event but this flow has been provided in five of the past six years so absence of the flow in 2016–17 does not pose a significant risk. Under wetter conditions, we expect that in addition to summer/autumn releases environmental water may contribute to delivery of some winter/spring flows, building on natural flows in the system to improve habitat for waterbugs and fish movement along the river.

Another priority release is the spring freshes to support the movement of juvenile Australian grayling back into the Tarago system. This event usually occurs naturally but drier springs have led to only the partial delivery of this flow. Anecdotal evidence suggests that the fish move on these partial events, which will be monitored in spring 2016.

The number of watering actions increases from the drought to the wet scenarios, thus increasing the volume of environmental water required. Carrying water over into 2017–18 is important under all conditions, to provide a secure ability to deliver summer and autumn freshes in the following year.

Table 3.3.2 Potential environmental watering for the Tarago system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Very low streamflows • Reduced passing flows • Irrigation releases likely	• Low streamflows • Some reduction to passing flows • Irrigation releases likely	• Average streamflows • Partial freshes naturally provided • Some irrigation releases likely	• Above-average streamflows • Partial-to-full freshes naturally provided • Irrigation releases unlikely
Expected availability of environmental water	• 1,500 ML carryover • 200 ML allocation • 1,700 ML total	• 1,500 ML carryover • 500–1,000 ML allocation • 2,000–2,500 ML total	• 1,500 ML carryover • 1,000–2,200 ML allocation • 2,500–3,700 ML total	• 1,500 ML carryover • 2,200–3,500 ML allocation • 3,700–5,000 ML total
Potential environmental watering – tier 1 (high priorities)	• Summer/autumn freshes	• Summer/autumn freshes • Autumn high flows (partial event)	• Summer/autumn freshes • Autumn high flows • Spring high flows (partial event)	• Summer/autumn freshes • Autumn high flows • Spring high flows • Winter/spring freshes
Potential environmental watering – tier 2 (additional priorities)	• Spring high flows (partial event)	• Spring high flows (partial event) • Autumn high flows (full event)	• Spring high flows (full event)	• N/A
Possible volume of environmental water required to achieve objectives[1]	• 1,000 ML (tier 1) • 800 ML (tier 2)	• 1,000–1,500 ML (tier 1) • 1,200 ML (tier 2)	• 1,500–2,700 ML (tier 1) • 1,200 ML (tier 2)	• Up to 3,500 ML (tier 1)
Priority carryover requirements	• 500 ML		• 1,000 ML	

1 Environmental water requirements for tier 2 actions are additional to tier 1 requirements.

Risk management

In preparing its seasonal watering proposal, Melbourne Water considered and assessed risks and identified mitigating strategies relating to implementing environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 3.3.3 shows the partners and stakeholder organisation with which Melbourne Water engaged when preparing the Tarago system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term plans such as regional waterway strategies. These longer-term plans incorporate a range of environmental, cultural, social and economic perspectives.

Table 3.3.3 Partners and stakeholders engaged in developing the Tarago system seasonal watering proposal

Stakeholder engagement
• Tarago and Bunyip Rivers Environmental Flow Advisory Group including representatives of local councils, irrigators, landholders and Landcare groups • Melbourne Water (Water Supply – Optimisation and Support) • Southern Rural Water • Victorian Environmental Water Holder

3.4 Maribyrnong system

Waterway manager – Melbourne Water

Storage manager – Southern Rural Water

Environmental water holder – N/A

Environmental values

The upper Maribyrnong catchment contains areas of relatively intact streamside vegetation which provide important habitat for native fish including migratory short-finned eels, common and ornate galaxias, flathead gudgeon, tupong and Australian smelt. A diverse community of waterbugs and a significant platypus population occur in several reaches of the system.

Social and economic values

The Maribyrnong River is located in the western suburbs of Melbourne and provides water (primarily from Rosslynne Reservoir on Jacksons Creek) to urban and rural users. Recreational opportunities such as boating, fishing, cycling, walking and picnicking in the adjacent parklands are popular. The waterways of the Maribyrnong system hold significance for Traditional Owners and their Nations in the region.

Settlement Road drought pool, by Bill Moulden, Melbourne Water

Environmental watering objectives in the Maribyrnong system

- Maintain or restore in-stream vegetation and reduce invasive terrestrial vegetation populations
- Allow for small-bodied fish passage through the system
- Maintain self-sustaining waterbug populations and suitable habitats
- Maintain water quality by flushing pools

System overview

Close to Tullamarine Airport, Jacksons Creek (flowing from the west) and Deep Creek (flowing from the north) join to form the Maribyrnong River. The river runs south through Yarraville in inner Melbourne before meeting the Yarra and flowing into Port Phillip Bay. Rosslynne Reservoir is the only major storage in the Maribyrnong catchment, located in the upper reaches of Jacksons Creek.

The priority river reaches for environmental watering in the Maribyrnong system are reaches 6 and 7 (upper and lower Jacksons Creek respectively) downstream of Rosslynne Reservoir. The release capacity of 20 ML per day from Rosslynne Reservoir is a significant constraint on the outcomes that can be achieved by environmental deliveries.

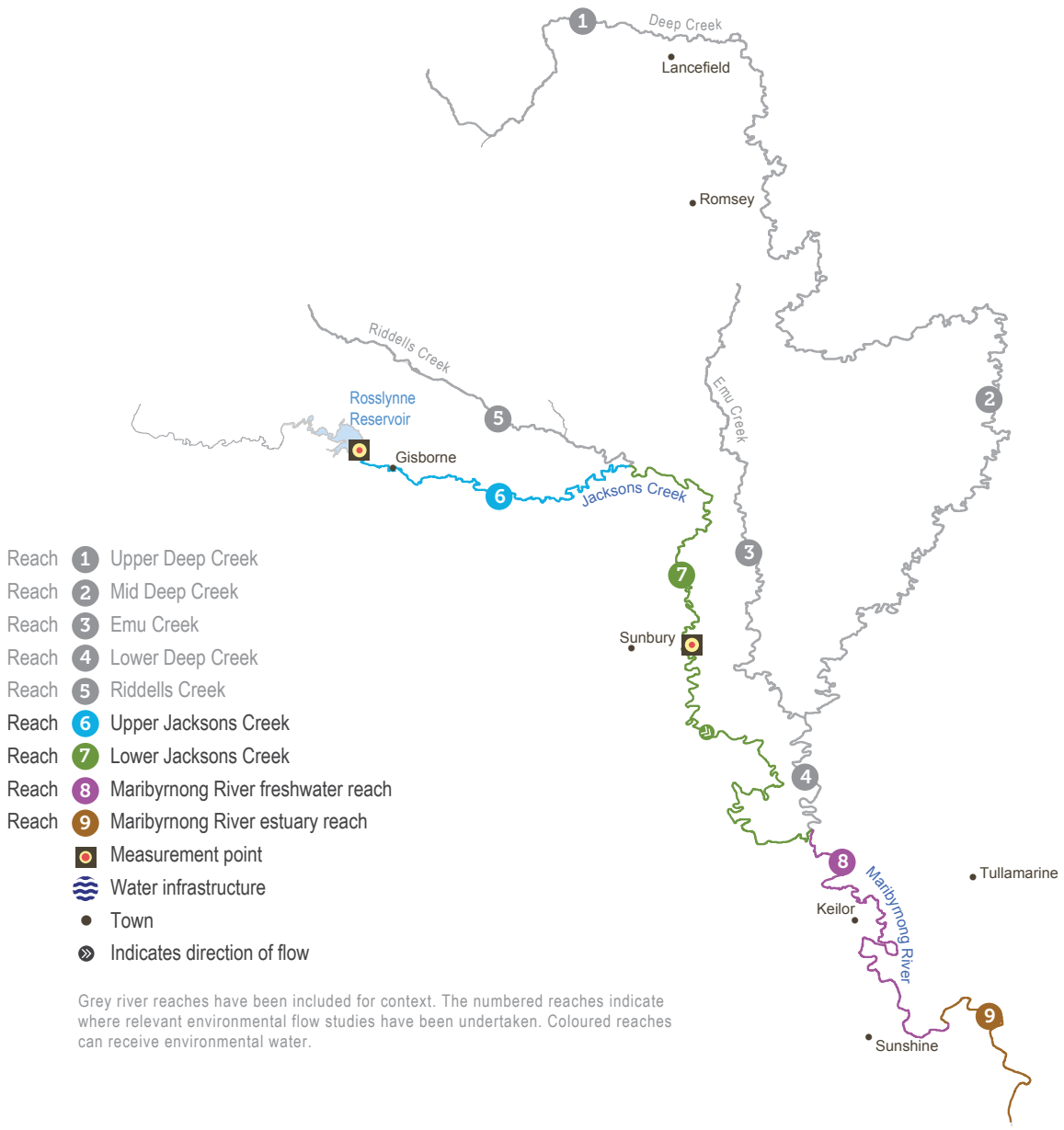
The VEWH does not hold an environmental entitlement in the Maribyrnong system. Over the past three years, Melbourne Water and the VEWH have worked with local diversion licence holders to purchase unused water that can then be delivered specifically for environmental outcomes in the system. This arrangement is negotiated each year and will only occur with the agreement of all parties involved.

Recent conditions

Since 2012 rainfall and run-off into the waterways of the Maribyrnong system have been decreasing with drier conditions. The lack of flow in the waterways has resulted in poor water quality in Jacksons Creek, particularly over summer below Rosslynne Reservoir. Environmental water has been released from the reservoir to freshen up the creek and prevent low oxygen levels in the water causing problems for fish, waterbugs and platypus. Without environmental water, the condition of the animals and plants in Jacksons Creek would have continued to decline.

Over summer and autumn low dissolved oxygen levels can occur, causing stress to aquatic animals, and prolonged very low flows can negatively impact in-stream vegetation. In 2015–16, 300 ML of water was delivered in two freshes to Jacksons Creek, primarily to maintain water quality to protect aquatic animals and in-stream vegetation in dry conditions.

Figure 3.4.1 The Maribyrnong system



Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 3.4.1.

Table 3.4.1 Potential environmental watering actions and objectives for the Maribyrnong River

Potential environmental watering[1]	Environmental objectives
Summer/autumn low-flow freshes (up to 3 events of 20–40 ML per day for up to 4 days) in December–May	• Maintain water quality by flushing pools • Support in-stream vegetation • Provide passage for small-bodied native fish
Low flows (4–6 ML per day continuously) in December–May	• Maintain self-sustaining waterbug populations and pool run habitats
Winter/spring low flows (20–40 ML per day continuously) in June–November	• Maintain or restore in-stream vegetation and disturb invasive terrestrial vegetation populations • Maintain channel morphology • Allow for small-bodied fish passage through the system

1 The range in flow requirements represent the target flow requirements for reaches 6 and 7.

Scenario planning

Table 3.4.2 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

Under drier climate scenarios, any available environmental water would be delivered to protect or maintain aquatic habitat in Jacksons Creek through the delivery of low-flow freshes and, under drought conditions, delivery of low flows. These deliveries aim to ensure the in-stream plants and animals have refuge to survive.

Under average and wet conditions it is expected unregulated flows will contribute to meeting the flow objectives. Environmental water could still be beneficial for filling in gaps between unregulated events or to continue small-scale unregulated events for a longer duration.

Risk management

In preparing its seasonal watering proposal, Melbourne Water considered and assessed risks and identified mitigating strategies relating to implementing environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 3.4.3 shows the partners, stakeholder organisations and individuals with which Melbourne Water engaged when preparing the Maribyrnong system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term plans such as regional waterway strategies and environmental water management plans. These longer-term plans incorporate a range of environmental, cultural, social and economic perspectives.

Table 3.4.3 Partners and stakeholders engaged in developing the Maribyrnong system seasonal watering proposal

Stakeholder engagement
• Melbourne Water (Diversions group) • Southern Rural Water • Keilor irrigators • Department of Environment, Land, Water and Planning • Victorian Environmental Water Holder

Table 3.4.2 Potential environmental watering for the Maribyrnong system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Minimal unregulated flows • Passing flows ceased	• Low volumes of unregulated flows • Passing flows partially to fully meet low flows	• Unregulated flows partially meet most objectives • Passing flows partially to fully meet low flows	• Unregulated flows meet most objectives • Passing flows partially to fully meet low flows
Potential environmental watering	• Summer/autumn low flows • Summer/autumn low-flow freshes	• Summer/autumn low-flow freshes	• Summer/autumn low-flow freshes • Winter/spring low flows	• Summer/autumn low-flow freshes • Winter/spring low flows
Volume of environmental water required to achieve objectives	• 300 ML	• 300 ML	• 600 ML	• 600 ML

3.5 Werribee system

Waterway manager – Melbourne Water

Storage manager – Southern Rural Water

Environmental water holder – Victorian Environmental Water Holder

Environmental values

The Werribee system supports a range of native fish including large populations of black bream and other species (such as the river blackfish, flathead gudgeon, short-finned eel, tupong and Australian smelt and several species of galaxiids). A diverse community of frogs and waterbugs inhabit the upper reaches and platypus are present in the lower reaches. The freshwater-saltwater interface of the Werribee River estuary is a regionally significant ecosystem due to the many aquatic plants and animals it supports, providing juvenile habitat and for the successful recruitment of fish such as black bream.

Social and economic values

The Werribee River provides the opportunity for recreational activities including fishing, bird watching, passive boating (canoeing, kayaking) and bushwalking. The system also provides irrigation water for agricultural industries throughout the Bacchus Marsh and Werribee areas and domestic water for Melton and Bacchus Marsh. Significant Aboriginal cultural heritage sites have been found along the riverbank and escarpments including fish traps, artefacts and burial sites. The Werribee River continues to be a place of significance for Traditional Owners and their Nations in the region.

Environmental watering objectives in the Werribee system

	Maintain diverse macrophytes (large water plants) and shrubs to provide shade and food for organisms further up the food chain
	Protect and boost native fish populations (including black bream and galaxiids) by providing pool habitat and flows for fish to move up and downstream and encouraging fish to spawn
	Maintain habitat for frogs, waterbugs and platypus
	Maintain pool water quality for fish and platypus and inundate estuary salt marsh with brackish water
	Move built-up silt from riffles (in the shallower parts of the river)

System overview

The Werribee River flows south-east from the Wombat State Forest near Ballan before dropping through the Werribee Gorge to Bacchus Marsh and then flowing into Port Phillip Bay at Werribee. The Lerderderg River is a major tributary that joins the river at Bacchus Marsh.

The priority river reaches for environmental flow delivery in the Werribee system are the reach downstream of Lake Merrimu (reach 6), the reach within Werribee (reach 9) and the estuary: these support a diverse range of native fish species, waterbugs and platypus. Flows targeting the estuary are expected to provide some benefits to reach 8 and water may also be delivered for environmental objectives in this reach under suitable conditions. Environmental water released from Lake Merrimu can be re-harvested in Melton Reservoir, minus en route losses. It can then be held and re-released from Melton at a later date for specific lower Werribee River outcomes. Flows are measured downstream of Lake Merrimu (reach 6), downstream of Melton Reservoir (reach 8) and at the Werribee Diversion Weir for reach 9 and the estuary.

Recent conditions

Rainfall into the Werribee system has been below-average for the past four years. Melton Reservoir has not spilled since October 2012 and consequently there has been minimal natural outflow to Port Phillip Bay. Environmental watering has been required to provide a large portion of flows in reach 9 and the estuary. Dry conditions persisted in 2015–16 with environmental watering focusing on the most critical objectives to help protect the health of the system under dry conditions.

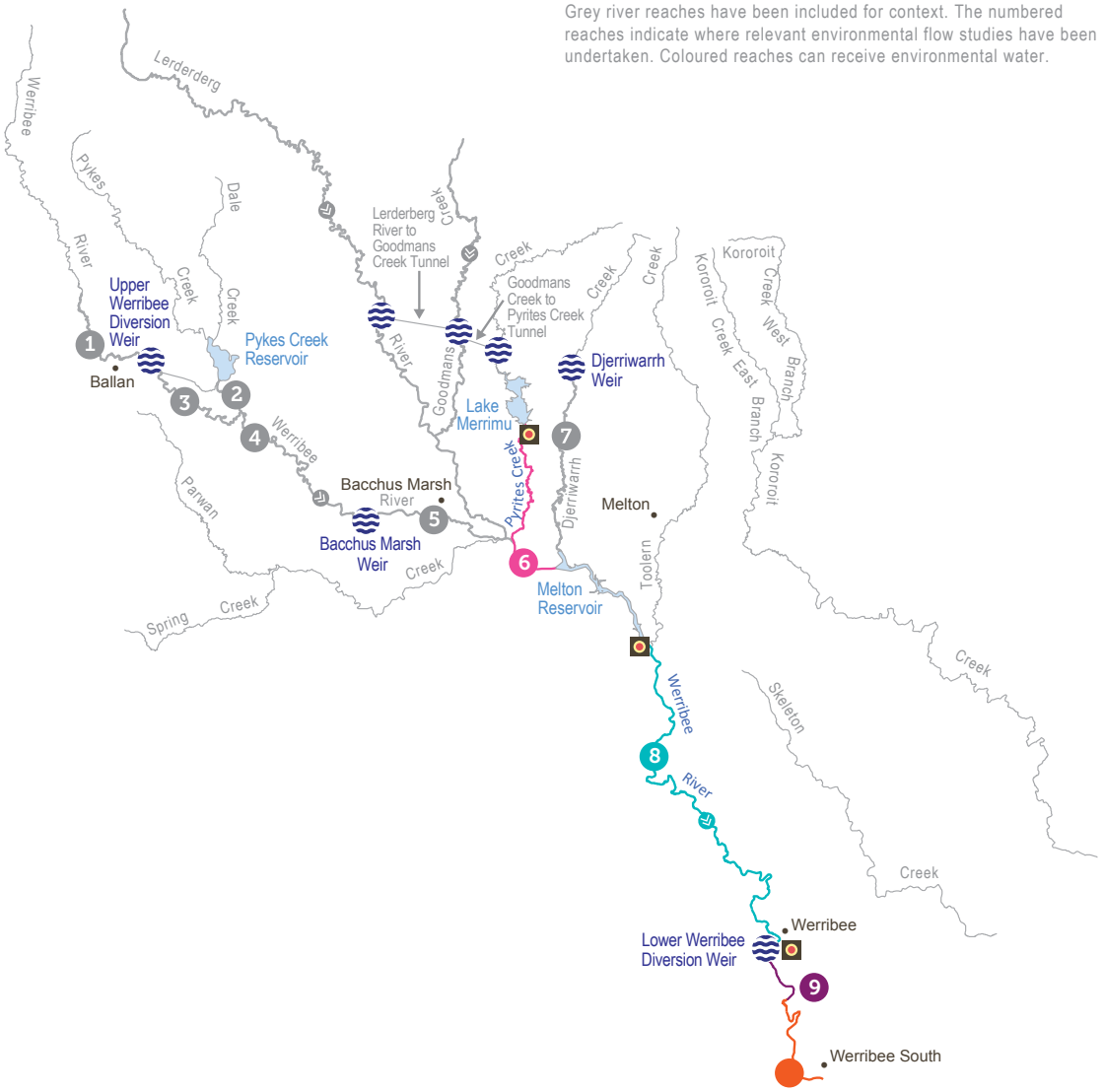
Baseflows and two freshes were provided to Pyrites Creek (reach 6) using environmental water. Maintaining baseflows is important to provide suitable frog habitat in winter/spring, while the freshes targeted outcomes for pygmy perch and waterbugs. The dry conditions affected deliveries, with significant losses resulting in the freshes not meeting the target flows and noticeably less of the releases from Lake Merrimu reaching Melton Reservoir downstream. A persistent trickle flow occurred throughout summer in the upper parts of Pyrites Creek as a result of leakage from Lake Merrimu while the lower section of the reach ceased to flow for extended periods.

With continuing dry conditions and low environmental water availability, it is becoming increasingly difficult each year to meet the flow objectives for the lower Werribee River. Issues such as blue-green algae and floating aquatic weeds were again evident in reach 9 through the Werribee township. These issues highlight the low-flow and high-nutrient loads in the river and affect fishing, boating and the general enjoyment people have from being near the river. Two freshes to the lower Werribee River were delivered in January and March 2016; while primarily aimed at

Figure 3.5.1 The Werribee system

Reach 1 Werribee River: Upstream of Upper Werribee Diversion Weir
Reach 2 Pykes Creek: Pykes Creek Reservoir to Werribee River
Reach 3 Werribee River: Upper Werribee Diversion Weir to Pykes Creek
Reach 4 Werribee River: Pykes Creek to Bacchus Marsh Weir
Reach 5 Werribee River: Bacchus Marsh Weir to Lerderderg River
Reach 6 Pyrites Creek: below Lake Merrimu to Melton Reservoir
Reach 7 Djerriwarrh Creek: below Djerriwarrh Weir to Melton Reservoir
Reach 8 Werribee River: Melton Reservoir to Lower Werribee Diversion Weir
Reach 9 Werribee River: Lower Werribee Diversion Weir to estuary
Reach Werribee Estuary
Measurement point
Water infrastructure
Town
Indicates direction of flow

Grey river reaches have been included for context. The numbered reaches indicate where relevant environmental flow studies have been undertaken. Coloured reaches can receive environmental water.



maintaining water quality and supporting fish passage, they also flushed the blue-green algae. These freshes were too small to have a significant or long-lasting effect on reducing the aquatic weed build-up.

The Werribee River will benefit from an additional 1,100 ML of water made available from Lake Merrimu in 2015–16. At the time of writing, this water was planned to be delivered in winter 2016, primarily to provide a large fresh event to the lower Werribee River, an event that has not occurred since 2012. This larger fresh is aimed at providing a significant flush to the river, improving habitat for fish and platypus and removing the aquatic weed accumulation. This will improve water quality in the lower Werribee River and is expected to result in less weed, algae and other issues in 2016–17, although follow-up flows are likely to be important to achieving this.

Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 3.5.1.

Table 3.5.1 Potential environmental watering actions and objectives for the Werribee system

Potential environmental watering	Environmental objectives
Pyrites Creek (reach 6)	
Spring/summer freshes (up to 3 freshes of 30 ML/day for 2 days in September–December)	• Improve waterbug habitat by scouring silt and sand from riffles • Promote vegetation growth
Spring/summer high flows (130 ML/day for 2 days in September–December)	• Flush organic matter from benches • Promote recruitment and growth of riparian vegetation
Winter/spring/summer baseflows (2 ML/day [or natural] in June–December)	• Provide waterbug and frog habitat
Lower Werribee River (reaches 8, 9 and the estuary)	
Spring/summer freshes (up to 2 freshes of 50–80 ML/day for 2 days in November–December)	• Promote juvenile black bream recruitment • Promote longer-distance movement of fish through reach 9
Winter/spring/summer baseflows (10 ML/day in June–December)	• Provide black bream habitat for spawning • Provide habitat for waterbugs and fish and support vegetation growth in reach 9
Autumn baseflows 10 ML/day during March–May	• Promote downstream migration of diadromous fish (fish that move between freshwater and saltwater to complete their life cycle) to the estuary • Provide habitat for waterbugs and fish and to support vegetation growth in reach 9
Summer/autumn freshes (up to 3 freshes of 80 ML/day[1] for 2 days during January–April)	• Maintain pool water quality for fish and platypus in reach 9 • Promote recruitment of juvenile black bream in the estuary • Scour silt and algae from riffles in reach 8
Winter/spring/summer freshes (up to 4 freshes of 350 ML/day for 3 days during June–December)[2]	• Promote diversity of riparian vegetation in reaches 8 and 9 • Provide fish movement cues (all) • Inundate saltmarsh vegetation with brackish water in the estuary

1 Recommendation is for 137 ML delivered in one day. The recommendation has been revised due to operational constraints to be 160 ML delivered over 2 days. Monitoring has shown that this achieves the hydraulic and water quality objective.

2 If this watering action is not delivered in 2015–16, it may be delivered in 2016–17 using the 1,100 ML of additional water provided in 2015–16. This is not shown in the scenario planning table below as it is intended to be delivered in 2015–16 at the time of writing.

Scenario planning

Table 3.5.2 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

As seasonal conditions improve across the planning scenarios from drought to wet, additional actions become a priority for environmental watering. The critical flows planned to be delivered under the drought and dry scenarios focus on deliveries to Pyrites Creek (reach 6) and freshes to protect the lower Werribee River, by maintaining water quality. However, the amount of water available may not be sufficient to meet all these demands, particularly under drought conditions. The expected volume of environmental water required to achieve the desired objectives increases as conditions become wetter, as re-harvesting Lake Merrimu releases in Melton Reservoir cannot occur when Melton Reservoir is spilling.

When possible, winter releases from Lake Merrimu to Pyrites Creek (reach 6) will be captured in Melton Reservoir, making the volume that reaches the reservoir available for releases downstream later in the water year. This is an essential management option to enable the best use of very limited environmental water under drought and dry conditions. Under average or wet conditions Melton Reservoir is likely to be spilling, meaning releases from upstream will spill through the reservoir and provide a small increase in unregulated flow downstream.

Carrying over some water into 2017–18 is essential to help protect the health of Pyrites Creek (reach 6) in the following year under dry conditions.

Table 3.5.2 Potential environmental watering for the Werribee system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No unregulated flows • Minimal consumptive releases out of storage into reach 8 in summer/ autumn	• No unregulated flows below Melton Reservoir, minimal passing flows to reach 6 • Consumptive releases out of storage into reach 8 in summer/ autumn	• Unregulated spills in winter/spring from Melton into reaches 8 and 9 and the estuary; most reach 6 baseflows met by passing flows • Consumptive releases out of storage into reach 8 in summer/autumn	• Unregulated spills in winter/spring from Melton into reaches 8 and 9 and the estuary; all reach 6 baseflows provided • Consumptive releases out of storage into reach 8 in summer/autumn
Expected availability of environmental water	• 350 ML carryover • 0 ML allocation • 50 ML inflows • 400 ML total	• 350 ML carryover • 500 ML allocation • 200 ML inflows • 1,050 ML total	• 350 ML carryover • 700 ML allocation • 400 ML inflows • 1,450 ML total	• 350 ML carryover • >800 ML allocation • >900 ML inflows • >2,050 ML total
Potential environmental watering – tier 1 (high priorities)	• Winter/spring/summer baseflows (reach 6) • Two spring/ summer freshes (reach 6) • Two summer/autumn freshes (lower reaches)	• Winter/spring/summer baseflows (reach 6) • Three spring/ summer freshes (reach 6) • Two summer/autumn freshes (lower reaches) • Autumn baseflows (lower reaches) • Spring/summer freshes (lower reaches)	• Three spring/summer freshes (reach 6) • Two summer/autumn freshes (lower reaches) • Autumn baseflows (lower reaches) • Two spring/summer freshes (lower reaches) • Winter/spring/summer baseflows (lower reaches)	• Three spring/summer freshes (reach 6) • Spring/summer high flows (reach 6) • Two summer/autumn freshes (lower reaches) • Autumn baseflows (lower reaches) • Two spring/summer freshes (lower reaches) • Winter/spring/summer baseflows (lower reaches)
Potential environmental watering – tier 2 (additional priorities)	• Winter/spring/summer freshes (lower reaches) • Autumn baseflows (lower reaches)	• Winter/spring/ • summer freshes (lower reaches)	• Additional winter/spring/ summer freshes (lower reaches)	• Additional winter/spring/ summer freshes (lower reaches)
Possible volume of environmental water required to achieve objectives[1]	• 350 ML (tier 1) • 1,500 ML (tier 2)	• 700 ML (tier 1) • 1,300 ML (tier 2)	• 900 ML (tier 1) • 1,300 ML (tier 2)	• 1,200 ML (tier 1) • 1,300 ML (tier 2)
Priority carryover requirements	• 200 ML			

1 Environmental water requirements for tier 2 actions are additional to tier 1 requirements.

Risk management

In preparing its seasonal watering proposal, Melbourne Water considered and assessed risks and identified mitigating strategies relating to implementing environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 3.5.3 shows the partners, stakeholder organisations and individuals with which Melbourne Water engaged when preparing the Werribee system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional waterway strategies, environmental water management plans and environmental flow studies, which incorporate environmental, cultural, social and economic considerations.

Table 3.5.3 Partners and stakeholders engaged in developing the Werribee system seasonal watering proposal

Partner and stakeholder engagement
• Werribee River Community Advisory Group including representatives of Melton, Wyndham and Moorabool councils, Waterwatch, Werribee Riverkeeper, Western Melbourne Catchment Network, Friends of Werribee Gorge and Longforest Mallee, Pinkerton Landcare, Friends of Toolern Creek, Werribee South Fishing Club, Werribee Anglers Club and Port Phillip and Westernport CMA
• Southern Rural Water and licensed diverters
• Victorian Environmental Water Holder

Pyrites Creek, by Bill Moulden, Melbourne Water

3.6 Moorabool system

Waterway manager – Corangamite Catchment Management Authority

Storage manager – Central Highlands Water

Environmental water holder – Victorian Environmental Water Holder

Environmental values

The Moorabool River is home to native fish species including the Australian grayling, river blackfish, Australian smelt, flat-headed gudgeon, southern pygmy perch, short-finned eel and tupong. The system contains extensive areas of endangered remnant vegetation including stream bank shrubland and riparian woodland ecological vegetation communities. Diverse populations of waterbugs, platypus and water rats are also present. The Moorabool River flows into the Barwon River, connecting it to the Ramsar-listed lower Barwon wetlands.

Social and economic values

The Moorabool system has important environmental values and supports a range of recreational activities with parks, walking trails, picnic sites, lookouts, swimming holes, fishing and camping spots and historic bridges located along its length. Lal Lal Reservoir is used to supply water to the Ballarat region. Water from Lal Lal is also delivered via the Moorabool River to She Oaks Weir to supply towns in the Geelong region. The Moorabool River is a place of importance for Traditional Owners and their Nations in the region.

Environmental watering objectives in the Moorabool system

	Maintain remnant vegetation communities including a range of macrophytes (large water plants) within the river channel; these communities provide shade and food for organisms further up the food chain
	Protect and boost native fish populations (including Australian grayling, southern pygmy perch, spotted galaxias, tupong and short-finned eel) by providing flows for fish to move upstream and downstream and encouraging fish to spawn
	Reshape the river bank and bed and ensure fish and other water animals have a range of habitat pools and places to shelter
	Improve water quality during the year, particularly during summer
	Maintain a wide range of waterbugs to provide energy, break down dead organic matter and support the river's food chain

System overview

The Moorabool River is a highly regulated river that, despite substantial extraction and many years of drought, still retains significant environmental values. It flows southward from the Central Highlands between Ballarat and Ballan to join the Barwon River at Fyansford. The catchment is heavily farmed with about three-quarters of the catchment area used for agriculture.

Water allocated to the Moorabool River environmental entitlement is stored in Lal Lal Reservoir and includes passing flows that help maintain flows in the river. The Moorabool is also a water supply catchment for Barwon Water with releases from Lal Lal Reservoir being diverted for urban water supply at She Oaks Weir. These releases contribute to environmental outcomes in reach 3a and 3b and allow more efficient delivery of environmental water to reach 4. Barwon Water and Corangamite CMA work together to maximise these benefits.

There are several large water storages in the upper reaches of the river (including Lal Lal Reservoir). In the lower reach (between She Oaks and Batesford) there are nine private diversion weirs that are a significant barrier to fish. These barriers have increased the extent of slow-flowing habitat and reduced habitat diversity in the lower reach of the Moorabool, reducing the diversity and abundance of migratory fish in this part of the river.

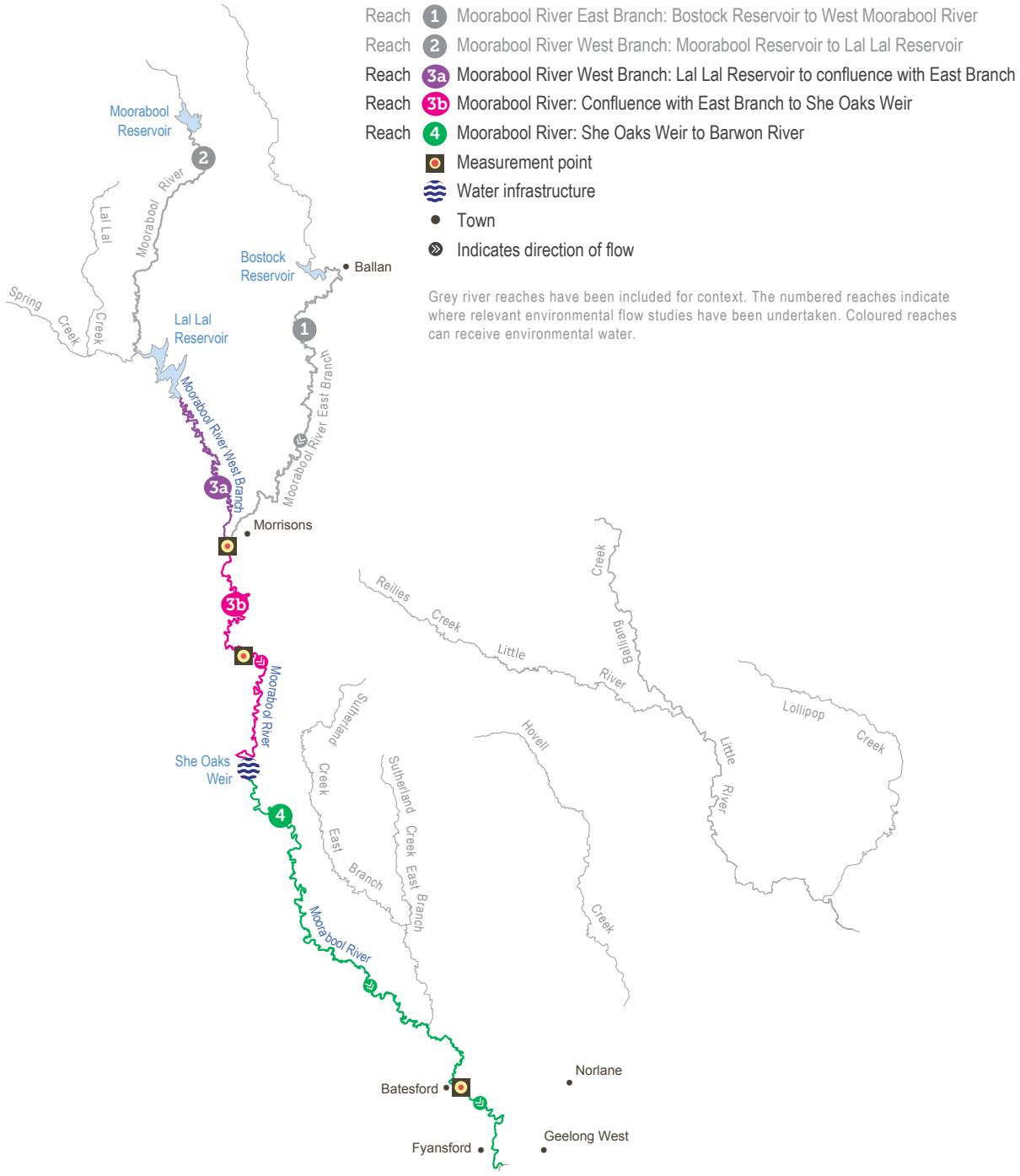
Environmental water can be used to manage flows in reaches 3a, 3b and 4. The priority reaches for environmental water delivery are the reaches between Lal Lal Reservoir and She Oaks Weir (reaches 3a and 3b, as shown on the map), as these are where the small amount of available environmental water can have the most beneficial impact. Environmental water delivered also provides benefits to significant flow-dependant values in reach 4 (which flows from She Oaks Weir, Meredith down to the confluence with the Barwon River in Geelong).

Recent conditions

There was a sharp decline in rainfall in the Moorabool catchment in 2015–16, with minimal river flows even in typically higher-flow periods in winter and spring. Water available under the entitlement relied heavily on water carried over from 2014–15 with only minor increases through the year. The lack of catchment inflows and warm weather caused cease-to-flow periods in summer for the first time since the millennium drought, resulting in a stretch of dry river bed near Batesford.

Trigger-based summer freshes were the priority for the Moorabool River in 2015–16, to improve water quality and top up habitat refuge pools as much as possible given the limited environmental water available. In summer, the trigger-based freshes restored flow connectivity between the Moorabool and Barwon rivers, highlighting the value of these small releases in dry periods.

Figure 3.6.1 The Moorabool system



Three trigger-based freshes were delivered to the Moorabool River in 2015–16, one in mid-December, one in March and one in May. Barwon Water's consumptive water releases from Lal Lal Reservoir also helped to meet low-flow targets in the summer period.

Scope of environmental watering

Potential environmental watering actions and associated environmental objectives are provided in Table 3.6.1.

Table 3.6.1 Potential environmental watering actions and objectives for the Moorabool system

Potential environmental watering[1]	Environmental objectives
Summer/autumn low flows (5–20 ML per day in December–May)	• Provide pool and riffle habitats for fish, waterbugs, platypus and submerged aquatic vegetation • Maintain water quality
Summer/autumn freshes (2–3 freshes targeting 30–60 ML per day for 3–5 days in December–May)[2]	• Allow fish and platypus movement and maintain access to habitat • Flush silt and scour biofilms and algae from streambed • Maintain fringing marginal zone vegetation • Trigger downstream spawning migration of adult short-finned eel and grayling • Maintain water quality, fill up habitat refuge pools and avoid critical loss of biota
Winter/spring low flows (60–86 ML per day in June – November)	• Allow fish movement throughout the reach • Maintain clear flow path and control intrusions by terrestrial vegetation
Winter/spring freshes (2–3 freshes targeting more than 162 ML per day for 10 days in June - November)	• Allow fish and platypus movement through the reach and maintain access to habitat • Trigger downstream spawning migration of adult tupong and upstream migration of juvenile galaxias, tupong, short-finned eel and grayling • Flush silt and scour biofilms and algae from streambed and transport of organic matter • Promote growth and recruitment of native riparian vegetation including woody shrubs and promote strong vegetation zonation on the banks
Winter/spring high flow (1 fresh targeting 500 to 3,000 ML per day for 1–2 days in June–November)	• Scour pools and maintain channel form and dimensions • Flushing of sediment to improve spawning sites • Inundate billabongs

1 The target reaches for environmental watering are reach 3a, 3b and 4 of the Moorabool system unless otherwise stated.
2 Due to the low water availability in the Moorabool system, trigger-based freshes will be provided as required to maintain water quality, particularly in important refuge pools. These events are likely to be significantly lower than the recommended magnitude and duration.

Scenario planning

Table 3.6.2 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

Due to the limited volume of environmental water expected to be available in the Moorabool system, the priority for environmental water delivery is to protect water quality and fish in the higher-risk summer/autumn period. Over summer in a dry year, trigger levels for dissolved oxygen, electrical conductivity and water temperature are monitored and used to inform the release of freshes to improve water quality. If wetter conditions eventuate, unregulated flows are likely to help meet minimum environmental flow requirements, and winter freshes or low flows may become a priority.

Although environmental watering focuses on reaches 3a and 3b, some releases will benefit reach 4. Where possible, deliveries to reaches 3a and 3b will be planned to maximise the benefit for reach 4, for instance by increasing summer fresh volumes when water availability allows. The CMA prioritises carryover of 750 ML each year (if possible) to allow delivery of trigger-based freshes in the following years if low inflows continue. Given low inflows in 2015–16, only about 700 ML was available to carry over into 2016–17.

Table 3.6.2 Potential environmental watering for the Moorabool system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Minimal catchment inflows • Limited passing flows	• Low catchment inflows • Passing flows	• Moderate catchment inflows • Unregulated and passing flows	• High catchment inflows • Unregulated and passing flows
Expected availability of environmental water	• 700 ML carryover • 300 ML inflows • ~1,000 ML total	• 700 ML carryover • 1,800 ML inflows • ~2,500 ML total	• 700 ML carryover • 4,300 ML inflows • ~5,000 ML total	• 700 ML carryover • 6,386 ML inflows • ~7,086 ML total
Potential environmental watering – tier 1 (high priorities)	• Summer/autumn freshes (trigger-based)	• Summer/autumn freshes (trigger-based) • Winter/spring freshes • Summer/autumn low flows	• Summer/autumn freshes • Winter/spring freshes • Summer/autumn low flows	• Summer/autumn freshes • Winter/spring freshes • Summer/autumn low flows
Potential environmental watering – tier 2 (additional priorities)	• Summer/autumn freshes • Winter/spring freshes • Summer/autumn low flows • Winter/spring low flows	• Summer/autumn freshes • Summer/autumn Low flows • Winter/spring freshes • Winter/spring low flows	• Summer/autumn low flows • Summer/autumn freshes • Winter/spring freshes • Winter/spring low flows • Winter/spring high flows	• Winter/spring low flows • Winter/spring high flows
Possible volume required to achieve objectives[1]	• 240 ML (tier 1) • 5,500 ML (tier 2)	• 1,670 ML (tier 1) • 4,070 ML (tier 2)	• 2,500 ML (tier 1) • 7,870 ML (tier 2)	• 2,500 ML (tier 1) • 5,600 ML (tier 2)
Priority carryover requirements	• 750 ML	• 750 ML	• 750 ML	• 750 ML

1 Environmental water requirements for tier 2 actions are additional to tier 1 requirements.

Risk management

In preparing its seasonal watering proposal, Corangamite CMA considered and assessed risks and identified mitigating strategies relating to the implementation of environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 3.6.3 shows the partners and stakeholder organisations with which Corangamite CMA engaged when preparing the Moorabool system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional waterway strategies, environmental water management plans and environmental flow studies, which incorporate environmental, cultural, social and economic considerations.

Table 3.6.3 Partners and stakeholders engaged in developing the Moorabool system seasonal watering proposal

Partner and stakeholder engagement
• Moorabool Stakeholder Advisory Committee (with representatives of People for a Living Moorabool, Geelong Landcare Network, Southern Rural Water, Central Highlands Water, Parks, Victoria, Barwon Water, the VEWH and the local community) • People for a Living Moorabool (community group) • Barwon Water • Central Highlands Water • Southern Rural Water • Department of Environment, Land, Water and Planning • Parks Victoria • Victorian Environmental Water Holder

3.7 Lower Barwon wetlands

Waterway manager – Corangamite Catchment Management Authority

Environmental water holder – Victorian Environmental Water Holder

Environmental values

Reedy Lake and Hospital Swamps form part of the internationally recognised Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar site and provide a home for many thousands of migratory birds from around the world.

The wetlands support about 47 threatened species and communities. These include some of Victoria's rarest species (such as the brolga, orange-bellied parrot, Australasian bittern, growling grass frog, Australian grayling and dwarf galaxias) and subtropical and temperate coastal saltmarsh communities.

Reedy Lake supports a range of vegetation communities including coastal saltmarsh, herbfields and reed beds, which provide important habitat for a variety of animal species. The relative extent of these vegetation communities is changing due to the absence of suitable wetting and drying cycles. Reed beds are continuing to expand, reducing freshwater habitat and the diversity of birds, fish and other animals the system supports.

Hospital Swamps is made up of five unique wetland basins that support a diversity of ecological values and processes. Large areas of threatened coastal saltmarsh and diverse fish and waterbird populations are present at the site. Vegetation communities in Hospital Swamps have remained largely unchanged over time due to the maintenance of natural wetting and drying cycles, which has protected the important environmental values of the wetlands.

Social and economic values

The lower Barwon wetlands are located close to Geelong, the second biggest city in Victoria. They form a very important part of the region's social fabric. The wetlands are valued by many people for their intrinsic beauty, ecological significance and recreational uses. In particular, the wetlands are used heavily by Geelong Field and Game and Geelong Field Naturalists for conservation activities and events, bird watching, game hunting and passive recreation. The system also supports a commercial eel fishery and is of significance to Traditional Owners and their Nations in the area.

Environmental watering objectives in the lower Barwon wetlands

	Provide suitable habitat including mud flats and shallow water for wading birds, and feeding opportunities and refuge for waterbirds and shorebirds
	Promote habitat for fish breeding and growth and improved conditions for migration and dispersal when wetlands are connected to the Barwon River
	Provide varying water levels and conditions to promote soil salinisation to support the persistence and growth of threatened saline-dependant ecological vegetation communities
	Maintain the high diversity of ecological vegetation communities in the wetlands Promote the growth of coastal saltmarsh, herbfields and lignum shrubland ecological vegetation communities

System overview

The estuarine reach of the Barwon River contains a system of wetlands and lakes including Lake Connewarre, Reedy Lake, Hospital Swamps, Salt Swamp and Murtnaghurt Lagoon. Environmental water can be actively managed at Reedy Lake and Hospital Swamps using regulating structures at the wetlands.

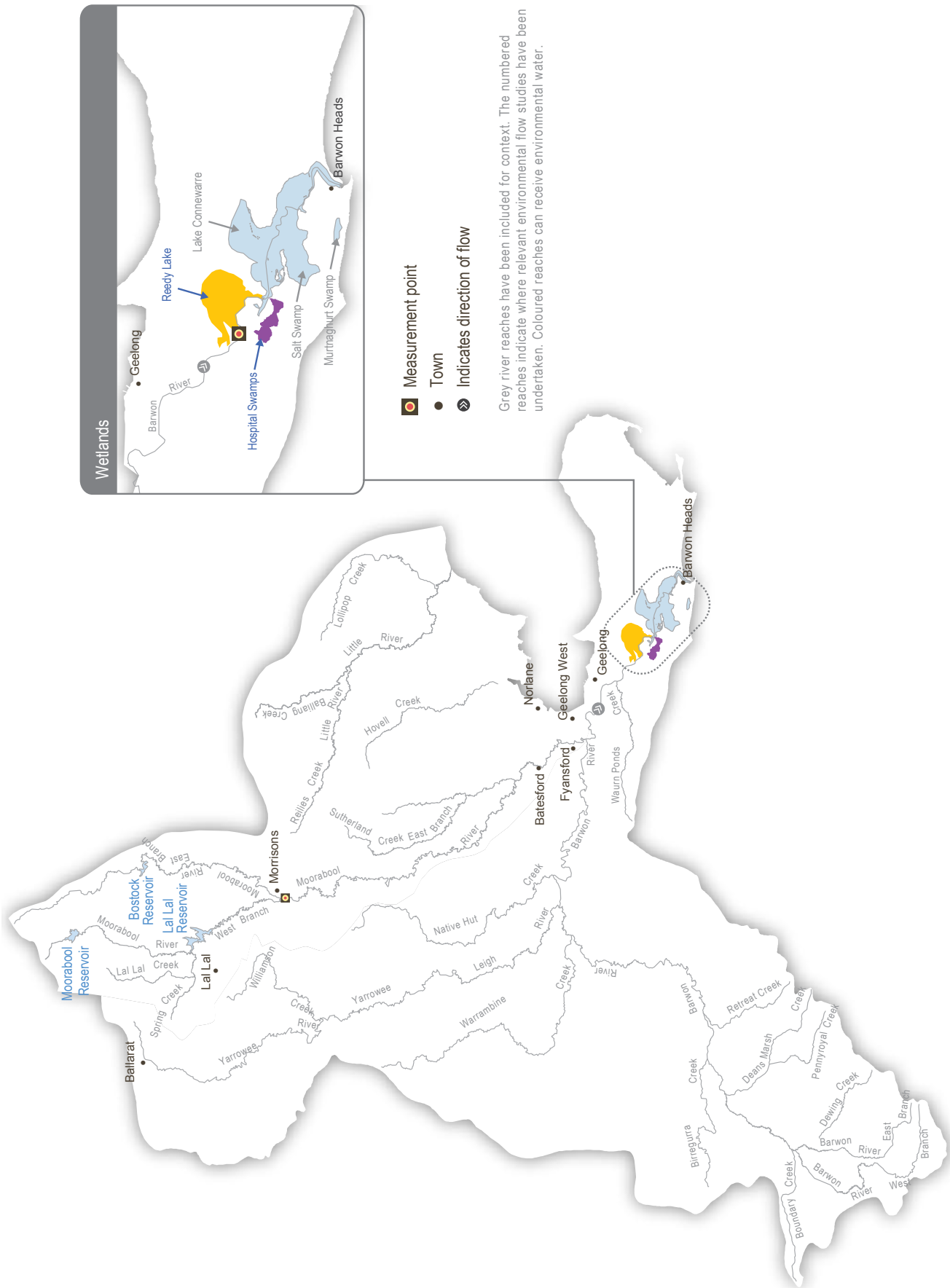
Unlike many other systems, the environmental entitlement does not provide access to water held in storage. Instead, it allows water to be diverted via regulators from the Barwon River into Reedy Lake and Hospital Swamps when river levels are above 0.7 m AHD (Australian Height Datum). High water levels in the Barwon River can also result in natural inundation of the wetlands.

Recent conditions

Dry conditions in the Barwon River catchment resulted in lower river flows than normal in 2015–16, meaning that the water levels in both Reedy Lake and Hospital Swamps were lower than in previous years, as less water could be diverted into the wetlands.

As in previous years, a natural pattern of wetting and drying was implemented in Hospital Swamps which meant inflows from the Barwon River entered the wetland in the winter/spring period and were actively drawn down (reducing the water level) over the drier summer months. This drying cycle helped to support important ecological processes: drying of the wetland is essential for maintaining the balance between fresh and salt water processes, which is necessary to support the diverse mix of vegetation communities and provide feeding and breeding habitat for waterbirds and native fish.

Figure 3.7.1 The Lower Barwon wetlands



Water was delivered to Reedy Lake whenever the levels in the Barwon River were above 0.7 m AHD. As the river level dropped below 0.7 m AHD quite regularly over summer 2015–16, water levels in Reedy Lake naturally fell to about half-full. Heavy rain in January 2016 resulted in high water levels in the Barwon River, increasing inflows to Reedy Lake, with water levels fluctuating in response to natural conditions.

Reedy Lake has largely remained in a constantly wet state since the 1970s. This has altered the soil and water chemistry allowing the extent of tall reed communities to nearly double. While reed beds form an important part of the lake's ecosystem, their continued expansion is reducing habitat diversity as they have taken over areas that previously supported different vegetation types and open water. In turn, this is reducing the number and diversity of internationally important migratory waterbirds the wetland supports. Unfortunately the carp population has also steadily increased and is now at a level where carp are diminishing the health of the lake. Carp prey on native fish and compete with them for habitat and food. They also damage aquatic vegetation.

Scope of environmental watering in 2016–17

Potential environmental watering actions and associated environmental objectives are provided in Table 3.7.1.

A more natural cycle of varying water levels is planned for both Hospital Swamps and Reedy Lake in 2016–17. The cycle will include delivering water in winter/spring and then lowering water levels over summer until the Barwon River level increases in autumn.

At Reedy Lake, introducing a more natural cycle of varying water levels will improve conditions to foster the growth of threatened vegetation communities while also managing the expansion of tall reeds which are seriously reducing habitat. This cycle will also support internationally significant bird species and most lake users. Temporarily lowering water levels at Reedy Lake will affect some users, including a local eel fisher. However, continuing to maintain high water levels in the lake poses a significant long-term risk to the health of the internationally important wetland, including the 47 threatened species and communities the lake supports.

If a more natural cycle of varying water levels is not initiated, the spread of reed beds could ultimately prevent recreational and commercial user access, and reduce populations of waterbirds and fish. This will lessen the fishing, hunting and birdwatching opportunities now available. With lower water levels there will also be the opportunity to control carp numbers, which will further benefit the user groups at Reedy Lake, improve native fish populations and reduce the damage that carp are causing to aquatic vegetation, ultimately benefiting bird populations as well.

Lowering water levels at Reedy Lake is the single most important management action to mitigate threats to the system and ensure all user groups can continue to value and use the lake into the future.

The Corangamite CMA has undertaken extensive consultation about the planned watering regimes for Reedy Lake and Hospital Swamps over the last six years with a broad range of stakeholders and interest groups representing over 1,500 people. These people have been involved in developing the environmental flow study and in additional scientific work exploring ecological risks, vegetation monitoring, alternative management approaches and infrastructure operations. The results from this comprehensive work show that lowering water levels at Reedy Lake is the only feasible management practice that will mitigate threats to the ecological health of the wetland and ensure all user groups can continue to use the system into the future.

No alternative water regime or management approaches could be identified that would enable the environmental health of the wetland to be protected while at the same time mitigating impacts to eel fishing. Corangamite CMA is continuing to work with state water and fisheries managers and the eel fisherman to explore alternative arrangements for eel fishing in the region.

Table 3.7.1 Potential environmental watering actions and objectives for the lower Barwon wetlands

Planning scenario	Environmental objectives
Reedy Lake	
Autumn/winter/spring filling flows (March/April–October)[1] *The inlet to Reedy Lake will be opened in autumn in response to a sustained increase in flows in the Barwon* River	• Maintain connectivity with the Barwon River • Provide feeding habitat for waterbirds in flooded vegetation and the wetland fringe • Promote fish reproduction
Spring/early summer drawdown (October–January) and continued low water levels throughout summer/autumn (January–March/April) *The inlet to Reedy Lake will be closed to allow water levels to drop through evaporation; during this period, the outlet may be manipulated if required to maximise the drawdown or to introduce saltwater to the lake*	• Reduce the threat of tall reeds in the system by increasing the salt content of the water and soil • Reduce the threat of carp and associated impacts on plants and animals • Provide increased habitat diversity (including salt pans, mudflats and shallow water) • Provide wading bird habitat in summer • Provide summer waterbird refuge and foraging habitat • Improve lake shore salinity and promote soil salinisation • Initiate decomposition of organic matter on the wetland bed, to increase lake productivity when it is refilled • Improve soil health and allow weathering of heavy metals in lake fringe soils • Promote suitable conditions for threatened vegetation communities (such as coastal saltmarsh, herbfields and lignum shrubland) • Allow seasonal recruitment of aquatic macrophytes at wetland fringes
Hospital Swamps	
Autumn/winter filling flows (May–November)[1] *Hospital Swamps will be connected to the Barwon River for at least 6 weeks by keeping the inlet and outlet open*	• Create habitat and support waterbug populations • Stimulate fish and waterbird breeding • Allow fish to colonise the wetland from the river • Allow soil and surface water salts to be diluted over winter • Promote and sustain growth of important wetland vegetation communities
Summer/autumn drawdown (December–March/April) *The inlet to Hospital Swamps will be closed to allow water levels to drop through evaporation; during this period, the outlet will be opened for short periods of time if a summer storm increases water levels above 0.85 m AHD*	• Reduce the threat of carp and associated impacts on plants and animals • Reduce the threat of tall reeds in the system by increasing the salt content of the water and soil • Provide increased habitat diversity (including salt pans, mudflats and shallow water) • Provide wading bird habitat in early summer • Provide early summer waterbird refuge and foraging habitat • Improve lake shore salinity and promote soil salinisation • Initiate decomposition of organic matter on the wetland bed, to increase lake productivity when it is refilled • Improve soil health and allow weathering of heavy metals in lake fringe soils • Promote suitable conditions for threatened vegetation communities (such as coastal saltmarsh, herbfields and lignum shrubland) • Allow seasonal recruitment of aquatic macrophytes at wetland fringes

1 Water can only be diverted into the lower Barwon wetlands when water levels in the Barwon River are above 0.7 m AHD at the lower Barrage Gauging Station, in line with provisions for accessing water under the environmental entitlement.

Scenario planning

Table 3.7.2 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

Inundation of the wetlands over the winter period and drawdown in summer are a priority under all scenarios but the extent of the wetting and drying will vary in response to natural conditions. For example, in a wet scenario it is unlikely that a substantial drawdown in Reedy Lake or Hospital Swamps will be achievable. However, some degree of drying is still important to promote vegetation diversity and soil salinisation and to provide a variety of feeding and breeding habitat for waterbirds. The wetlands will be managed adaptively throughout the year in response to climatic conditions to maximise environmental outcomes.

The planned action will be carefully managed throughout the drawdown by the Corangamite CMA, with monitoring in place to ensure that the drawdown can be adaptively managed as needed.

Table 3.7.2 Potential environmental watering for the lower Barwon wetlands under a range of planning scenarios

Planning scenario	Dry	Average	Wet
Expected river conditions	• Some natural inflows from the Barwon River in winter/spring • Dry conditions over summer will assist in the drawdown of the wetlands	• Some natural inflows from the Barwon River in winter/spring • Mild conditions over summer may assist in facilitating some drawdown of the wetland water levels	• Overbank flows likely to inundate the wetlands as a result of higher river flows, stormwater inflows and local rain/run-off • Extensive drawdown of wetlands is unlikely
Reedy Lake			
Potential environmental watering	• Autumn/winter/spring filling flows (March/April–October) • Spring/early summer/autumn drawdown and low water levels (October–March/April)		
Hospital Swamps			
Potential environmental watering	• Autumn/winter/spring filling flows (May–November) • Summer/autumn drawdown (December–March/April)		

Risk management

In preparing its seasonal watering proposal, Corangamite CMA considered and assessed risks and identified mitigating strategies relating to the implementation of environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 3.7.3 shows the partners, stakeholder organisations and individuals with which Corangamite CMA engaged when preparing the lower Barwon wetlands seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional waterway strategies, environmental water management plans and environmental flow studies, which incorporate environmental, cultural, social and economic considerations.

Table 3.7.3 Partners and stakeholders engaged in developing the lower Barwon wetlands seasonal watering proposal

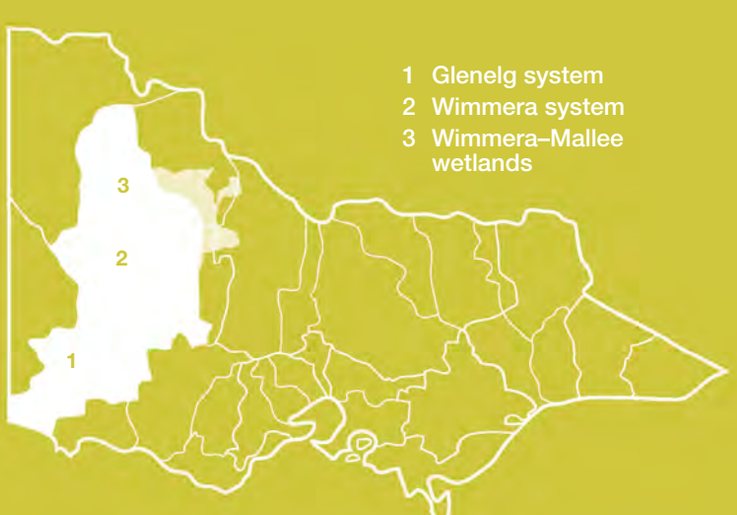
Partner and stakeholder engagement
• Lower Barwon Community Advisory Committee – with representatives of Field and Game Geelong Branch, Geelong Environment Council, Geelong Field Naturalists Club, Geelong Gun and Rod Association, Federation University, RMIT University, Department of Environment, Land, Water and Planning, Environment Victoria, VR Fish, Barwon Water, local landowners, community members, local commercial eel fishing licence holders (until late 2015), Parks Victoria, Southern Rural Water and the VEWH. Additional stakeholders are invited on an as needs basis, including science and engineering consultants and the Department of Economic Development, Jobs, Transport and Resources.
• Other stakeholders include commercial eel fishers and the members for South Barwon, Bellarine, and Western Victoria.

Hospital swamps, by Saul Vermeeren, Corangamite CMA

Glenelg River, by Chloe Wiesenfeld, Victorian Environmental Water Holder

Section 4

Western Region



4.1 Western Region overview

Environmental water in the Western Region is shared between the Wimmera and Glenelg systems and the Wimmera–Mallee wetlands. Important waterways that receive environmental water include sections of the Glenelg, Wimmera and MacKenzie rivers and Mount William, Burnt and Bungalally creeks, as well as priority wetlands formerly supplied by the Wimmera–Mallee channel system.

Environmental water is supplied from the Wimmera–Mallee headworks system which also supplies towns, industries and farms across the Western Region. The complex network of channels and pipelines in the water supply and distribution systems managed by GWMWater enables water to be shifted between storages and delivered in different catchments, including from the Glenelg catchment to the Wimmera catchment.

Waterways in the Western Region are highly valued by local residents and visitors for their environmental and aesthetic values and are widely used for recreational activities such as fishing, camping, swimming, boating, bushwalking and wildlife watching.

Seasonal outlook 2016–17

Inflows to the Wimmera–Mallee headworks system are highly variable. Though the floods in September 2010 and January 2011 significantly boosted streamflows and storage levels, this has been followed by a sequence of dry years. 2015–16 was particularly dry, with some parts of the region experiencing the driest conditions on record.

Conditions in 2016–17 may again be dry, resulting in low environmental water availability, especially in the early part of the season. Due to the very dry catchments, significant and prolonged rainfall will be required to see improvements in streamflows, storage levels and water allocations. This means carryover from 2015–16 will again be essential to maintain basic habitat and functions in key wetlands and rivers in 2016–17.

If dry conditions prevail in 2016–17, environmental watering in the Western Region will be again limited to protecting water quality in the Wimmera and Glenelg systems to maintain habitat for native fish. With low water availability, deliveries will largely be restricted to the summer/autumn period, when water quality risks are highest. There will likely be periods of cease-to-flow in both systems. The focus of environmental watering in the Wimmera–Mallee wetlands will be providing refuges within the dry landscape to support local animals.

The Murray–Darling Basin Plan

The Wimmera system forms part of the larger Murray–Darling Basin and water diversions and environmental water deliveries in this region are also subject to the requirements of the Murray–Darling Basin Plan.

The VEWH's environmental planning and delivery is consistent with the requirements of the Murray–Darling Basin Plan. The potential environmental watering outlined in section 4 fulfils Victoria's obligations under section 8.26 of the plan to identify annual environmental watering priorities for Victoria's water resource areas.

Refer to section 5 for further information about the Murray–Darling Basin Plan.

4.2 Glenelg system

Waterway manager – Glenelg Hopkins Catchment Management Authority

Storage manager – GWMWater

Environmental water holder – Victorian Environmental Water Holder

Environmental values

The lower section of the Glenelg River has been recognised as one of Australia's 15 national biodiversity hotspots due to the high-value aquatic life it supports, including the endangered Glenelg freshwater mussel and Glenelg spiny crayfish. It is also home to platypus and important native fish populations including river blackfish, estuary perch and pygmy perch, some of which migrate long distances upstream from the Glenelg River estuary to complete their lifecycles. Frasers Swamp is another important feature of the upper Glenelg system, supporting a healthy growling grass frog population.

The Glenelg River supports a variety of riparian vegetation communities including the endangered Wimmera bottlebrush. Riparian and floodplain vegetation is comprised of river red gums with paperbark and tea tree understorey.

Social and economic values

The Glenelg system is valued for a wide range of fishing opportunities and several fishing competitions are held on the river throughout the year. Other recreational activities are popular along the river including walking, sightseeing boat cruises, canoeing, bird watching and camping. Many landholders rely on the Glenelg River for stock water and use the productive floodplains for grazing. The river also provides tourism opportunities and supports businesses within townships such as Harrow, Casterton, Dartmoor and Nelson. The waterways in the Glenelg system are places of importance for Traditional Owners and their Nations in the region.

System overview

The Glenelg River supports a wide range of flow-dependent environmental values including rare and threatened plants and animals. Its diversity results from its range of landforms and climate conditions and its connection with the estuary.

The Glenelg River is an integral part of the Wimmera–Mallee headworks system, which supplies towns and properties across the Western Region. The river is regulated at Moora Moora Reservoir and Rocklands Reservoir. Water is also diverted from the Glenelg catchment to the Wimmera catchment by the Moora Moora channel and the Rocklands–Toolondo–Taylors channel and at three weirs on the upper Wannon River. Environmental water is actively managed in the main stem of the Glenelg River below Rocklands Reservoir with passing flows rules in place for the upper Wannon River diversions.

Due to their high environmental value, the priority river reaches are from the Rocklands Reservoir to 5-Mile Outlet (reach 1a), 5-Mile Outlet to the confluence with the Chetwynd River (reach 1b) and from the Chetwynd River to the Wannon River (reach 2). Environmental water in the Glenelg system is released from Rocklands Reservoir for reach 1a via the reservoir wall outlet and for reach 1b via the 5-Mile and 12-Mile outlets, with through-flows delivering water to reach 2. The Glenelg River reach 3 and estuary also benefit from environmental water releases.

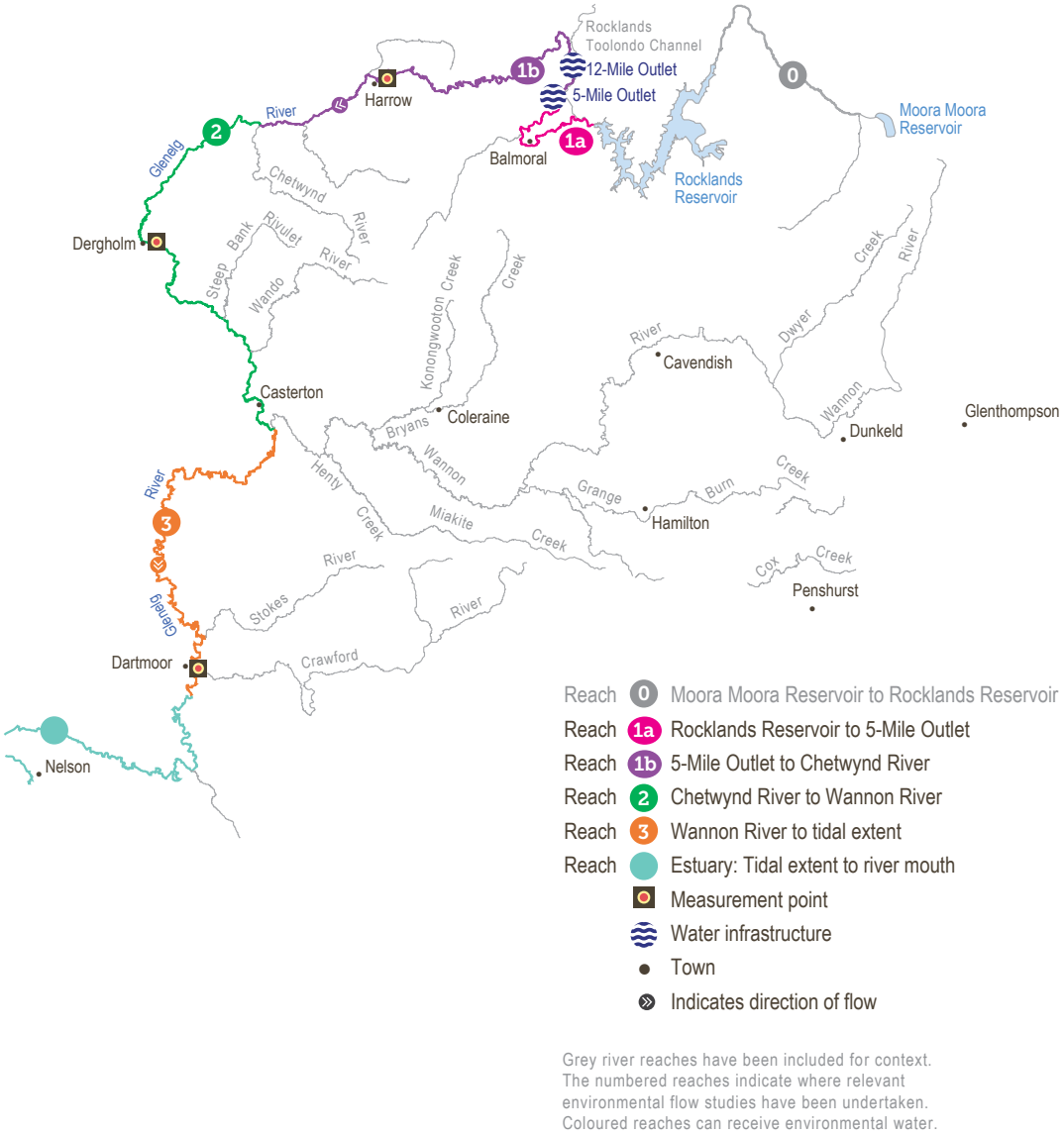
Although not managed for environmental needs, the Glenelg River above Rocklands Reservoir (reach 0) runs mostly through the Grampians National Park and retains significant environmental values. Further work is being undertaken to confirm the flow requirements of this reach. Work is also being undertaken to better understand the role that environmental releases from Rocklands Reservoir play in the health of the Glenelg River estuary (which is listed as a heritage river reach and has been nominated for listing under the Ramsar Convention).

Environmental watering objectives in the Glenelg system
Maintain a healthy and diverse mix of riverside plant life
Protect and boost populations of native fish including the threatened variegated pygmy perch
Provide flows for fish to move upstream and downstream and between the river and the ocean, encouraging fish (such as eel, bream, estuary perch and tupong) to spawn
Maintain a wide range of waterbugs to provide energy, break down organic matter and support the river's food chain
Move built-up sand on the river bed to provide healthy habitat pools and places to shelter for fish, platypus and other water animals (such as the critically endangered Glenelg freshwater mussel and endangered Glenelg spiny crayfish)

Recent conditions

The Glenelg catchment was extremely dry in 2015–16. Low rainfall and inflows meant water allocations were only 16 percent and passing flows from Rocklands Reservoir were severely reduced. Management of environmental water focused on maintaining water quality at key locations and reducing risks to plants and animals from the prolonged dry conditions in the river.

Figure 4.2.1 The Glenelg system



Grey river reaches have been included for context. The numbered reaches indicate where relevant environmental flow studies have been undertaken. Coloured reaches can receive environmental water.

Environmental water carried over from 2014–15 was critical to support flows in 2015–16. Along with low passing flows, low environmental water availability meant that no winter or spring watering was possible. In response to deteriorating water quality, environmental water was released to the Glenelg River in late October 2015, with two subsequent freshes released in December and February.

Water quality was improved as a result of all three freshes. Only a limited length of river could be watered as the losses for all deliveries were very high due to the dry conditions. Releases directly downstream of Rocklands Reservoir only reached Balmoral and releases from the 5-Mile and 12-Mile outlets reached Dergholm at much reduced rates compared to a wetter year. The river effectively ceased to flow at Casterton from November to May with environmental releases only temporarily connecting discreet refuge pools to boost water quality.

Water quality was monitored at key sites in reaches 1b and 2 to inform and monitor the impact of environmental flow releases. Although results demonstrated that each delivery did improve water quality, salinity steadily increased through the year.

Fish moved to refuge pools as the river ceased to flow and the river became a series of disconnected pools. A priority objective for flow management, given the low water availability in 2015–16, was to avoid critical losses of native fish. Fish abundance remained high during fish surveys undertaken in early 2016 with diversity at sampling sites reflecting previous sampling efforts.

Vegetation in and along the Glenelg River has been especially impacted by prolonged cease-to-flow conditions with key habitat areas drying out and increased grazing pressure in riparian areas through 2015–16.

Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 4.2.1.

Table 4.2.1 Potential environmental watering actions and objectives for the Glenelg system

Potential environmental watering	Environmental objectives
Summer/autumn freshes targeting reach 1a (2 freshes of 60 ML/day for 2–3 days each in December–May)	• Provide variable flows during low-flow season to support waterbugs, diverse habitats and water quality • Facilitate localised scouring of sand for fish habitat • Maintain condition of emergent vegetation by wetting lower banks • Flush pools to prevent water quality decline during low flows
Summer/autumn freshes targeting reaches 1b (2 freshes of 100 ML/day for 2–3 days each in December–May)	
Summer/autumn freshes targeting reach 2 (2 freshes of 150 ML/day for 2–3 days each in December–May)	
Summer/autumn baseflows targeting reach 1a (10 ML/day or natural in December–May)[1]	• Protect against rapid water quality decline over low-flow period • Maintain edge habitats, pools and shallow water habitat availability for fish, waterbugs and platypus • Maintain a near-permanent inundated stream channel to prevent excessive in-stream terrestrial species growth and promote in-stream vegetation
Summer/autumn baseflows targeting reach 1b (15 ML/day or natural in December–May)[1]	
Summer/autumn baseflows targeting reach 2 (25 ML/day or natural in December–May)[1]	
Winter/spring freshes targeting reach 1b (1–5 freshes of 250 ML/day for 1–5 days in June–November)[2]	• Wet benches to improve condition of emergent vegetation and maintain habitat diversity • Increase the baseflow water depth and connectivity to provide stimulus and opportunity for fish movement • Facilitate localised scouring of sand for fish habitat • Maintain pools and inundate benches to improve in-stream habitat and vegetation diversity
Winter/spring freshes targeting reach 2 (1–5 freshes of 300 ML/day for 1–5 days in June–November)	
Winter/spring baseflows targeting reach 1a (60 ML/day or natural in June–November)[1, 3]	• Provide desirable water quality conditions for fish, waterbugs and aquatic vegetation • Maintain seasonality of flows and improve habitat diversity by increasing wetted area from summer period • Maintain shallow water habitat availability for fish and waterbugs and facilitate annual dispersal of juvenile platypus
Winter/spring baseflows targeting reach 1b (100 ML or natural per day in June–November)[1, 3]	
Winter/spring baseflows targeting reach 2 (160 ML/day or natural in June–November)[1, 3]	

1 Cease-to-flow events occur naturally in the Glenelg system and may be actively managed. In the most recent flows study, the recommendation is that cease-to-flow events should occur as infrequently as possible and not exceed the duration of events that might have occurred naturally, to reduce stress on environmental values. Cease-to-flow events should be followed with a fresh.

2 Winter/spring freshes in reach 1a are important to the health of the Glenelg River but due to operational constraints and potential flooding risks achievement relies solely on natural events.

3 Passing flows provided under the environmental entitlement generally provide winter/spring baseflows. However, if passing flows are reduced, managed environmental water releases may be required to supplement them or to ensure appropriate rates of rise and fall and provide appropriate conditions in fresh events.

Scenario planning

Table 4.2.2 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

It is unlikely that there will be sufficient environmental water available to deliver all potential environmental watering actions in 2016–17. Tier 1 watering actions are those that can be delivered with the available water. Tier 2 watering actions include the water required to meet the remaining actions recommended by the scientific flow study under different climatic scenarios. While the actions are similar in each climatic scenario, the magnitude, duration and/or frequency differ between scenarios: therefore the volume required under each scenario also differs.

Due to the prolonged dry conditions in the region and associated low flows, water quality is likely to remain poor and pose a risk to aquatic species. Environmental water will help to minimise but not completely mitigate these impacts. As the dry conditions continue, the condition of the plants and animals in the system is likely to deteriorate, and the ability of the plants and animals to survive and recover will be reduced.

Under most scenarios, there will likely be periods of cease-to-flow in summer. Where possible, the duration of these cease-to-flow periods will be carefully managed and monitored to minimise adverse impacts and inform environmental water releases. The priority is to protect water quality and refuge pools to ensure habitat is available for native fish and other animals (such as platypus) in the warmer months (when the risks are highest). Winter watering will only be possible if there are significant inflows and allocations in the early part of the water year.

If wet conditions eventuate, the priority will be increasing the magnitude, frequency and duration of planned watering actions and providing or supplementing flows in the winter/spring period. Natural river flows and passing flows are also likely to contribute to achieving these objectives. Reserving water for carry over into the 2017–18 water year will also be a priority if wetter conditions eventuate.

Table 4.2.2 Potential environmental watering for the Glenelg system under a range of planning scenarios

Planning scenario	Extreme drought	Drought	Dry	Average	Wet
Expected availability of environmental water[1]	• 6,334 ML carryover • 5,000 ML VEWH • 0 ML CEWH[2] • 11,334 ML total[3]	• 6,334 ML carryover • 7,839 ML VEWH • 0 ML CEWH[2] • 14,173 ML total[3]	• 6,334 ML carryover • 17,979 ML VEWH • 0 ML CEWH[2] • 24,313 ML total[3]	• 6,334 ML carryover • 30,553 ML VEWH • 0 ML CEWH[2] • 36,887 ML total[3]	• 6,334 ML carryover • 45,560 ML VEWH • 0 ML CEWH[2] • 51,894 ML total[3]
Expected river conditions	• No passing, compensation or unregulated flows	• No passing, compensation or unregulated flows	• Restricted passing and compensation flows and no unregulated flows	• Some passing, compensation and unregulated flows, particularly in winter/spring	• Some passing, compensation and unregulated flows
Potential environmental watering – tier 1 (high priorities)[4]	• Summer/autumn freshes reach 1b • Summer/autumn freshes reach 2 • Summer/autumn baseflows reach 1b • Summer/autumn freshes reach 1a • Winter/spring freshes reach 1b	• Summer/autumn freshes reach 1b • Summer/autumn freshes reach 2 • Summer/autumn baseflows reach 1b • Summer/autumn freshes reach 1a	• Summer/autumn freshes reach 1b • Summer/autumn freshes reach 1a • Winter/spring freshes reach 1b • Summer/autumn freshes reach 2 • Spring/summer/ autumn baseflows reach 1b	• Summer/autumn freshes reach 1b • Summer/autumn freshes reach 1a • Winter/spring freshes reach 1b • Summer/autumn freshes reach 2 • Summer/autumn baseflows reach 1b • Summer/autumn baseflows reach 1a • Summer/autumn baseflows reach 2	• Summer/autumn freshes reach 1b • Summer/autumn freshes reach 1a • Winter/spring freshes reach 1b • Summer/autumn freshes reach 2 • Summer/autumn baseflows reach 1b • Summer/autumn baseflows reach 1a • Summer/autumn baseflows reach 2 • Winter/spring baseflows
Potential environmental watering – tier 2 (additional priorities)	• Summer/autumn baseflows reach 1b • Summer/autumn baseflows reach 1a • Summer/autumn baseflows reach 2 • Winter/spring baseflows reach 1a • Winter/spring baseflows reach 1b • Winter/spring freshes reach 2 • Winter/spring baseflows reach 2	• Summer/autumn baseflows reach 1a • Summer/autumn baseflows reach 1b • Winter/spring freshes reach 1b • Summer/autumn baseflows reach 2 • Winter/spring baseflows reach 1a • Winter/spring baseflows reach 1b • Winter/spring freshes reach 2 • Winter/spring baseflows	• Spring/summer/ autumn baseflows reach 1b • Summer/autumn baseflows reach 1a • Winter/spring baseflows reach 1b • Winter/spring baseflows reach 1a • Summer/autumn baseflows reach 2 • Winter/spring freshes reach 2 • Winter/spring baseflows reach 2	• Summer/autumn baseflows reach 2 • Winter/spring baseflows reach 1a • Winter/spring baseflows reach 1b • Winter/spring baseflows reach 2	• N/A
Possible volume of environmental water required to achieve objectives[5]	• 5,600 ML (tier 1) • 33,700 ML (tier 2)	• 7,087 ML (tier 1) • 47,793 ML (tier 2)	• 12,157 ML (tier 1) • 39,973 ML (tier 2)	• 18,443 ML (tier 1) • 17,967 ML (tier 2)	• 23,450 ML (tier 1)

1 Environmental water in the Wimmera–Glenelg system is shared between the Glenelg and Wimmera systems. The volumes specified show the likely availability across the shared systems and include 5,000 ML of allocation expected to be available through trade in 2016–17.

2 Commonwealth environmental water is only available for use in the Wimmera system.

3 This volume is a forecast of the total water likely to be available under the VEWH entitlement in 2016–17, including carryover water and the forecast allocation for the complete water year. The forecast opening allocation for each climate scenario is 0 ML under all scenarios, meaning the only water available is likely to be the carryover of about 6,300 ML at the start of the water year.

4 As the entitlement is shared between the Wimmera and Glenelg catchments, planning for tier 1 for each CMA has included a simplifying assumption that half of the expected allocations will be available to each CMA. A prioritisation process will be undertaken in consultation with the Wimmera and Glenelg Hopkins CMAs to determine the potential watering actions that will be undertaken in each system in the 2016–17 year.

5 Environmental water requirements for tier 2 actions are additional to tier 1 requirements.

Risk management

In preparing its seasonal watering proposal, Glenelg Hopkins CMA considered and assessed risks and identified mitigating strategies relating to implementing environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 4.2.3 shows the partners, stakeholder organisations and individuals with which Glenelg Hopkins CMA engaged when preparing the Glenelg system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional waterway strategies, environmental water management plans and environmental flow studies, which incorporate environmental, cultural, social and economic considerations.

Table 4.2.3 Partners and stakeholders engaged in developing the Glenelg system seasonal watering proposal

Stakeholder engagement
• Aboriginal groups (Gunditj Mirring Traditional Owner Aboriginal Corporation and Barengi Gadjin Land Council) • Parks Victoria • Glenelg Hopkins CMA Advisory Group (including representatives of stakeholder groups and landholders in the region) • Recreational groups: Balmoral Angling Club, Casterton Angling Society, VRFish, Dartmoor Angling Club, Warrnambool Offshore and Light Game Club, individual anglers • Community members and landholders (through direct engagement) • GWMWater • Wimmera CMA • Victorian Environmental Water Holder

Glenelg River, by Chloe Wiesenfeld, Victorian Environmental Water Holder

4.3 Wimmera system

Waterway manager – Wimmera Catchment Management Authority

Storage manager – GWMWater

Environmental water holders – Victorian Environmental Water Holder and Commonwealth Environmental Water Holder

Environmental values

The Wimmera River and its tributaries boast a wide range of environmental and social values. The Wimmera system is home to many significant plant and animal species including one of Victoria's few self-sustaining populations of freshwater catfish. It also contains self-sustaining endemic fish species including the flat-headed gudgeon and Australian smelt.

The MacKenzie River contains the only stable population of platypus in the Wimmera and also supports good populations of native fish, waterbugs, threatened Glenelg spiny crayfish and turtles. Particularly in dry times, it provides diverse habitat and refuge for these populations.

Protecting and restoring riparian vegetation communities is an environmental water objective for the Burnt and Bungalally creeks. Upper Burnt Creek contains an important native fish community and a population of threatened western swamp crayfish. Burnt Creek in particular provides habitat corridors for both aquatic and terrestrial species. Mount William Creek is a priority reach to assist in maintaining the creek's important populations of river blackfish, southern pygmy perch and threatened western swamp crayfish, in both the upper and lower sections.

Social and economic values

The Wimmera system offers many popular recreational activities including walking, boating, rowing, waterskiing, fishing and camping. It also provides important amenity for Wimmera residents in what is a very dry landscape. There are several events held on the waterways including the annual Kanamaroo Festival, the Horsham Triathlon, the Dimboola Rowing Regatta and the Horsham, Jeparit and Dimboola fishing competitions on the Wimmera River. The waterways in the Wimmera system continue to be important for Traditional Owners and their Nations in the region.

System overview

The Wimmera River commences in the Pyrenees Range near Elmhurst and receives flows from several tributaries including the MacKenzie River and the Mount William, Burnt and Bungalally creeks. All of these can receive environmental water, as can the Wimmera River downstream of lower Mount William Creek. Just east of Mt Arapiles the Wimmera River swings to the north and continues through Dimboola and Jeparit to Lake Hindmarsh, one of Victoria's largest freshwater lakes. During exceptionally wet periods, Lake Hindmarsh overflows into Outlet Creek and on to Lake Albacutya, an internationally recognised Ramsar-listed wetland extending to the Wirrengren Plain in the southern Mallee.

Water in the Wimmera system is stored in three on-stream reservoirs—Lake Wartook on the MacKenzie River, Lake Lonsdale on Mount William Creek and Lake Bellfield on Fyans Creek—and in several off-stream storages: Taylors Lake, Lake Fyans and Toolondo Reservoir. The channel system enables water movement between storages and from the Glenelg to the Wimmera system. Inter-basin transfers of water can occur from the Glenelg system, from Rocklands Reservoir via Rocklands-Toolondo Channel and from Moora Moora Reservoir via the Moora Channel to the Wimmera system. Water from the system is also delivered to towns and several Wimmera–Mallee wetlands in the Loddon, Avoca and Mallee catchments.

Passing flows are provided to the Wimmera River and to Mount William and Fyans creeks. Where possible, environmental water releases will be combined with passing flows, unregulated flows and the delivery of consumptive water en route, to optimise environmental outcomes.

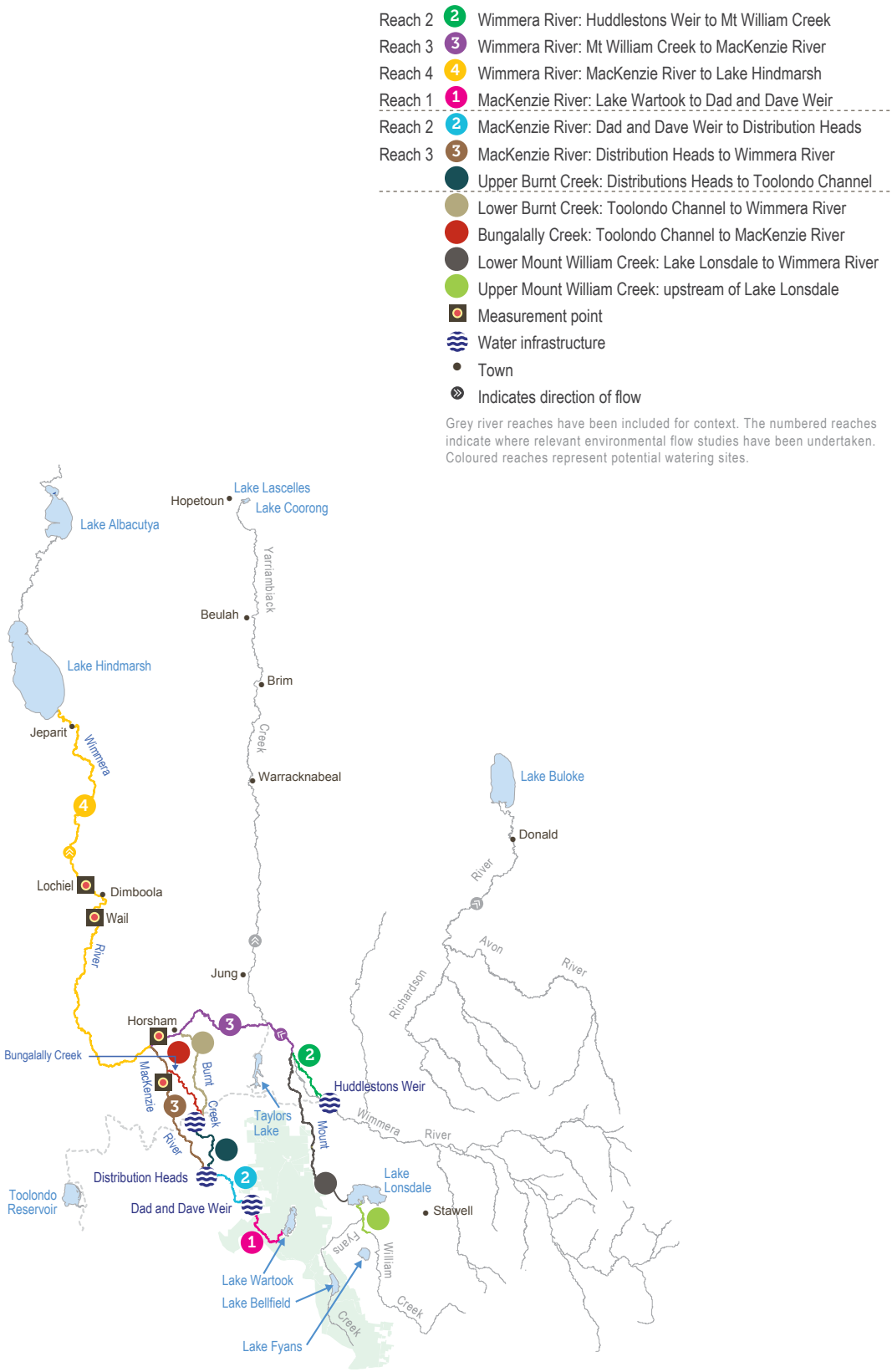
Priority reaches for environmental watering in the Wimmera system are the Wimmera River reach 4, MacKenzie River reaches 2 and 3, upper and lower Mount William Creek, upper and lower Burnt Creek and Bungalally Creek, due to the range of environmental values they support.

Yarriambiack Creek, a distributary of the upper Wimmera River, has historically received some flows during high-flow events in the Wimmera River. However, the creek now receives more flows due to modifications to the offtake. This reduces the effectiveness of environmental water deliveries to the high-priority reaches of the Wimmera River. In line with past practice during dry years, flows entering the creek may be blocked to ensure watering objectives in the Wimmera River are not compromised.

Environmental watering objectives in the Wimmera system

	Restore, protect and boost diverse populations of native fish including one of Victoria's few self-sustaining populations of freshwater catfish
	Maintain water quality to provide suitable conditions for fish and other water-dependent plants and animals
	Provide flows to support platypus, maximising habitat in which they can rest, breed, feed and allow dispersal to other areas
	Improve the condition, abundance and diversity of aquatic, emergent and riparian vegetation
	Support communities of waterbugs which provide energy, break down dead organic matter and support the river's food chain

Figure 4.3.1 The Wimmera system



Recent conditions

This year the Wimmera system has had the driest inflows on record, with environmental water releases making up the majority of flows for the lower Wimmera River as well as other waterways during drier months. Allocations to June 2016 were low (16 percent) and there were no passing flows in the Wimmera system. As a result, actions in 2015–16 relied heavily on environmental water carried over from 2014–15. Given the low water availability, the focus in 2015–16 was on maintaining water quality as much as possible, to maximise the habitat available for plants and animals in the dry climate by maintaining drought refuges.

With the limited water available, watering in the Wimmera system commenced in October 2015 and was restricted to two freshes for the Wimmera River, one top-up for Mokepilly pool on upper Mount William Creek and summer/autumn baseflows for MacKenzie River, with some through-flows to upper Burnt Creek. There was not enough environmental water in 2015–16 to deliver flows to reach 3 of the MacKenzie River, the lower Wimmera River downstream of Dimboola Weir, lower Burnt Creek, Bungalally Creek or lower Mount William Creek.

Despite the dry conditions, the fish community in the Wimmera River is withstanding the stresses of drought with a good diversity found this year and evidence of catfish recruitment over a series of years. The western swamp crayfish in Mt William Creek at Mokepilly is a notable discovery as well as the southern pygmy perch recruitment there in 2015. Recent bird surveys have found a high diversity of birds along the lower Wimmera River indicating the importance of providing open water and habitat in the dry landscape.

While environmental flow targets were not achieved due to the limited water availability, the releases helped maintain water quality and habitat availability for aquatic species. In March 2016, an adult male platypus and a juvenile female platypus were found in the MacKenzie River, indicating the continued growth of the platypus population in this river.

Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 4.3.1.

Table 4.3.1 Potential environmental watering actions and objectives for the Wimmera system

Potential environmental watering	Environmental objectives
Wimmera River (reach 4)	
Summer/autumn baseflows (15 ML/day or natural in December–May)[1]	• Maintain edge habitats in deeper pools and runs, and shallow water habitat availability for waterbugs and native fish from the local area • Maintain near-permanent inundated stream channel for riparian vegetation and to prevent excessive in-stream terrestrial species growth
Winter/spring baseflows (30 ML/day in June–November)	• Provide flows variability to maintain diversity of habitats
Summer/autumn freshes (1–3 freshes of 70 ML/day for 2–7 days in December–May)	• Provide variable flows during low-flow season for waterbugs, fish movement and to maintain water quality and diversity of habitat
Winter/spring freshes (1–5 freshes of 70 ML/day for 1–4 days in June–November)	• Increase the baseflow water depth to provide stimulus for fish movement • Provide flow variability to maintain water quality and diversity of fish habitats
Moderate winter/spring freshes (1–3 freshes of 200 ML/day for 1–3 days in June–November[2])	• Wet lower benches, entraining organic debris and promoting diversity of habitat
Higher winter/spring freshes (1–2 freshes of up to 1,300 ML/day for 2–3 days in June–November)	• Flush surface sediments from hard substrates to support waterbugs • Wet higher benches, entraining organic debris and promoting diversity of habitat
MacKenzie River (reach 2 and 3)	
Year-round baseflows (of 2–27 ML/day or natural, year-round)[1]	• Maintain edge habitats and deeper pools and runs for waterbugs • Maintain inundated stream channel to protect and restore riparian and floodplain vegetation communities (including the Wimmera bottlebrush) and support aquatic vegetation for fish habitat • Maintain sufficient area of pool habitat for intact fish communities and shallow water habitats for small-bodied fish • Facilitate annual dispersal of juvenile platypus into the Wimmera River

Potential environmental watering	Environmental objectives
Summer/autumn freshes (3–4 freshes of 5–50 ML/day for 2–7 days each in December–May)	• Provide variable flows during low-flow season for waterbugs, for fish movement and to maintain water quality and diversity of habitat
Winter/spring freshes (5 freshes of 35–55 ML/day for 2–7 days in June–November)	• Stimulate fish movement and maintain water quality and habitat diversity
Higher winter/spring freshes (1–5 freshes of up to 130–190 ML/day for 1–4 days in June–November)	• Stimulate fish movement and maintain water quality • Flush surface sediments from hard substrates to support waterbugs • Wet higher benches, entraining organic debris and promoting diversity of habitat
Burnt Creek	
Year-round baseflows targeting upper Burnt Creek (1 ML/day or natural, year-round)[1]	• Maintain edge habitats and deeper pools and runs for waterbugs • Maintain inundated stream channel to protect and mimic riparian and floodplain vegetation communities and prevent excessive streambed colonisation by terrestrial vegetation species • Maintain sufficient area of pool habitat for intact fish communities and shallow water habitats for small-bodied fish
Summer/autumn freshes targeting upper Burnt Creek (3 freshes of 30 ML/day for 2–7 days each in December–May)	• Prevent decline in water quality by flushing pools during low flows
Winter/spring freshes targeting upper Burnt Creek (1–5 freshes of 55 ML/day for 3–7 days in June–November)	• Provide variable flows for fish movement and diversity of habitat • Flush surface sediments from hard substrates for waterbugs
Higher winter/spring freshes targeting upper Burnt Creek (1–3 freshes of up to 160 ML/day for 1–3 days in June–November)	• Disturb biofilms present on rocks or woody debris to support waterbugs
Year-round fresh targeting lower Burnt Creek (1 fresh of 45 ML/day or natural for 2 days at any time)	• Inundate riparian vegetation to maintain condition and facilitate recruitment • Entrain organic debris in the channel to support waterbugs • Maintain structural integrity of channel
High-flow fresh targeting lower Burnt Creek (1 fresh of 90 ML/day for 1 day in August–November)	• Inundate floodplain vegetation to maintain condition and facilitate recruitment • Entrain organic debris from the floodplain to support waterbugs • Maintain floodplain geomorphic features
Mount William Creek	
Top-up of upper Mount William Creek pools	• Maintain habitat for native fish
Year-round baseflows targeting lower Mount William Creek (5 ML/day or natural, year-round)[1]	• Maintain edge habitats and shallow water habitat for waterbugs and endemic fish • Maintain inundated stream channel to protect and restore riparian and floodplain vegetation communities and prevent excessive streambed colonisation by terrestrial vegetation species
Summer/autumn freshes targeting lower Mount William Creek (3 freshes of 20–30 ML/day for 2–7 days in December–May)	• Prevent decline in water quality by flushing pools during low flows • Provide variable flows during low-flow season for waterbugs, for fish movement and to maintain water quality and diversity of habitat
Winter/spring freshes targeting lower Mount William Creek (1–5 freshes of up to 100 ML/day for 1–7 days in June–November)	• Wet benches, entrain organic debris and promote habitat diversity • Flush surface sediments from hard substrates to support waterbugs
Higher winter/spring freshes targeting lower Mount William Creek (1–3 freshes of up to 500 ML/day for 1–3 days in June–November)	• Wet highest benches, entrain organic debris and promote habitat diversity
Bungalally Creek	
Year-round fresh (1 fresh of 60 ML/day for 2 days at any time)	• Inundate riparian zone to maintain condition and facilitate recruitment for riparian vegetation communities • Maintain structural integrity of channel and prevent loss of channel capacity

1 Cease-to-flow events occur naturally in the Wimmera system and may be actively managed. In the most recent flow study, the recommendation is that cease-to-flow events should occur as infrequently as possible and not exceed the duration of events that might have occurred naturally, to reduce stress on environmental values. Cease-to-flow events should be followed with a fresh lasting at least seven days.

2 Dependent on catchment conditions, the timing of this fresh may vary to optimise environmental outcomes.

A study exploring the feasibility of creating a refuge pool in an anabranch of the Wimmera River near Jeparit Weir is now underway. Once the study is complete, the site may be considered as an additional potential environmental watering action.

Scenario planning

Table 4.3.2 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

It is unlikely that there will be sufficient environmental water available to deliver most potential environmental watering actions in 2016–17. Tier 1 watering actions represent those able to be delivered with the available water. Tier 2 watering actions include the water required to meet the remaining actions recommended by the scientific flow study under different climatic scenarios. While the actions are similar in each climatic scenario, the magnitude, duration and/or frequency differ between scenarios: therefore the volume required under each scenario also differs.

Due to the prolonged dry conditions in the region and associated low flows, water quality is likely to remain poor. This poses risks to aquatic species. Environmental water will help to minimise but not completely mitigate these risks.

Under most scenarios, there will likely be periods of cease-to-flow. The priority is to protect water quality and refuge pools in rivers and creeks to ensure habitat is available for native fish and other animals (such as platypus) during the warmer months (when risks are highest). Winter watering will only be possible if there are significant inflows and allocations in the early part of the water year.

Dry conditions can limit the opportunity to deliver some environmental watering actions due to infrastructure constraints or water quality issues in the Wimmera system. For example, opportunities to deliver environmental flows to lower Mount William Creek are restricted under dry conditions because Lake Lonsdale is expected to remain empty, as was the case at the start of 2016–17. Wimmera CMA and the VEWH will work closely with GWMWater to maximise environmental outcomes within the constraints posed by dry conditions.

If wet conditions eventuate, the priority will be increasing the magnitude, frequency and duration of planned watering actions and providing flows in the winter/spring period. Natural river flows and passing flows are also likely to contribute to achieving these objectives.

Reserving water to carry over into the 2017–18 water year will also be a priority if wetter conditions eventuate.

Table 4.3.2 Potential environmental watering for the Wimmera system under a range of planning scenarios

Planning scenario	Extreme drought	Drought	Dry	Average	Wet
Expected availability of environmental water entitlements[1]	• 6,334 ML carryover • 5,000 ML VEWH • 0 ML CEWH[2] • 11,334 ML total[3]	• 6,334 ML carryover • 7,839 ML VEWH • 0 ML CEWH[2] • 14,173 ML total[3]	• 6,334 ML carryover • 17,979 ML VEWH • 0 ML CEWH[2] • 24,313 ML total[3]	• 6,334 ML carryover • 30,553 ML VEWH • 0 ML CEWH[2] • 36,887 ML total[3]	• 6,334 ML carryover • 45,560 ML VEWH • 0 ML CEWH[2] • 51,894 ML total[3]
Expected river conditions	• No passing or unregulated flows	• No passing or unregulated flows	• Restricted passing and no unregulated flows	• Some passing and unregulated flows particularly in winter/spring	• Some passing flows and unregulated flows
Potential environmental watering – tier 1 (high priorities)[4]					
MacKenzie River reaches 2 & 3	• Summer/autumn freshes • Winter/spring freshes	• Summer/autumn freshes • Winter/spring freshes	• Summer/autumn freshes and baseflows • Winter/spring freshes and baseflows	• Summer/autumn freshes and baseflows • Winter/spring freshes and baseflows	• Summer/autumn freshes and baseflows • Winter/spring freshes and baseflows
Wimmera River reach 4	• Summer/autumn freshes • Winter/spring freshes	• Summer/autumn freshes • Winter/spring freshes	• Summer/autumn freshes and baseflows • Winter/spring freshes and baseflows	• Winter/spring freshes and baseflows summer/autumn freshes and baseflows	• Summer/autumn freshes and baseflows • Winter/spring freshes and baseflows
Upper Burnt Creek	• Summer/autumn freshes • Winter/spring freshes	• Summer/autumn freshes • Winter/spring freshes	• Summer/autumn freshes and baseflows • Winter/spring freshes and baseflows	• Summer/autumn freshes and baseflows • Winter/spring freshes and baseflows	• Summer/autumn freshes and baseflows
Upper Mt William Creek	• Pool top-ups	• Pool top-ups	• Pool top-ups	• Pool top-ups	• N/A
Lower Burnt Creek	• N/A	• N/A	• N/A	• N/A	• Winter/spring freshes and baseflows

Planning scenario	Extreme drought	Drought	Dry	Average	Wet
Bungalally Creek	• N/A	• N/A	• N/A	• N/A	• Fresh any time of year
Potential environmental watering – tier 2 (additional priorities)					
MacKenzie River reaches 2 & 3	• Summer/autumn freshes and baseflows • Winter/spring freshes and baseflows	• Summer/autumn freshes and baseflows • Winter/spring freshes and baseflows	• Summer/autumn freshes and baseflows • Winter/spring freshes and baseflows	• Winter/spring freshes and baseflows	• N/A
Wimmera River reach 4	• Summer/autumn freshes and baseflows • Winter/spring freshes and baseflows • Winter/spring moderate freshes	• Summer/autumn freshes and baseflows • Winter/spring freshes and baseflows • Winter/spring moderate freshes	• Summer/autumn freshes and baseflows • Winter/spring freshes and baseflows • Winter/spring moderate freshes • Winter/spring higher freshes	• Summer/autumn freshes and baseflows • Winter/spring freshes and baseflows • Winter/spring moderate freshes • Winter/spring higher freshes	• Summer/autumn freshes and baseflows • Winter/spring freshes and baseflows • Winter/spring moderate freshes • Winter/spring higher freshes
Upper Burnt Creek	• Summer/autumn freshes and baseflows • Winter/spring freshes and baseflows	• Summer/autumn freshes and baseflows • Winter/spring freshes and baseflows	• Summer/autumn freshes and baseflows • Winter/spring freshes and baseflows • Winter/spring higher freshes	• Summer/autumn freshes and baseflows • Winter/spring freshes and baseflows • Winter/spring higher freshes	• Summer/autumn freshes and baseflows • Winter/spring freshes and baseflows • Winter/spring higher freshes
Upper Mt William Creek	• Pool top-ups	• Pool top-ups	• Pool top-ups	• Pool top-ups	• Pool top-ups
Lower Mount William Creek	• Year-round baseflows • Summer/autumn freshes • Winter/spring freshes	• Year-round baseflows • Summer/autumn freshes • Winter/spring freshes	• Year-round baseflows • Summer/autumn freshes • Winter/spring freshes • Winter/spring higher freshes	• Year-round baseflows • Summer/autumn freshes • Winter/spring freshes • Winter/spring higher freshes	• Year-round baseflows • Summer/autumn freshes • Winter/spring freshes • Winter/spring higher freshes
Lower Burnt Creek				• Fresh any time of year	• Fresh any time of year • August–November high flow fresh
Bungalally Creek				• Fresh any time of year	• Fresh any time of year
Possible volume of environmental water required to achieve objectives[5]	• 5,667 ML (tier 1) • 36,570 ML (tier 2)	• 7,087 ML (tier 1) • 40,143 ML (tier 2)	• 12,157 ML (tier 1) • 46,666 ML (tier 2)	• 18,443 ML (tier 1) • 40,480 ML (tier 2)	• 25,947 ML (tier 1) • 41,766 ML (tier 2)

1 Environmental water in the Wimmera–Glenelg system is shared between the Glenelg and Wimmera systems. The volumes specified show the likely availability across the shared systems and include 5,000 ML of allocation expected to be available through trade in 2016–17.

2 Commonwealth environmental water is only available for use in the Wimmera system.

3 This volume is a forecast of the total water likely to be available under the VEWH entitlement in 2015–16, including carryover water and the forecast allocation for the complete water year. The forecast opening allocation for each climate scenario is 0 ML under all scenarios, meaning the only water available is likely to be carryover water of about 6,300 ML at the start of the water year.

4 As the entitlement is shared between the Wimmera and Glenelg catchments, planning for tier 1 for each CMA has included a simplifying assumption that half of the expected allocations will be available to each CMA. A prioritisation process will be undertaken in consultation with the Wimmera and Glenelg Hopkins CMAs to determine the potential watering actions that will be undertaken in each system in the 2016–17 year.

5 Environmental water requirements for tier 2 actions are additional to tier 1 requirements.

Risk management

In preparing its seasonal watering proposal, Wimmera CMA considered and assessed risks and identified mitigating strategies relating to implementing environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 4.3.3 shows the partners and stakeholder organisations with which Wimmera CMA engaged when preparing the Wimmera system seasonal watering proposal. Other stakeholders and individuals are consulted throughout the year to assist the Wimmera CMA in implementing the seasonal watering plan.

Seasonal watering proposals are informed by longer-term regional waterway strategies, environmental water management plans and environmental flow studies, which include environmental, cultural, social and economic considerations.

Table 4.3.3 Partners and stakeholders engaged in developing the Wimmera system seasonal watering proposal

Stakeholder engagement
• Glenelg Hopkins CMA • Local governments (including Horsham Rural City Council and Hindmarsh Shire Council) • GWMWater • Victorian Environmental Water Holder

Wimmera River, by Chloe Wiesenfeld, Victorian Environmental Water Holder

4.4 Wimmera–Mallee wetlands

Waterway managers – Mallee, North Central and Wimmera catchment management authorities

Storage manager – GWMWater

Environmental water holder – Victorian Environmental Water Holder

Environmental values

There is great variation in the character of wetlands in the Wimmera–Mallee system. Though generally much smaller in size than other wetlands that receive environmental water in the Northern, Central and Gippsland regions, wetlands in the Wimmera–Mallee system provide important habitat, feeding and breeding opportunities for a range of waterbirds and animals in a predominantly dry landscape. Rare and vulnerable vegetation species (such as spiny lignum, ridged water milfoil and cane grass) are also present in some wetlands.

The Wimmera–Mallee wetlands include a wide range of wetland types (such as freshwater meadows, open freshwater lakes and freshwater marshes). This diversity is important to provide a range of different open-water habitats for the plants and animals in the western part of the state. They also vary in size, consist of many different vegetation communities and are home to native waterbird populations including brolgas, egrets, blue-billed ducks, freckled ducks, Australian painted snipes and glossy ibis. The wetlands provide a valuable source of water for other native animals including the vulnerable growling grass frog, turtles and many other species that rely on these wetlands as drought refuges and drinking holes.

Social and economic values

These wetlands are highly valued by the community and provide places for recreational activities including canoeing, yabbying, duck and quail hunting and bird watching.

Environmental watering objectives in the Wimmera–Mallee wetlands
Provide watering holes for native animals across the landscape
Strengthen and maintain plant life in and around the wetlands, including to provide shade, shelter and food for native animals
Provide habitat and food for frogs and turtles
Create shallow and deep wetlands to provide habitat for a wide range of waterbirds

System overview

The Wimmera–Mallee wetlands include 51 wetlands on public and private land spread across the dry north-west area of Victoria. Historically, the wetlands received water from the open channel system before the Wimmera–Mallee pipeline was completed. As part of the pipeline project, all stock and domestic supply dams were replaced with tanks and the open channel distribution system was replaced by pipeline. The project achieved significant water savings for environmental watering of the area's flow-stressed rivers, creeks and waterways and created regional development opportunities; but it also substantially reduced the open water in the formerly channel-supplied areas. To mitigate the loss of open water in the landscape, a 1,000 ML environmental entitlement was created to supply to wetlands (some with associated dams) that were previously supplied through the old channel system; the entitlement is supplied via the Wimmera–Mallee pipeline system. A project was completed to identify priority wetlands to be connected to the pipeline system, and all 51 wetlands are now connected to the pipeline.

Recent conditions

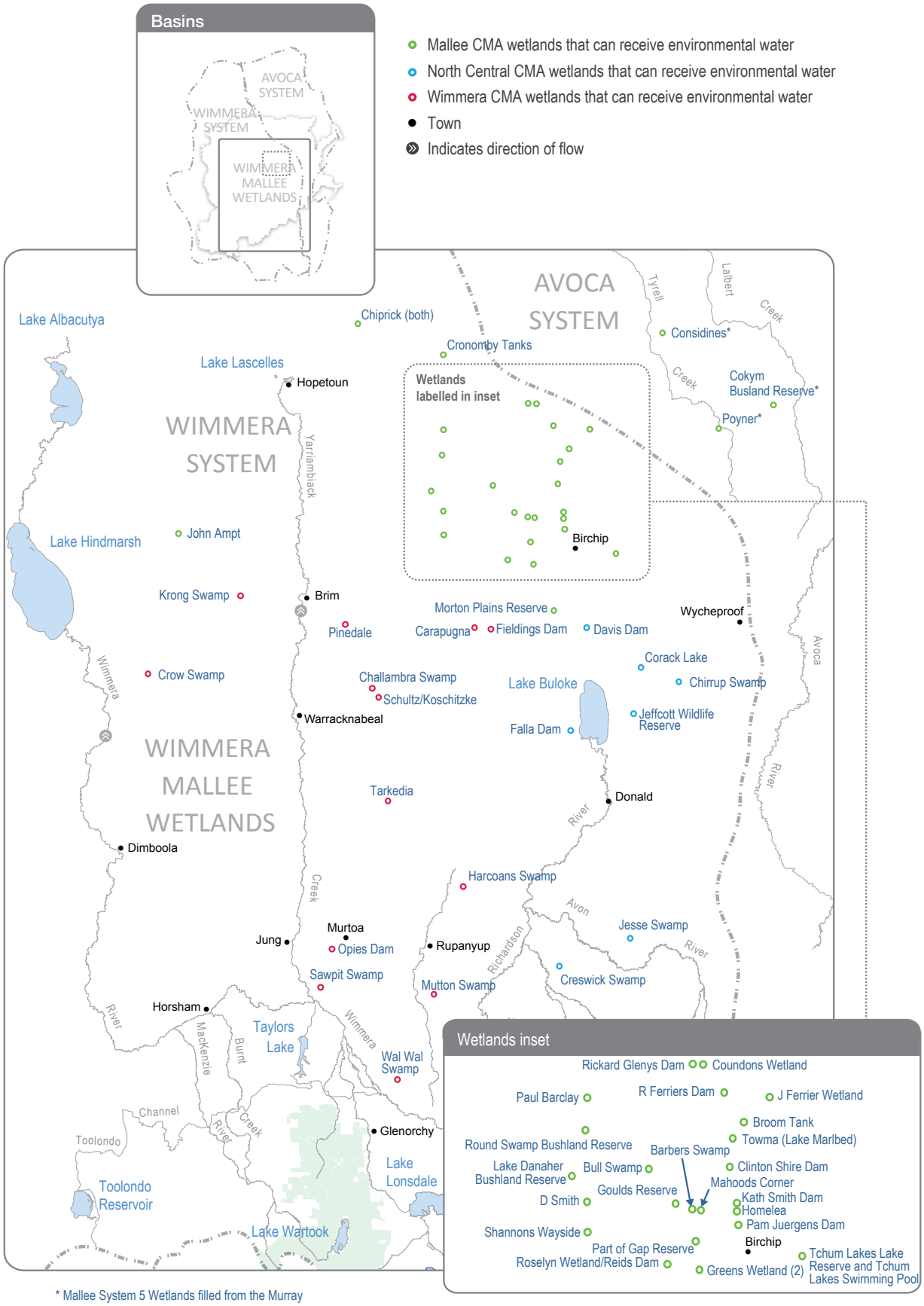
The Wimmera–Mallee region was very dry in 2015–16 with no allocation made to the wetland environmental entitlement. Despite this, carryover from previous years meant there was still environmental water available for use in 2015–16.

Deliveries were made to 40 wetlands in 2015–16: 24 wetlands in the Mallee area, seven in the north-central area and nine in the Wimmera area. Deliveries were made in spring 2015 and autumn 2016, with some wetlands receiving water once and others receiving water twice.

Given the dry conditions, watering was mostly of smaller parts of the wetlands to provide drought refuge in the landscape. There was some delivery of water into the main wetland areas at Cokum Bushland Reserve, Corack Lake and Jesse Swamp in spring 2015. Water was delivered to these wetlands to support vegetation growth and increase wetland type diversity, providing feeding opportunities for shallow wading birds and breeding habitat for frogs and turtles.

Many different animals (such as brolgas, wedge-tailed eagles, herons, ibis, yabbies, parrots, ducks, turtles, frogs, kangaroos and wallabies) used the Wimmera–Mallee wetlands in 2015–16. Vegetation (both submerged in the wetlands and on the banks) responded well at the wetlands that were watered and is contributing to improvement in the environmental conditions at these wetlands.

Figure 4.4.1 The Wimmera–Mallee wetlands



* Mallee System 5 Wetlands filled from the Murray

Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 4.4.1. The watering actions for these wetlands will typically be in spring or autumn but may occur at any time of the year depending on environmental need and seasonal conditions.

Table 4.4.1 Potential environmental watering actions and objectives for the Wimmera–Mallee wetlands

Potential environmental watering	Environmental objectives
North Central wetlands	
Davis Dam	• Support black box and cane grass vegetation • Provide drought refuge and a watering point for animals
Creswick Swamp	• Support a diversity of aquatic plants including re-established marbled marshwort • Provide refuge, feeding and breeding opportunities for frog and turtles
Chirrup Dam	• Provide drought refuge and a watering point for animals (particularly frogs and turtles) to facilitate recolonisation of Chirrup Swamp when it is naturally inundated
Corack Lake	• Provide conditions that support an abundance of aquatic plants • Provide refuge and nursery habitat for turtles and frogs • Provide variety of feeding conditions for waterbirds (such as drawdown zones and shallows)
Falla Dam	• Maintain as a drought refuge for turtles and frogs
Jeffcott Wildlife Reserve	• Maintain the diversity of aquatic plants • Provide refuge and breeding conditions for water-dependent species (such as frogs, waterbugs, turtles and waterbirds)
Jesse Swamp	• Promote native aquatic plant growth including re-establishment of marbled marshwort • Provide shallow foraging habitat for waterbirds (including brolgas) and feeding opportunities for frogs
Wimmera wetlands	
Carapugna	• Retain water in the wetland to sustain animals (especially frogs and wetland and woodland birds) • Sustain and where possible increase the abundance of wetland plants, especially threatened species
Challambra Swamp	
Crow Swamp	
Fieldings Dam	
Krong Swamp	
Mutton Swamp	
Pinedale	
Sawpit Swamp	
Schultz/Koschitzke	
Tarkedia	
Wal Wal Swamp	
Harcoans Swamp	
Opies Dam	
Mallee wetlands	
Barbers Swamp	• Maintain the health of fringing lignum and black box communities • Provide suitable feeding and breeding habitat for various waterbird guilds
Bull Swamp	
Cokum Bushland Reserve	
Tchum Lakes Lake Reserve (North Lake - Wetland)	
Tchum Lakes Swimming Pool (North Lake – Dam)	
Broom Tank	• Maintain the health of fringing lignum and black box communities • Improve the diversity and quality of wetland vegetation communities
Poyner	
Towma (Lake Marlbed)	
Clinton Shire Dam	• Maintain the health of fringing lignum and black box communities • Provide watering points for terrestrial and aerial animals
Pam Juergens Dam	

Potential environmental watering	Environmental objectives
Goulds Reserve	• Maintain the health of fringing lignum and black box communities
Greens Wetland (2)	
J Ferrier Wetland	
Part of Gap Reserve	
Roselyn Wetland	
Newer Swamp	
Mahoods Corner	• Provide suitable feeding and breeding habitat for various waterbird guilds • Improve the diversity and quality of wetland vegetation communities
Shannons Wayside	
Chiprick (both)	• Provide watering points for terrestrial and aerial animals
D Smith Wetland	
Homelea Wetland	
John Ampt	
Kath Smith Dam	
Paul Barclay	
R Ferriers Dam	
Rickard Glenys Dam	
Considines	• Maintain the health of fringing lignum and black box communities • Provide watering points for terrestrial and aerial animals • Improve the diversity and quality of wetland vegetation communities
Coundons Wetland	• Maintain the health of fringing lignum and black box communities • Maintain habitat opportunities for turtles and frogs • Provide watering points for terrestrial and aerial animals
Cronomby Tanks	• Maintain the health of fringing lignum and black box communities • Maintain habitat opportunities for turtles and frogs
Lake Danaher Bushland Reserve	• Maintain the health of fringing lignum and black box communities • Maintain habitat opportunities for turtles and frogs • Improve the diversity and quality of wetland vegetation communities
Morton Plains Reserve	• Maintain the health of fringing lignum and black box communities • Improve the diversity and quality of wetland vegetation communities • Provide suitable feeding and breeding habitat for various waterbird guilds

Scenario planning

Table 4.4.2 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

Environmental water delivery to the wetlands relies on capacity in the Wimmera–Mallee pipeline system. CMAs work closely with GWMWater and land managers (including Parks Victoria, the Department of Environment, Land, Water and Planning and landowners) to manage around these capacity constraints and deliver environmental water to these wetlands.

The wetlands considered for potential environmental watering in 2016–17 have been determined after assessing their scientific watering requirements and watering history and considering climatic conditions, water availability and the likely capacity in the Wimmera–Mallee pipeline system.

Under drought conditions, the specific wetlands are planned to receive a small volume of water, in many cases topping up water levels from previous environmental watering. As conditions become wetter, the number of sites and extent of watering increases, with some wetland watering also aiming to inundate some of the surrounding vegetation. As a result, the expected water use increases as resources and conditions improve.

Due to the lower reliability of environmental water in the Wimmera–Mallee wetland system, carrying over water following wetter periods is considered important to assist in managing supply during dry times. A critical carryover volume of 134–218 ML has been identified, depending on the scenario.

Table 4.4.2 Potential environmental watering for the Wimmera–Mallee wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected catchment conditions	• No rainfall or catchment inflows are likely to contribute to water levels in the wetlands	• No rainfall or catchment inflows are likely to contribute to water levels in the wetlands	• Some localised catchment inflows may contribute to water levels in some wetlands	• Catchment inflows are likely to contribute to water levels in the wetlands
Expected availability of environmental water	• 623 ML carryover • 0 ML allocation • 623 ML available	• 623 ML carryover • 0 ML allocation • 623 ML available	• 623 ML carryover • 50 ML allocation • 673 ML available	• 623 ML carryover • 1,000 ML allocation • 1,623 ML available
Potential environmental watering	• Barbers Swamp • Broom Tank • Bull Swamp • Carapugna • Challambra Swamp • Chirrup Swamp • Chiprick (both) • Clinton Shire Dam • Cokum Bushland Reserve[1] • Considines[1] • Corack Lake • Creswick Swamp • Cronomby Tanks • Crow Swamp • D Smith Wetland • Fieldings Dam • Greens Wetland (2) • Homelea • J Ferrier Wetland • Jeffcott Wildlife Reserve • Jesse Swamp • John Ampt • Lake Danaher Bushland Reserve • Mahoods Corner • Morton Plains Reserve • Mutton Swamp • Opies Dam • Part of Gap Reserve • Paul Barclay • Pinedale • Poyner[1] • R Ferriers Dam • Rickard Glenys Dam • Roselyn Wetland/Reids Dam • Newer Swamp • Schultz/Koschitzke • Shannons Wayside • Tarkedia Dam • Towma (Lake Marlbed) • Wal Wal Swamp	• Barbers Swamp • Broom Tank • Bull Swamp • Carapugna • Challambra Swamp • Chirrup Swamp • Chiprick (both) • Clinton Shire Dam • Cokum Bushland Reserve[1] • Considines[1] • Corack Lake • Creswick Swamp • Cronomby Tanks • Crow Swamp • D Smith Wetland • Davis Dam • Falla Dam • Fieldings Dam • Greens Wetland (2) • Homelea • J Ferrier Wetland • Jeffcott Wildlife Reserve • Jesse Swamp • John Ampt • Kath Smith Dam • Lake Danaher Bushland Reserve • Mahoods Corner • Morton Plains Reserve • Mutton Swamp • Opies Dam • Pam Juergens Dam • Part of Gap Reserve • Paul Barclay • Pinedale • Poyner[1] • R Ferriers Dam • Rickard Glenys Dam • Roselyn Wetland/Reids Dam • Newer Swamp • Schultz/Koschitzke • Shannons Wayside • Tarkedia Dam • Tchum Lakes Lake Reserve (North Lake - Wetland) • Tchum Lakes Swimming Pool (North Lake - Dam) • Towma (Lake Marlbed) • Wal Wal Swamp	• Barbers Swamp • Broom Tank • Bull Swamp • Carapugna • Challambra Swamp • Chirrup Swamp • Chiprick (both) • Clinton Shire Dam • Cokum Bushland Reserve[1] • Considines[1] • Corack Lake • Coundons Wetland • Creswick Swamp • Cronomby Tanks • Crow Swamp • D Smith Wetland • Davis Dam • Falla Dam • Fieldings Dam • Goulds Reserve • Greens Wetland (2) • Homelea • J Ferrier Wetland • Jeffcott Wildlife Reserve • Jesse Swamp • John Ampt • Kath Smith Dam • Lake Danaher Bushland Reserve • Mahoods Corner • Morton Plains Reserve • Mutton Swamp • Opies Dam • Pam Juergens Dam • Part of Gap Reserve • Paul Barclay • Pinedale • Poyner[1] • R Ferriers Dam • Rickard Glenys Dam • Roselyn Wetland/Reids Dam • Newer Swamp • Sawpit Swamp • Schultz/Koschitzke • Shannons Wayside • Tarkedia Dam • Tchum Lakes Lake Reserve (North Lake - Wetland) • Tchum Lakes Swimming Pool (North Lake - Dam) • Towma (Lake Marlbed) • Wal Wal Swamp	• Barbers Swamp • Broom Tank • Bull Swamp • Carapugna • Challambra Swamp • Chirrup Swamp • Chiprick (both) • Clinton Shire Dam • Cokum Bushland Reserve[1] • Considines[1] • Corack Lake • Coundons Wetland • Creswick Swamp • Cronomby Tanks • Crow Swamp • D Smith Wetland • Davis Dam • Falla Dam • Fieldings Dam • Goulds Reserve • Greens Wetland (2) • Harcoans • Homelea • J Ferrier Wetland • Jeffcott Wildlife Reserve • Jesse Swamp • John Ampt • Kath Smith Dam • Krong Swamp • Lake Danaher Bushland Reserve • Mahoods Corner • Morton Plains Reserve • Mutton Swamp • Opies Dam • Pam Juergens Dam • Part of Gap Reserve • Paul Barclay • Pinedale • Poyner[1] • R Ferriers Dam • Rickard Glenys Dam • Roselyn Wetland/Reids Dam • Newer Swamp • Sawpit Swamp • Schultz/Koschitzke • Shannons Wayside • Tarkedia Dam • Tchum Lakes Lake Reserve (North Lake - Wetland) • Tchum Lakes Swimming Pool (North Lake - Dam) • Towma (Lake Marlbed) • Wal Wal Swamp
Possible volume of environmental water required to achieve objectives	• 137 ML	• 293 ML	• 656 ML	• 861 ML
Priority carryover requirements	• 134 ML	• 141 ML	• 141 ML	• 218 ML

1 Water supplied to these wetlands in supply system 5 is made available from GWMWater allocations.

Risk management

In preparing its seasonal watering proposal, the Wimmera, Mallee and North Central CMAs considered and assessed risks and identified mitigating strategies relating to implementing environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 4.4.3 shows the partners, stakeholder organisations and individuals with which the Wimmera, Mallee and North Central CMAs engaged when preparing the Wimmera–Mallee wetlands seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional waterway strategies, environmental water management plans and environmental flow studies, which incorporate environmental, cultural, social and economic considerations.

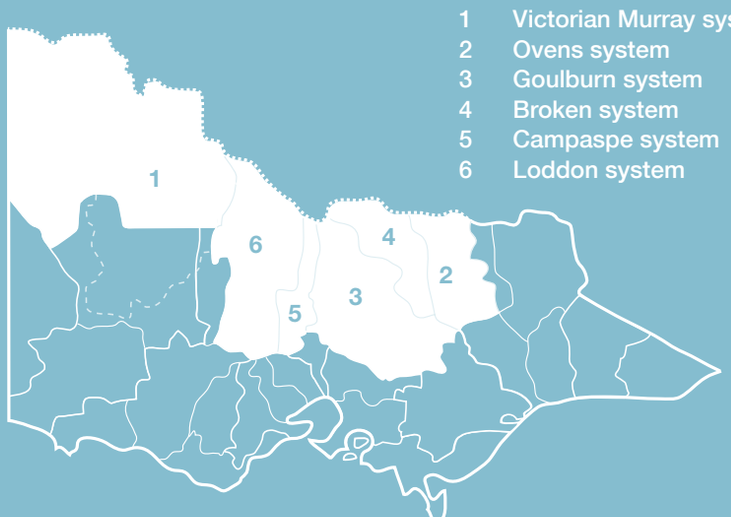
Table 4.4.3 Partners and stakeholders engaged in developing the Wimmera–Mallee wetlands seasonal watering proposal

Partner and stakeholder engagement
All CMAs
• GWMWater • Parks Victoria • Victorian Environmental Water Holder
Mallee CMA
• Mallee CMA Aboriginal Reference Group, an advisory committee to Mallee CMA comprising Aboriginal representatives from across the region • Mallee CMA Land and Water Advisory Committee, an advisory group to Mallee CMA comprising community members from across the region • Landholders with wetlands on their properties in the Mallee • Barenji Gadjin Land Council • Department of Environment, Land, Water and Planning • North Central and Wimmera CMAs
North Central CMA
• Wimmera–Mallee Wetlands Environmental Water Advisory Group comprising community members; interest groups; North Central CMA Community Consultative Committee representatives; a North Central CMA Board member; Department of Environment, Land, Water and Planning and the VEWH • North Central CMA Community Consultative Committee, a community advisory group to the North Central CMA Board • Landholders with wetlands on their properties in the North Central area • Landcare groups • Barenji Gadjin Land Council • Department of Environment, Land, Water and Planning • Mallee and Wimmera CMAs
Wimmera CMA
• Landholders with wetlands on their properties in the Wimmera area • North Central and Mallee CMAs

Hattah-Kulkyne National Park, by David Blom

Section 5

Northern Region



1 Victorian Murray system
2 Ovens system
3 Goulburn system
4 Broken system
5 Campaspe system
6 Loddon system

5.1 Northern Region overview

The Northern Region has a vital network of rivers, wetlands and floodplains that provide homes for ancient river red gums and a diversity of other plants and animals. Priority sites include the Goulburn, Broken, Loddon and Campaspe rivers as well as wetlands and floodplains on these systems and on the Victorian Murray system, including Barmah Forest, Gunbower Forest, Hattah Lakes and Lindsay, Wallpolla and Mulcra islands.

Local Aboriginal communities have an enduring connection to these sites, many of which have important heritage values (such as scar trees, middens, burial sites, artefacts and ovens). Waterways across the Northern Region provide highly valued amenity and recreational opportunities for residents and visitors as well as business opportunities from tourism. Importantly, these waterways also support irrigated agriculture which contributes significantly to Australia's prosperity through food and fibre production.

Environmental water available for use in the northern Victorian systems is held in the Ovens, Murray, Goulburn, Broken, Loddon and Campaspe storages, which also hold water for consumptive water entitlements. The water systems of the Northern Region are highly connected. Infrastructure and water trading allows water to move from one system to another. This allows environmental water to move between systems for delivery to priority environmental sites across northern Victoria, if needed. However, most environmental water in these systems is prioritised to provide benefits in the regions in which the water is held.

Seasonal outlook 2016-17

Each year on 15 May, the Northern Victoria Resource Manager releases a water availability outlook for northern Victoria for the coming year. These seasonal outlooks are updated monthly once the season begins, and are available at www.nvrm.net.au.

The 2016–17 outlook suggests water availability will most likely be lower than in recent years, with allocations against high-reliability entitlements unlikely to reach 100 percent unless near-average inflows into storages occur. Under a dry inflow scenario (for example, assuming inflows remain similar to the lowest 10 percent of inflows on record), the Goulburn and Murray systems are expected to reach around 50 percent

Nyah-Vinifera floodplain, by Mallee CMA

allocations against high-reliability entitlements for the year, which is around half of the allocations available in 2015–16. If inflows are worse than this, allocations could be lower.

For the Campaspe, Loddon, Broken and Bullarook systems, dry conditions will see zero or very low allocation. Under very dry conditions, there is a risk that no environmental water will be able to be delivered, including any water carried over and already held in storage. This significant risk of delivery constraints has been factored into environmental water planning for 2016–17. Average inflows should result in these four systems reaching 100 percent allocation against high-reliability entitlements.

Environmental water demands in northern Victoria are generally highest in winter and spring. As the outlook indicates, water availability early in the season may be relatively low, so carryover from 2015–16 will be important to help meet early-season demands. The VEWH's carryover into 2016–17 is expected to be sufficient to support priority demands. Small transfers may occur between systems to support potential shortfalls under some planning scenarios, notwithstanding possible delivery constraints.

If conditions remain very dry across the region, environmental watering will mainly focus on delivery of actions planned under a drought or dry scenario. Carryover planning for 2017–18 will also be essential under continuing dry conditions.

The VEWH coordinates with other environmental water holders in northern Victoria, New South Wales and South Australia to deliver environmental outcomes at the broader Murray–Darling Basin scale.

The VEWH liaises with the MDBA and the Commonwealth Environmental Water Office to maximise the benefits of environmental water delivery in Victorian systems. Delivery of Living Murray and Commonwealth environmental water to meet Victorian environmental water objectives is covered in the following sections.

Environmental water delivered through northern Victorian waterways can sometimes be reused to achieve further environmental benefits downstream (see section 1.4.2 on return flows). If return flows are not to be reused at Victorian environmental sites, the VEWH, Living Murray and CEWH return flows may continue to flow across the border to South Australia where they will be used to provide environmental benefits at sites such as those in the Coorong, Lower Lakes and Murray Mouth region.

The VEWH may also authorise waterway managers to order Living Murray and Commonwealth water for downstream sites, provided there are no adverse impacts on Victorian waterways.

What is the Murray–Darling Basin Plan?

Northern Victoria is a part of the Murray–Darling Basin and environmental water deliveries in the Northern Region are subject to the requirements of the Murray–Darling Basin Plan. The plan was developed by the MDBA under the *Commonwealth Water Act 2007* and became law in November 2012. The plan sets legal limits on the amount of water that can be taken from the Murray–Darling Basin's surface and groundwater resources. Chapter 8 of the plan also sets out a high-level environmental watering plan which defines environmental objectives to protect, restore and build the resilience of water-dependent ecosystems and their associated functions. The VEWH's environmental planning and delivery is consistent with the requirements of the plan. The potential environmental watering outlined in sections 4 and 5 of this seasonal watering plan fulfil Victoria's obligations to identify annual environmental watering priorities for Victoria's water resource areas under section 8.26 of the Murray–Darling Basin Plan.

5.2 Victorian Murray system

Waterway managers – Goulburn Broken, North Central and Mallee catchment management authorities

Storage managers – Goulburn-Murray Water, Lower Murray Water, Murray–Darling Basin Authority (River Murray Operations)

Environmental water holders – Victorian Environmental Water Holder, Murray–Darling Basin Authority (the Living Murray program), Commonwealth Environmental Water Holder

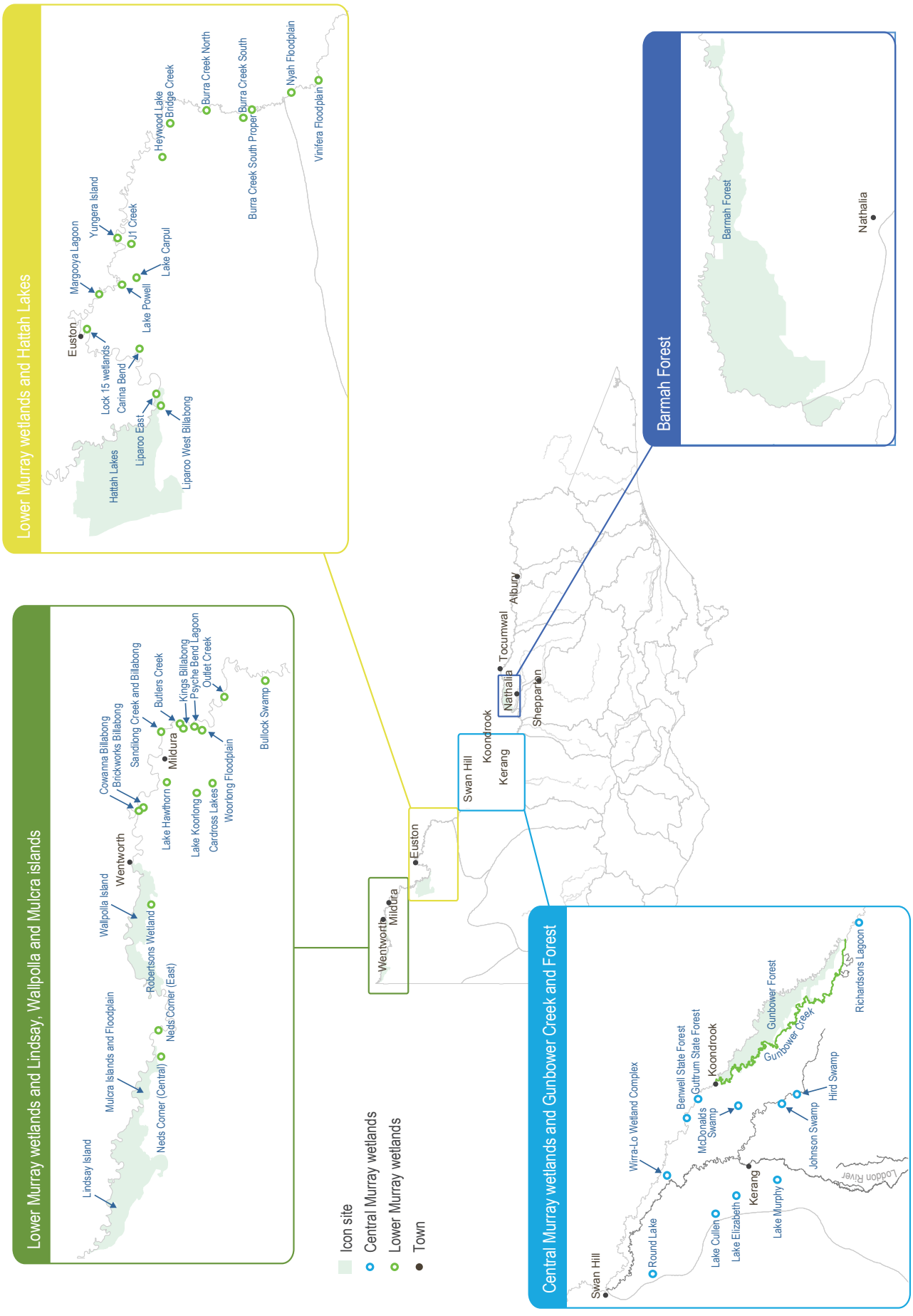
Region overview

As Figure 5.2.1 shows, the Victorian Murray system contains many significant floodplains and wetland systems covering the Goulburn Broken, North Central and Mallee CMA areas. The system contains floodplains and wetlands that are of international importance and include the iconic Hattah Lakes, Barmah Forest and Kerang wetlands, as well as other nationally and regionally significant sites. The system provides a wide range of habitat types that support rare and threatened waterbird species including the painted snipe, brolga, royal spoonbill and white-bellied sea eagle. They are also home to the endangered Murray hardyhead fish. The Victorian Murray system supports a variety of recreational activities (such as camping, fishing, water sports, bird watching and recreational hunting) and Aboriginal cultural heritage values (such as scar trees, middens, burial sites, artefacts and ovens).

Environmental water can be supplied from a range of sources to meet demands in the Victorian Murray system. This includes entitlements held by the VEWH, the Living Murray program and the CEWH; reuse of return flows; and in some instances use of consumptive water en route. The source of the water and ability to deliver all watering actions will depend on water availability, water commitments by other environmental water holders and operational conditions. As a result, the following Victorian Murray system sections do not specify the expected environmental water availability.

Australian little bittern, Johnson Swamp, by Simon Starr

Figure 5.2.1 The Victorian Murray system



5.2.1 Barmah Forest

Environmental values

The Barmah–Millewa Forest is the largest river red gum forest in Australia and the most intact freshwater floodplain system along the River Murray. The forest is a significant feeding and breeding site for waterbirds including bitterns, ibis, egrets, spoonbills and night herons, as well as for significant fish, frog and turtle populations.

The forest also supports a broad range of floodplain vegetation communities including river red gum forest, river red gum woodland, wetlands and the threatened Moira grass plains.

Social and economic values

The Barmah Forest supports a variety of recreational and tourism activities such as camping, bushwalking, fishing, river cruises and bird watching.

The forest is valued for its part in Australia's heritage and for its natural and Aboriginal and European cultural heritage values. Aboriginal sites of significance include scar trees, middens, burial sites, artefacts and ovens. The Barmah Forest continues to be a place of significance for Traditional Owners and their Nations in the region. Non-Aboriginal artefacts are largely associated with past forestry and grazing in the forest.

Environmental watering objectives in Barmah Forest	
	Enhance the health of river red gum communities and aquatic vegetation within the wetlands and watercourses and on the floodplain Encourage germination and growth of Moira grass
	Provide feeding locations and allow colonial waterbirds to successfully fledge their young
	Use flows to connect floodplains to the river, enabling carbon transfer, providing drought refuge, boosting floodplain animal and bird habitats and providing bugs and other food resources for native fish species, waterbirds, frogs and turtles
	Protect and boost populations of native fish by providing flows to encourage fish to spawn

System overview

The Barmah–Millewa Forest covers 66,000 hectares and straddles the Murray and Edwards rivers between the townships of Tocumwal, Deniliquin and Echuca. The Victorian component is the Barmah National Park and River Murray Reserve covering 28,500 hectares of forest and wetlands.

Water management in the Barmah–Millewa Forest depends on gravity distribution from the River Murray. When river flows are above 15,000 ML per day downstream of Yarrawonga Weir, both sides of the forest are managed as a whole. When flows are below this, each side of the forest can be managed separately by operating the regulators individually. Below flows of about 10,500 ML per day downstream of Yarrawonga Weir, all regulators usually remain closed.

River regulation and water extraction from the River Murray has reduced the frequency, duration and magnitude of flood events in the Barmah–Millewa Forest. This has affected the diversity, extent and condition of vegetation communities and the habitat and health of dependent animal species.

Environmental water releases seek to protect critical habitat under dry conditions and build on unregulated flows and the delivery of consumptive water en route to maximise environmental outcomes when possible. As Barmah Forest is located in the upper reaches of the River Murray, environmental water delivered to the forest can often be used again at sites further downstream as part of multi-site watering events.

Recent conditions

Rainfall was lower-than-average for the majority of winter-spring in 2015. A few small natural peaks above choke capacity occurred that provided water to the lower wetlands before high consumptive water deliveries through the Barmah choke were combined with environmental water to provide a flood event across the floodplain from August to November.

Millewa Forest on the New South Wales side of the Murray was the primary focus of environmental water delivery in 2015–16. This was agreed as part of a reciprocal arrangement between New South Wales and Victorian program partners to maximise environmental benefits and minimise risks to the forest each year, given the constraints that restrict the ability to manage floodplain watering of both forests concurrently. Some low-level watering did occur in Barmah in 2015–16 (including shallow flooding of wetlands in late winter/early spring), in addition to some flows connecting the River Murray and the creeks through the forest. Within Barmah, environmental watering was extended through to the end of January in Boals Deadwood Wetland to support a successful colonial waterbird breeding event.

Wetland plants and river red gums responded very well to the shallow flooding in Barmah Forest. There was a clear contrast in plant health between the areas flooded and those that remained dry. The watering allowed wetland plants to reproduce and river red gums to put on a flush of new growth. Waterbirds bred successfully, with about 750 nests of ibis and 20 of royal spoonbills as well as multiple colonies of cormorants in Barmah Forest. In Millewa Forest, a similar numbers of ibis, around 200 pairs of royal spoonbills and 100 pairs of eastern great egrets also bred. About 45 male Australasian bitterns–a nationally endangered bird–were heard calling and are believed to have also bred as well as numerous other wetland-dependent bird species.

Native fish continued to be monitored but despite the watering southern pygmy perch were again not found: this has been the case since the millennium drought.

While this species appears to have become locally extinct, protecting their habitat is still a high priority in case there are still remnant populations. Deliberate flow pulses in the River Murray channel through Barmah–Millewa Forest resulted in spawning of silver and golden perch. The pulses provide flow variability which is necessary to trigger perch spawning. Frogs, turtles, reptiles and other animals in the forest also benefited from the environmental water deliveries in 2015–16.

Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 5.2.1.

Table 5.2.1 Potential environmental watering actions and objectives for Barmah Forest

Potential environmental watering	Environmental objectives
Spring/summer pulsed flows in the River Murray channel (3 pulses of up to 500 ML/day for 8 days each in October–December)[1]	• Provide flow variability within the main river channel to encourage spawning of native fish species, primarily the golden and silver perch
Spring/summer freshes to Gulf and Boals creeks (100 ML/day for 3–5 days as required in September–March)	• Maintain critical drought refuge areas within Barmah Forest • Protect fish and turtle populations in permanent waterways
Spring/summer baseflows to Gulf and Boals creeks (100 ML/day for 30–60 days as required in September–December)	• Maintain general drought refuge areas within Barmah Forest • Maintain fish and turtle populations in permanent waterways • Maintain connectivity to the river • Remove accumulated organic matter (cycling carbon to the river system and minimising anoxic blackwater development) • Maintain water quality
Spring inundation of floodplain marshes (variable flow rates to extend the duration and inundation extent of natural flooding in September–November)[2]	• Provide flooding of sufficient duration to promote growth of floodplain marsh vegetation in open plains
Targeted wetland watering to Boals Deadwood and Top Island wetlands (100–250 ML/day for 4 months in October–January)	• Support breeding of colonial nesting and flow-dependent waterbirds

1 This action may be achieved through management of river operations and not require environmental water.
2 Environmental water is restricted to 18,000 ML per day downstream of Yarrawonga to September and 15,000 ML per day after September.

Scenario planning

Table 5.2.2 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

Environmental water requirements vary significantly for Barmah Forest in response to natural conditions. Under drier conditions, objectives focus on maintaining the condition of permanent creeks to sustain fish and turtle populations.

As conditions become wetter, the focus shifts to the provision of larger-scale outcomes (such as extending the duration of natural flooding to promote the germination of wetland plants such as Moira grass in floodplain marshes, providing benefits to broader floodplain vegetation communities including river red gum forests).

Targeted wetland watering may occur under a range of conditions to support the breeding of colonial nesting waterbirds and other flood-dependent birds.

Table 5.2.2 Potential environmental watering for Barmah Forest under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Unregulated flow periods unlikely • Flows in the River Murray will remain within channel all year	• Some small unregulated flows in late winter/spring • Small chance of overbank flows in late winter/spring	• Likely chance of small-to-medium unregulated flows in winter/spring • Likely chance of overbank flows in winte	• High probability of moderate-to-large unregulated flows in winter/spring • Expected large overbank flows
Potential environmental watering	• Spring/summer pulsed flows in the River Murray channel • Spring/summer freshes	• Spring/summer baseflows • Targeted wetland watering	• Spring/summer baseflows • Spring inundation of floodplain marshes • Targeted wetland watering	• Spring/summer baseflows • Spring inundation of floodplain marshes • Targeted wetland watering
Possible volume of environmental water required to achieve objectives[1]	• 2,000 ML (no return flows)	• 37,000 ML (no return flows)	• 463,000 ML (with 360,000 ML return flows)[2]	• 484,000 ML (with 360,000 ML return flows)[2]

1 The possible volumes of environmental water required in Barmah Forest are estimates; the actual volumes required are highly dependent on natural conditions.
2 The volumes identified include the volume required to achieve floodplain marsh vegetation objectives in both the Barmah and Millewa forests and may be met by unregulated flows.

Risk management

In preparing its seasonal watering proposal, the Goulburn Broken CMA considered and assessed risks and identified mitigating strategies relating to the implementation of environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

The Goulburn Broken CMA consulted key stakeholders when preparing the seasonal watering proposal for Barmah Forest. Table 5.2.3 shows these stakeholders.

Seasonal watering proposals are informed by longer-term regional waterway strategies, environmental water management plans and environmental flow studies which incorporate environmental, cultural, social and economic considerations.

Table 5.2.3 Partners and stakeholders engaged in developing the Barmah Forest seasonal watering proposal

Partners engagement
• Department of Environment, Land, Water and Planning
• Murray–Darling Basin Authority (River Murray Operations and Living Murray program)
• NSW National Parks and Wildlife Service
• NSW Office of Environment and Heritage
• Parks Victoria
• Yorta Yorta Nation Aboriginal Corporation
• Commonwealth Environmental Water Office
• Victorian Environmental Water Holder

5.2.2 Gunbower Creek and Forest

Environmental values

Gunbower Forest contains a range of important environmental values including diverse and rare wetland habitats, vulnerable and endangered plants and animals and large areas of remnant vegetation communities (such as river red gum forest). The forest provides a diversity of habitats for birds and is known to support internationally recognised migratory waterbirds.

Gunbower Creek provides important habitat for native fish such as Murray cod, trout cod and freshwater catfish. Due to the diversity of fish in the creek, it is considered to be a valuable refuge and source of fish for the recolonisation of surrounding waterways.

Social and economic values

Gunbower Creek and Forest are both valuable sites from a cultural and socioeconomic perspective. Local Aboriginal communities have a strong connection to the Gunbower Forest area. The forest provides social and economic values through timber production, apiculture (bee keeping), recreation and tourism. The creek supports recreational activities (such as boating, fishing and bird watching) and is the major carrier for the delivery of irrigation supply to the surrounding productive lands.

Environmental watering objectives in Gunbower Creek and Forest
Improve the resilience of wetland plant life and help river red gums recover from damage they experienced in the millennium drought
Maintain populations of small-bodied fish species in forest wetlands and rehabilitate large- and small-bodied native fish communities in Gunbower Creek Use flows to connect Gunbower Forest to Gunbower Creek enabling fish, insects, crustaceans, molluscs, worms and carbon to move between them, supporting the life cycle of Gunbower's native fish
Provide feeding, breeding and refuge habitat for waterbirds including colonial nesting species
Maintain the form of the creek bank and channel, and a diversity of creek-bed surface to support all stream life

System overview

Gunbower Forest is a large flood-dependent forest situated on the River Murray floodplain in northern Victoria between Torrumbarry and Koondrook. Covering 19,450 hectares, it is bounded by the River Murray to the north and Gunbower Creek to the south. It is an internationally significant site under the Ramsar Convention and forms part of the Living Murray Gunbower–Koondrook–Perricoota icon site. River regulation and water extraction from the River Murray and Gunbower Creek has reduced the frequency, duration and magnitude of flood events in Gunbower Forest over the long term. This has affected the extent and condition of habitat and the health of dependent animal communities.

Gunbower Creek is managed primarily as an irrigation carrier and supplies the Torrumbarry Irrigation Area from the River Murray. The daily variation in the creek through spring, summer and autumn is much higher now than under natural conditions due to irrigation demand. This results in significant ecological impacts including impacts on native fish populations. Environmental water is used to smooth out the variation by filling the gaps in flows caused by irrigation demand within the creek. This supports fish migration and breeding and promotes other ecological processes while maintaining water delivery for irrigation needs. Flows linking the creek to the Gunbower Forest floodplain and the River Murray can be restored through environmental watering and are vital to enhance ecosystem functioning (such as carbon exchange).

The Living Murray structural works program in the middle and lower forest was completed in 2013. The works allow up to 3,800 hectares of the wetlands and floodplain to be watered with considerably less water than would be required under natural conditions. The works enable efficient watering through Gunbower Creek of the forest to maintain wetland and floodplain condition.

Recent conditions

Gunbower Forest has received four years of consecutive flooding as a result of natural and managed events. From early September to mid-November 2015, nearly 29,000 ML of environmental water was delivered through Gunbower Forest. It was mainly delivered through the Hipwell Road Channel Regulator but for the first time water was also delivered through newly refurbished regulators in the lower landscape (the Yarran Creek, Black Swamp, Reedy Lagoon and Little Gunbower Lagoon regulators) to inundate areas of permanent and semipermanent wetlands. Environmental water was delivered to enhance the resilience of wetland vegetation, provide feeding habitat for waterbirds and enable native fish movement and carbon and nutrient cycling between the creek and forest.

The water delivered in 2015–16 inundated over 2,800 hectares of the forest including about 1,720 hectares of river red gums and 1,112 hectares of wetlands. Field observations showed that river red gums have responded with a flush of new growth and are in a better condition to withstand future dry conditions.

A diversity of aquatic plants germinated in the wetlands in response to the watering, with an excellent response in those areas that received water in the early spring delivery. For the second year in a row river swamp wallaby grass (a threatened plant species) germinated, which is important to replenish the wetland seed bank across the forest.

The high-value permanent and semipermanent wetlands in the lower part of Gunbower Forest have provided critical refuge areas in the landscape for waterbirds and source populations of vegetation. The importance of these areas was shown in the strong response to the 2015 environmental watering. A number of waterbirds utilised the

resources in the wetlands for feeding and breeding during the 2015 watering event including large numbers of black swans, Australian wood ducks, white-bellied sea eagles, yellow-billed spoonbills and great egrets. A small colony of cormorants (40 nests) was recorded breeding in the Little Reedy Wetland complex.

Environmental water was provided through Gunbower Creek to support native fish in autumn and winter, during the off-irrigation season. Traditionally, the creek was drawn down to a series of disconnected deep pools at the end of the irrigation season: this is now recognised as a major limiting factor to the survival of juvenile fish, particularly Murray cod. Providing environmental flows during this period enables continued connectivity between habitats and food resources to support native fish species.

Strong recruitment of Murray cod in Gunbower Creek was observed through monitoring in 2014, corresponding to the delivery of environmental watering designed specifically to trigger spawning of Murray cod in spring and early summer in 2013–14. In 2015–16 the North Central CMA received many anecdotal reports of juvenile Murray cod being caught downstream of Cohuna, indicating that juvenile and adult Murray cod are benefiting from the creek management with winter, spawning and movement flow components. Despite this, the overall Murray cod population in Gunbower Creek requires ongoing environmental management for it to recover and become self-sustaining in the long term.

Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 5.2.4.

Table 5.2.4 Potential environmental watering actions and objectives for Gunbower Creek and Forest

Potential environmental watering	Environmental objectives
Gunbower Forest	
Winter/spring watering of Reedy Lagoon and Black Swamp (top-up flows as required in July–December)	• Maintain the health and resilience of vegetation communities in permanent wetlands • Maintain suitable feeding and refuge habitat for waterbirds • Support a significant bird breeding event if one is triggered naturally
Provide top-ups in autumn/winter for Reedy Lagoon and Black Swamp	• Maintain/enhance the health and resilience of vegetation communities in permanent wetlands • Maintain suitable feeding, breeding and refuge habitat for waterbirds including colonial nesting species
Winter/spring watering of Pig Swamp and associated floodrunners	• Improve the health of vegetation communities (including river red gums, sedgy riverine and tall marsh) in the semipermanent wetland • Improve suitable feeding, breeding and refuge habitat for waterbirds, frogs and other water-dependant animals
Winter/spring connectivity flows between Gunbower Creek and River Murray through Yarran Creek and Shillinglaws regulators	• Promote lateral movement of fish, turtles and seed propagules between the River Murray and Gunbower Creek
Provide an extension of natural flooding in Gunbower Forest floodplain, floodrunners and wetlands (with variable flow rates to maintain appropriate inundation extent)	• Improve the health of river red gum communities • Maintain/enhance healthy populations of native fish in wetlands and increase opportunities for riverine fish to access floodplain resources • Maintain suitable feeding, breeding and refuge habitat for waterbirds including colonial nesting species • Support a significant bird breeding event if one is triggered naturally
Gunbower Creek	
Winter baseflows (up to 400 ML/day between July–August and May–June)	• Maintain food and habitat resources for native fish including the recently recruited Murray cod in Gunbower Creek • Maintain native fish access to resources
Spring/summer high flows (targeting a gradual increase in flows up to 700 ML/day including various periods of stable flows in August–January)	• Promote conditions for spawning and larvae survival • Maintain native fish access to habitat and food resources, including recently recruited juvenile fish
Summer/autumn high flows (above 300 ML per day, between January to May)	• Maintain native fish access to habitat and food resources including recently recruited juvenile fish

Scenario planning

Table 5.2.5 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

The scale of the floodplain watering in Gunbower Forest will be determined by climatic conditions, delivery capacity and environmental water availability.

The main objective for 2016–17 is to provide a drying regime to the majority of the permanent and semipermanent wetlands. Drying aims to reduce the number of carp across the forest: they have bred in large numbers in the last two seasons of environmental watering after a large carp invasion in the natural floods between 2010–2012.

Therefore in drought conditions, watering is only planned to occur at two very high-priority wetlands (Reedy Lagoon and Black Swamp). The two wetlands will provide drought refuge for waterbirds and other water-dependent animals and also maintain wetland vegetation. Top-up flows to ensure the wetland vegetation remains in good health may be provided in autumn/winter if another very dry season is predicted in 2017–18: there would also be planning for carryover water into the next season to meet the permanent wetland demands.

Watering of Pig Swamp is a priority under all possible conditions except drought. Located in upper Gunbower Forest, this semipermanent wetland was disconnected from the irrigation network as part of a Goulburn-Murray Water water savings project in 2007 and no longer receives irrigation outfalls or natural flooding except in very large events when flows in the River Murray are above 50,000 ML per day. Watering will support stressed river red gums and wetland vegetation that have not received any water since the 2011 floods.

In wet years, higher flows (above 20,000 ML per day for two weeks) in the River Murray may result in natural flooding and could provide opportunities to support lateral connectivity between the forest, creek and the Murray system. If the duration of higher flows exceeds three weeks in the River Murray, moderate levels of flooding will naturally occur in the forest. Environmental water may be used to extend the duration and extent of flooding to improve the health of the floodplain ecosystem still recovering from the millennium drought.

If a significant bird breeding event is triggered, environmental water may be delivered to assist in maintaining an appropriate inundation depth and area to support the waterbirds to fledging.

Gunbower Creek is a highly regulated system. As a result, natural conditions do not greatly influence the objectives or flow requirements in the system. Environmental water management will aim to support all aspects of native fish life cycles, ensuring there is sufficient habitat and food resources for native fish throughout the year.

The highest priority for watering in Gunbower Creek is maintaining flowing habitat to support juvenile native fish through winter when there is no irrigation water and improvement works over winter are occurring in the system. Additionally, delivery of environmental water to smooth out flows during the irrigation period and provide summer stable flows will be prioritised to promote opportunities for breeding and larval dispersal, particularly for Murray cod which can abandon their nests in response to sudden changes in flow height (a common feature of irrigation water delivery patterns). If sufficient water is available, additional flow components (such as increased baseflows) will be targeted to support fish movement and enable native fish to access different habitats.

Table 5.2.5 Potential environmental watering for Gunbower Creek and Forest under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No natural inflows into Gunbower Forest	• Natural inflows into Gunbower Forest unlikely	• Natural inflows into Gunbower Forest are likely in winter/spring but unlikely to be significant	• Overbank flows may occur in winter/spring
Potential environmental watering – tier 1 (high priorities)	• Top-up watering of Reedy Lagoon and Black Swamp • Gunbower Creek winter baseflows • Gunbower Creek spring/summer high flows	• Top-up watering of Reedy Lagoon and Black Swamp • Gunbower Creek winter baseflows • Gunbower Creek spring/summer high flows • Gunbower Creek summer/autumn high flows	• Top-up watering of Reedy Lagoon and Black Swamp • Winter/spring watering Pig Swamp • Gunbower Creek winter baseflows • Gunbower Creek spring/summer high flows • Gunbower Creek summer/autumn high flows	• Winter/spring watering Pig Swamp • Winter/spring connectivity flows • Gunbower Creek winter baseflows • Gunbower Creek spring/summer high flows • Gunbower Creek summer/autumn high flows
Potential environmental watering – tier 2 (additional priorities)	• Top-up watering of Reedy Lagoon and Black Swamp (autumn) • Gunbower Creek summer/autumn high flows	• Top-up watering of Reedy Lagoon and Black Swamp (autumn) • Winter/spring watering Pig Swamp	• Top-up watering of Reedy Lagoon (autumn) • Winter/spring connectivity flows	• Extension of natural inundation of Gunbower Forest floodplain, floodrunners and wetlands • Gunbower Creek spring increased flows
Possible volume of environmental water required to meet objectives[1, 2]	• 23,000 ML (tier 1) • 6,000 ML (tier 2)	• 28,000 ML (tier 1) • 1,550 ML (tier 2)	• 28,000 ML (tier 1) • 4,050 ML (tier 2)	• 50,000 ML (tier 1) • 6,500 ML (tier 2)
Priority carryover requirements	• 4,000 ML	• 4,000 ML	• 2,000 ML	• N/A

1 Represents the estimated volume of water required to underwrite the losses associated with the delivery of consumptive water en route (except for discrete wetland watering actions).
2 Environmental water requirements for tier 2 are additional to tier 1 requirements.

Risk management

In preparing its seasonal watering proposal, North Central CMA considered and assessed risks and identified mitigating strategies relating to the implementation of environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 5.2.6 shows the partners and stakeholder organisations with which North Central CMA engaged when preparing the Gunbower Creek and Forest seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional waterway strategies, environmental water management plans and environmental flow studies, which incorporate environmental, cultural, social and economic considerations.

Table 5.2.6 Partners and stakeholders engaged in developing the Gunbower Creek and Forest seasonal watering proposal

Stakeholder engagement
• Commonwealth Environmental Water Office
• Gannawarra Shire Council, Campaspe Shire Council, Cohuna Progress Association and Murray Tourism Board
• Gunbower Island Community Reference Group (with representation from the Cohuna Progress Association, bird observers, Field and Game Australia, BirdLife Australia, Gunbower Landcare Group, irrigators and general community members)
• Gunbower Operations Advisory Group (with representation from Goulburn-Murray Water, Parks Victoria, Department of Environment, Land, Water and Planning [regional], Vic Forests, State Forests New South Wales, North Central CMA, MDBA, CEWH and the VEWH)
• Gunbower Technical Working Group (with representatives of Department of Environment, Land, Water and Planning [Threatened Flora and Fauna]; Goulburn Broken CMA; and specialist fish, vegetation and bird consultants and ecologists)
• North Central CMA Natural Resource Management Committee, an advisory group to the North Central CMA Board comprising regional community members
• Victorian Environmental Water Holder
• Yorta Yorta and Barapa Barapa Traditional Owners

5.2.3 Central Murray wetlands

Environmental values

The wetlands within the central Murray system are highly significant, supporting vulnerable or endangered species including the Australasian bittern, Murray hardyhead, Australian painted snipe and growling grass frog. The wetlands provide habitat for many threatened bird species (including the great egret and white-bellied sea eagle) listed under a range of legislation and international agreements. There are internationally recognised, Ramsar-listed wetlands within the system including Lake Cullen, Hird Swamp and Johnson Swamp, while the others are of bioregional significance.

Social, cultural and recreational values

The Barapa Barapa, Yorta Yorta and Wamba Wamba Nations are the Traditional Owner groups of the central Murray wetlands. The area is considered one of the most archaeologically important areas of Victoria with numerous middens, mounds, artefacts, scar trees and surface scatters documented.

The wetlands are used extensively for various recreational activities including bird watching, bushwalking and duck hunting in some wetlands. Tourism to the region supports the local economy and other indirect economic benefits are derived from groundwater recharge and carbon storage that the wetlands support.

Environmental watering objectives in central Murray wetlands
Maintain river red gum, black box, lignum woodland and wetland plant communities
Provide appropriate wetting and drying conditions that support seed germination, seedling survival and recruitment including of semi-aquatic plant species in damp areas of wetlands
Maintain habitat for the critically endangered Murray hardyhead
Provide habitat for waterbird resting, feeding and breeding
Provide habitat for the endangered growling grass frog

System overview

The central Murray wetland system consists of ten wetlands on the River Murray floodplain. Nine of these can receive environmental water: Lake Cullen, Hird Swamp, Johnson Swamp, Round Lake, McDonalds Swamp, Lake Elizabeth, Lake Murphy, Richardsons Lagoon and the Wirra–Lo wetland complex. These are all wetlands of regional significance.

The central Murray wetlands are almost wholly contained within the Torrumbarry Irrigation Area. This area has experienced dramatic changes since European settlement with the construction of levees, roads and channels. Most of the wetlands are now cut off from natural flooding and rely on the provision of environmental water to maintain their ecological character and health.

Guttrum and Benwell forests are a regionally significant wetland system and border the River Murray. Neither forest has permanent infrastructure to deliver environmental water although some semipermanent wetlands can be watered via temporary pumping from the River Murray.

Recent conditions

Significantly low rainfall, high temperatures and barriers—channels, roads and levees—that prevent natural run-off meant that minimal natural inflows were received in the central Murray wetlands in 2015–16. Environmental water was the primary water source provided in 2015–16.

Environmental watering in 2015–16 included top-up flows to Round Lake and Lake Elizabeth to maintain and establish suitable conditions for Murray hardyhead; and to Johnson Swamp, Richardson's Lagoon and Wirra–Lo wetland complex to support a diversity of waterbirds, plants and other animals typical of temporary freshwater marshes.

Four of the wetlands in the central Murray system did not receive environmental water in 2015–16 including McDonalds Swamp, Hird Swamp, Lake Cullen and Lake Murphy. A partial fill of McDonalds Swamp planned for autumn 2016 did not go ahead due to the risk of introducing high levels of toxic blue-green algae from the irrigation system into the wetland. The delivery to McDonalds Swamp is now planned to occur in late winter to early spring 2016. A drying regime was implemented for Hird Swamp, Lake Cullen and Lake Murphy: this helps promote germination and establishment of vegetation in and around the wetland and also promotes productivity and provides an important food source for wading waterbirds.

The drying of Lake Murphy resulted in a very productive mudflat and shallow water habitats that supported a diversity of feeding and breeding waterbirds into mid-summer including at least 1,000 individuals of 25 different waterbird species.

Round Lake remained permanently inundated during the season to support the resident Murray hardyhead population. While fish surveys in spring 2015 did not catch any Murray hardyhead individuals, surveyors observed some of the fish congregating in the shallower areas of the wetland. A low catch rate reflects the difficulties sampling for this species and its natural boom-and-bust population cycles.

In Lake Elizabeth the coverage of aquatic plant species favoured by Murray hardyhead have become more widespread since the first environmental watering in 2014. The plants should provide ideal habitat for the Murray hardyhead that were translocated into the wetland in autumn 2016.

A large variety and number of waterbirds were recorded at Wirra–Lo wetland complex, Johnson Swamp and Richardsons Lagoon in 2015–16. This included significant

species listed in the *Victorian Flora and Fauna Guarantee Act 1988*: the intermediate egret, Australasian bittern, little bittern, blue-billed duck, royal spoonbill, Baillon's crake, Latham's snipe, painted snipe and brolga. Successful breeding of Australasian bittern, Australian little bittern and brolga was recorded at Johnson Swamp. Other threatened species such as the sharp-tailed sandpiper, marsh sandpiper and whiskered tern were also recorded at some of these wetlands.

Wirra–Lo wetland complex was part of a former irrigation property that has been prioritised for rehabilitation with the strong support of the landholders. The landholders used irrigation water run-off and altered irrigation infrastructure to maintain the wetland's integrity for years. The wetland now has an environmental covenant to protect the land from farming and has been voluntarily disconnected from the irrigation network. Environmental water was first delivered to the Wirra–Lo wetland complex in 2014 and follow-up watering occurred in 2015–16. Each watering has triggered the rapid growth of aquatic and amphibious plant species (such as wavy marshwort, robust milfoil and spiny mud-grass). Environmental water in combination with land rehabilitation works and a native vegetation planting program is supporting a diverse range of wetland animal species including frogs and waterbirds.

Guttrum and Benwell forests have not received natural inflows since the heavy rains and consequent high flows in the River Murray in 2010–11. Although the natural inundation assisted the forest to partly recover from the millennium drought, recent observations suggest that the forests are still in relatively poor condition and require a more natural watering regime and reduced grazing pressure to support their recovery.

Scope of environmental watering

Potential environmental watering actions (including wetland drying) and their environmental objectives are shown in Table 5.2.7.

Table 5.2.7 Potential environmental watering actions and objectives for central Murray wetlands

Potential environmental watering	Environmental objectives
Wetland watering	
Round Lake (top-up flows as required to maintain water quality targets)	• Maintain habitat for Murray hardyhead • Maintain suitable waterbird habitat
Lake Elizabeth (top-up flows as required to maintain water quality targets)	• Maintain habitat for translocated Murray hardyhead • Support submerged salt-tolerant aquatic plant assemblage and a diversity of waterbirds
Wirra–Lo wetland complex (fill in winter/spring and provide top-ups if required)	• Rehabilitate river red gum and aquatic vegetation communities, providing habitat for the growling grass frog and a diversity of waterbirds
Guttrum and Benwell forests (semipermanent wetlands only; fill in winter/spring and provide top-ups if required)[1]	• Promote a variety of aquatic vegetation, semi-aquatic vegetation and river red gum communities in semipermanent wetlands • Provide feeding and breeding habitat for waterbirds
McDonalds Swamp (fill in winter/spring and provide top-ups if required)	• Maintain a diverse vegetation community by supporting juvenile river red gums and reducing coverage of common reed and cumbungi communities through environmental water management
Richardsons Lagoon (top up in winter/spring and provide top-ups if required)	• Promote a variety of aquatic plant species that support a variety of water-dependent species including fish, waterbirds, frogs and turtles
Hird Swamp West and East (partial fill in autumn/winter)	• Maintain a variety of vegetation communities (including open-water habitat) to support waterbird feeding and breeding habitats
Lake Cullen (top up in spring if natural flooding occurs)	• Maintain a viable stock of submerged salt-tolerant aquatic plants to support waterbird feeding and breeding habitats
Wetland drying	
Johnson Swamp and Lake Murphy (drawdown and drying)	• These wetlands will not be actively watered in 2016–17 • The drying will assist in maintaining a diversity of habitats to support a wide range of wetland-dependent birds and animals and to promote the growth and establishment of vegetation in and surrounding the wetland

1 Guttrum and Benwell forest may receive environmental water in 2016–17 pending further investigation by North Central CMA. Infrastructure projects for Guttrum and Benwell forests are being assessed as part of the Sustainable Diversion Limit Offset component of the Murray–Darling Basin Plan. Until works are approved and completed, environmental watering will only consider semipermanent wetlands that can receive water that is pumped from the River Murray.

Scenario planning

Table 5.2.8 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

Landscape-scale planning for these wetlands has been undertaken by the North Central CMA to optimise the wetland watering regimes over multiple years. An important consideration in this planning includes ensuring that there is a diversity of habitat types available across the region to support waterbirds and other water-dependent animals at any point in time.

In a given year, multiple wetlands may require environmental water at the same time. Inter-annual planning helps to manage this risk of increased pressure on environmental water resources, particularly if there is a return to drought conditions. It also helps support waterbird populations by ensuring that suitable habitat for breeding, feeding and nesting is available across northern Victoria.

The wetlands of highest priority for environmental water management in the central Murray wetlands in 2016–17 are Round Lake and Lake Elizabeth. Round Lake supports what is considered to be the only stable population of the critically endangered Murray hardyhead in the Kerang region. Murray hardyhead were also recently translocated to Lake Elizabeth and the lake will be prioritised to receive environmental water in 2016–17 to support the new population. It is important that these wetlands are maintained for future stocking and translocation programs to prevent the regional loss of the species.

In drier conditions, environmental water is planned to be delivered to fill and maintain water depth in some wetlands, to support the needs of wetland-dependent vegetation, fish and bird species. Water availability may increase if catchment conditions become wetter, which would support delivery to more wetlands within the central Murray to help meet native plant, animal and waterbird objectives. Under very wet conditions natural floods may partially or completely fill some of the central Murray wetlands, but environmental water will be required to maintain water depth to support waterbird breeding and vegetation condition.

While environmental water is planned to be delivered to Lake Cullen in 2016–17, its significant size and potential groundwater issues means that delivery depends on a degree of natural inundation of the wetland which in 2016–17 would only occur under extremely wet conditions. If natural flooding does occur, environmental water may be used to top up and maintain water levels to reduce the potential detrimental impact from a short, shallow inundation and groundwater intrusion. Further assessment will be undertaken to inform the most appropriate management option considering the timing, extent and duration of any natural inundation.

No environmental water is planned to be delivered to Johnson Swamp and Lake Murphy in 2016–17. These wetlands are undergoing a drying phase to promote habitat diversity for waterbirds and also to support young river red gums that established after recent environmental watering.

Table 5.2.8 Potential environmental watering for central Murray wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected catchment conditions	• Catchment run-off and unregulated flows into the wetlands is unlikely	• Catchment run-off and unregulated flows into the wetlands is unlikely	• Some catchment run-off and unregulated flows into the wetlands is likely, particularly in winter/spring	• Catchment run-off and unregulated flows into the wetlands may significantly contribute to water levels in the wetlands, particularly in winter/spring
Potential environmental watering – tier 1 (high priorities)	• Round Lake • Lake Elizabeth	• Round Lake • Lake Elizabeth	• Round Lake • Lake Elizabeth • Wirra–Lo wetland complex • Guttrum and Benwell forests • McDonalds Swamp • Richardsons Lagoon	• Round Lake • Lake Elizabeth • Wirra–Lo wetland complex • Guttrum and Benwell forests • McDonalds Swamp • Richardsons Lagoon
Potential environmental watering – tier 2 (additional priorities)	• Wirra–Lo wetland complex • Guttrum and Benwell forests • McDonalds Swamp • Richardsons Lagoon	• Wirra–Lo wetland complex • Guttrum and Benwell forests • McDonalds Swamp • Richardsons Lagoon	• Hird Swamp	• Hird Swamp • Lake Cullen
Possible volume of environmental water required to meet objectives1	• 3,850 ML (tier 1) • 5,175 ML (tier 2)	• 3,100 ML (tier 1) • 4,300 ML (tier 2)	• 7,400 ML (tier 1) • 1,500 ML (tier 2)	• 7,400 ML (tier 1) • 19,000 ML (tier 2)
Priority carryover requirements	• 3,900 ML	• 3,100 ML	• 5,800 ML	• 5,800 ML

1 Possible environmental water requirements for tier 2 are additional to tier 1 requirements.

Risk management

In preparing its seasonal watering proposal, North Central CMA considered and assessed risks and identified mitigating strategies relating to the implementation of environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 5.2.9 shows the partners, stakeholder organisations and individuals with which North Central CMA engaged when preparing the central Murray wetlands seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional waterway strategies, environmental water management plans and environmental flow studies, which incorporate environmental, cultural, social and economic considerations.

Table 5.2.9 Key stakeholders engaged in the development of the central Murray wetlands seasonal watering proposal

Stakeholder engagement
• Birdlife Australia
• Central Murray Wetlands Environmental Water Advisory Group (made up of community members, private landholders, interest groups including Game Management Authority, North Central CMA project staff, Board and Community Consultative Committee representation)
• Commonwealth Environmental Water Office
• Community members
• Department of Environment, Land, Water and Planning
• Field and Game Australia
• Gannawarra Shire Council
• Goulburn-Murray Water
• North Central CMA Board
• North Central CMA Community Consultative Committee, an advisory group to the North Central CMA Board made up of regional community members
• Parks Victoria
• Swan Hill Rural City Council
• Victorian Environmental Water Holder

McDonalds swamp, by North Central CMA

5.2.4 Hattah Lakes

Environmental values

Hattah Lakes provides immense waterbird breeding habitat, particularly for colonial nesting waterbirds including several species of cormorant. Being located in a remote and arid landscape, Hattah Lakes also provides large-scale drought refuge for waterbirds and other vertebrate animals. Nine fish species have been reported in the lakes and five of these have conservation significance in Victoria, including the freshwater catfish and fly-specked hardyhead.

Flood-dependent vegetation at Hattah Lakes ranges from wetland communities that require frequent flooding to communities that require inundation every few years (such as lignum and black box). The lakes support more than 100 plant species that are considered rare or threatened in Victoria. One of these rare plants, the winged peppercress, is listed as nationally endangered under the *Environmental Protection and Biodiversity Conservation Act 1999*.

Social and economic values

Hattah Lakes is a popular location for camping, canoeing, birdwatching and photography. The lakes are also valued by Traditional Owners in the region, who have a continuing connection to the land. There are more than 1,000 registered sites of importance including burial sites, scar trees and shell middens.

Environmental watering objectives for the Hattah Lakes

- Restore a healthy and diverse mix of wetland and floodplain plant life to maintain the ecological character of this internationally protected site
- Maintain high-quality habitat for native fish in wetlands
- Use flows to connect the lakes to the river so large-bodied fish (including Murray cod and perch) can move, feed and breed
- Provide feeding and breeding habitat for a range of waterbird species including threatened and migratory species and colonial species (such as the spoonbill and egret)

System overview

Hattah Lakes is a complex of more than 20 semipermanent freshwater lakes over an area of 48,000 hectares. The lakes complex forms part of the Hattah–Kulkyne National Park. Located adjacent to the River Murray in north-west Victoria, the ecology of the lakes and floodplain is strongly influenced by flooding regimes.

The Hattah Lakes system is naturally filled when there are high flows in the River Murray. When floods recede some individual lakes hold water for years. The high flows that cause floods in the lakes are less than they were before, when the Murray system was unregulated.

In the absence of regular high flows in the River Murray, large-scale engineering works were completed under the Living Murray program to improve water regimes at Hattah Lakes under low-flow conditions. Pumps and regulators are used to deliver, retain and discharge water from the floodplain, to provide the water regimes that support the environmental values in the system.

Recent conditions

Natural flooding at Hattah Lakes has been absent since 2011. To replicate natural floods and assist commissioning of new water delivery infrastructure, environmental water has been delivered to Hattah Lakes three times since 2013. The first two deliveries reached high elevations on the floodplain and supported black box woodlands. Most recently, in spring 2015 water was used to top up semipermanent wetlands. The inundation extent was reduced compared to previous years, allowing a drying phase to favour vegetation on the drying beds of lakes and recruitment of river red gums.

The environmental watering over the last three years saw a range of positive results. Most notably, the condition of river red gum and black box woodlands has improved. After environmental watering, botanists recorded 80 new locations of rare or threatened plants, with a low abundance of exotic weeds. The wetlands have also benefited through nutrient exchange and release of carbon, which makes plants grow rapidly and provides optimal conditions for fish and birds to feed and reproduce.

The watering in spring 2015 provided connectivity between the lakes and the River Murray. During the watering event, golden perch that were present in the lakes were observed moving in response to environmental flows in Chalka Creek and exiting the wetlands to the River Murray. The release also provided a chance for little pied cormorants to breed and improved habitat for woodland birds including threatened regent parrots.

Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 5.2.10.

Table 5.2.10 Potential environmental watering actions and objectives for the Hattah Lakes

Potential environmental watering[1]	Environmental objectives
Winter/spring inundation of semipermanent wetlands (provide top-up flows as required targeting a water level of 42.5 m AHD July–November)	• Maintain deeper water for waterbird breeding events • Maintain potential breeding habitat for fish including golden perch • Provide connectivity between the Hattah Lakes system and the River Murray channel
Winter/spring inundation of temporary wetlands (fill wetlands above 42.5 m AHD July–November)	• Provide inundation of red gum forest and woodland for growth and reproduction

1 The Hattah Lakes pump station will also be operated to meet annual maintenance requirements.

Scenario planning

Table 5.2.11 outlines potential environmental watering and expected water usage under a range of planning scenarios.

In recent years the watering requirements for the red gum forest, woodlands and semipermanent wetlands at Hattah Lakes have been met, and these communities now need time to dry and allow new understorey to develop. Additional watering is not required in 2016–17 and the priority for Hattah Lakes is to provide widespread and substantial drawdowns to allow vegetation to grow and establish. As the water in wetlands evaporates it also provides lots of shallow water, which is the preferred habitat for wading birds.

Under a drought or dry scenario there are low environmental water demands in the lakes system, and water is only required to undertake annual operational maintenance of the Hattah Lakes pump station.

Natural flow cues will be used to help inform decisions to undertake larger-scale watering at Hattah Lakes if conditions are average to wet, aiming to replicate watering events that would have occurred before major dams and weirs were built.

Table 5.2.11 Potential environmental watering for the Hattah Lakes under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No unregulated flows in the River Murray year-round • No natural inflows expected into wetlands or floodplain		• Short periods of high flows in the River Murray in late winter and early spring will provide minor filling of wetlands and the floodplain	• Lengthy periods of high flows and floods with major spills from storages, resulting in widespread inundation of the floodplain and inundating most wetlands
Potential environmental watering	• Operational maintenance of pump station and infrastructure commissioning		• Winter/spring fresh in Chalka Creek south • Winter/spring inundation of semipermanent wetlands	• Winter/spring fresh in Chalka Creek south • Winter/spring inundation of temporary wetlands
Possible volume of environmental water required to meet objectives	• 2,000 ML		• Up to 22,000 ML	• Up to 35,000 ML

Risk management

In preparing its seasonal watering proposal, Mallee CMA considered and assessed risks and identified mitigating strategies relating to the implementation of environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 5.2.12 shows the partners and stakeholder organisation with which Mallee CMA engaged when preparing the Hattah Lakes seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional waterway strategies, environmental water management plans and environmental flow studies, which include environmental, cultural, social and economic considerations.

Table 5.2.12 Partners and stakeholders engaged in developing the Hattah Lakes seasonal watering proposal

Partner and stakeholder engagement
• Commonwealth Environmental Water Office
• Goulburn-Murray Water
• Murray–Darling Basin Authority
• Parks Victoria
• Department of Environment, Land, Water and Planning
• Victorian Environmental Water Holder
• Mallee CMA Water Technical Advisory Committee (an advisory group to Mallee CMA comprising community members)

5.2.5 Lower Murray wetlands

Environmental values

The lower Murray wetlands are comprised of multiple wetlands, creek and billabongs on the floodplain of the River Murray. Depending on their location in the landscape, interactions with groundwater and their management history, the wetlands may be permanent, temporary, freshwater or saline. The differences in water regime and water quality among the wetlands provide a range of habitats for plants and animals. For example, permanent, saline wetlands (such as Brickworks Billabong) provide vital habitat for the endangered Murray hardyhead fish. Unlike permanent wetlands, temporary freshwater wetlands fill and dry intermittently. During the filling phase they provide short-term boom periods when river red gum trees and wetland plants grow, spread and provide habitat for aquatic animals.

Social and economic values

There are several irrigation districts in the Sunraysia region that are supplied by the River Murray and contribute significant wealth to the local economy. Camping, fishing and other water-based recreational activities are popular along the River Murray including at some wetlands in the lower Murray system. Waterbirds provide opportunities for bird watching and hunting. Aboriginal culture is strongly linked to the floodplain of the River Murray, which for many thousands of years would have maintained a concentrated population due to the abundant resources it provided.

Environmental watering objectives in the lower Murray wetlands
Increase the diversity, extent and abundance of wetland plant life
Provide feeding and breeding habitat for a range of waterbird species including threatened and migratory species and colonial species (such as the egret)
Improve water quality and increase habitat for fish
Improve the condition of river red gums, black box and lignum to provide habitat for large animals (such as lace monitors and bats)

System overview

The lower Murray wetlands span more than 700 kilometres of linear floodplain along the River Murray between Swan Hill and the South Australian border. This includes creeks, wetlands and floodplains that are ecologically important and reflect the natural character and attributes of the River Murray floodplain.

The regulation and diversion of River Murray flows has dramatically altered the hydrology of the lower Murray wetlands. River regulation has substantially reduced the frequency and duration of the high river flows that are needed to water billabongs and floodplains. This change to the water regime has caused a decline in the environmental values of floodplain wetland sites.

Environmental water can be delivered to some wetlands in the region through a combination of direct pumping from the River Murray and through use of irrigation supply infrastructure. All the wetlands can be managed independently of each other.

Recent conditions

The last time that sustained high flows in the River Murray were sufficient to inundate vast areas of lower Murray wetlands and floodplains was in 2010 and 2011. Since 2011 high river flows have mostly been absent so wetlands have relied on the delivery of environmental water to support aquatic life.

Environmental water was delivered to some wetlands in 2015–16 including to Burra Creek North, Neds Corner East and Central, Butlers Creek, Brickworks Billabong, Cardross Lake, Cowanna Billabong, Lakes Powell and Carpul, Nyah and Vinifera floodplains and Lake Hawthorn. This watering achieved a range of positive outcomes for native fish, birds and terrestrial animals.

In 2014–15 Lakes Powell and Carpul received environmental water for the first time since 2011–12. The filling complemented the gains made from the previous watering by improving the condition of black box vegetation that had regenerated around the lakes. The watering also provided habitat and feeding opportunities for many thousands of waterbirds.

At Brickworks Billabong environmental watering supported a population of critically endangered Murray hardyhead. In March 2015, 2,500 Murray hardyhead were translocated to Brickworks Billabong, adding to the existing population. Since that time, watering of the billabong has maintained the condition of ruppia, an aquatic plant that provides habitat for the fish. Monitoring in January 2016 has demonstrated that Murray hardyhead are thriving and breeding in the wetland, with high numbers of adult and juvenile fish present.

Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 5.2.13.

Environmental watering will focus on maintaining and improving vegetation condition, habitat quality and availability throughout the wetlands, floodplains and waterways in the lower Murray region, and in some cases, rehabilitating salt-affected wetlands.

Table 5.2.13 Potential environmental watering actions and objectives for the lower Murray wetlands

Potential environmental watering	Environmental objectives
Wetland watering	
Brickworks Billabong (spring, autumn and top-ups as required to maintain water quality targets and minimum water level)	• Maintain and improve the condition of aquatic vegetation and water quality for Murray hardyhead
Cardross Lakes (top up as required to maintain water quality targets and minimum water level)	
Lake Koorlong (top up as required to maintain water quality targets and minimum water level)	
Burra Creek South (winter/spring)	• Provide productive lake habitat for waterbirds • Restore floodplain productivity to maintain resident populations of vertebrate animals including carpet pythons and insectivorous bats • Promote emergent and semi-emergent aquatic vegetation
Burra Creek South Proper (spring)	
Burra Creek North (winter/spring)	
Nyah floodplain (spring/summer)	• Improve condition and structure of wetland vegetation • Provide seasonal feeding and reproductive opportunities for native fish • Provide breeding habitat for waterbirds including colonial nesting species • Restore floodplain productivity to maintain resident populations of vertebrate animals including carpet pythons, sugar gliders and grey-crowned babblers
Vinifera floodplain (spring/summer)	
Liparoo East (winter/spring)	• Improve condition of the lignum swampy woodland vegetation community and provide habitat for waterbird breeding
Liparoo West (winter/spring)	
Woorlong floodplain (winter/spring/autumn)	• Improve wetland productivity • Reinstate submerged and semi-emergent aquatic plants • Improve nesting opportunities in flooded lignum surrounding the wetlands • Improve the health of surrounding river red gum and black box
Carina Bend (winter/spring)	• Maintain and improve the health of river red gum, black box and lignum
J1 wetland (winter/spring/autumn)	
Yungera wetland (winter/spring/autumn)	
Bridge Creek (spring)	
Cowanna Billabong (winter/spring)	• Support fish and birds • Increase wetland productivity • Provide opportunities for fish to move between wetlands and the River Murray
Butlers Creek (spring/summer)	
Neds Corner East and Central (spring)	• Provide breeding and roosting habitat for colonial waterbirds
Margooya Lagoon (winter/spring/summer)	• Improve river red gum condition • Improve the native fish assemblage of the lagoon • Restore submerged aquatic vegetation in the open-water areas of the wetland
Lock 15 wetlands (all year)	• Improve the productivity of connected riparian zones and wetlands • Restore floodplain productivity to maintain resident populations of vertebrate animals including carpet python and insectivorous bats • Contribute to the carbon requirements of the River Murray channel ecosystem
Lake Hawthorn (spring, and top-ups as required to maintain water level targets)	• Restore aquatic vegetation, particularly ruppia • Provide habitat for waterbirds
Psyche Bend Lagoon (autumn, winter or spring)	• Provide freshwater inflows and flushing flows to reduce salinity levels and improve the condition and diversity of wetland vegetation, improving ecological function
Bullock Swamp (autumn, winter or spring)	
Outlet Creek (Karadoc Swamp) (spring)	
Wetland drying	
Kings Billabong, Heywood Lake, Robertsons wetland, Lakes Powell and Carpul, Sandilong Creek and wetland	• These wetlands will not be actively watered in 2016–17 • Drying will assist in maintaining a diversity of habitats to support a wide range of wetland-dependent birds and animals and to promote the growth and establishment of vegetation in and surrounding the wetland

Scenario planning

Table 5.2.14 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

It has been more than five years since the drought-breaking floods of 2011, but conditions have been very dry ever since. Despite the gains made as a result of the widespread floods five years ago, many wetlands require environmental watering. The approach in 2016–17 is to continue recovery and build resilience in fish and wetland vegetation communities so they can better endure current and future dry conditions.

The highest-priority wetlands for environmental watering in 2016–17 are Cardross Lakes, Lake Koorlong and Brickworks Billabong, as these sites support the critically endangered Murray hardyhead.

Depending on seasonal conditions and water availability, remaining wetlands are prioritised in line with their recommended watering regimes and considering the condition of the environmental values at each site. If conditions become average or wet, additional wetlands will be watered to mimic conditions that would naturally occur in wetter years. In this way the environmental responses are maximised as plants and animals respond to natural environmental cues.

For some temporary wetlands, the desired wet phase has been achieved consistently in recent years. Some wetlands will not be actively watered in 2016–17 and will be allowed time to dry. This will allow time for vegetation to germinate and establish, to increase the diversity of habitats available for aquatic plants and animals during the next wet phase. At the same time, the dry phase will provide opportunities for terrestrial animals to access resources within a temporarily dry wetland.

Table 5.2.14 Potential environmental watering for lower Murray wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected catchment conditions	• No unregulated flows in the River Murray year-round • Wetlands rely on environmental water delivery		• Sustained periods of high flows in the River Murray in late winter and early spring will provide some opportunity for low-lying wetlands to be naturally inundated but most wetlands will still rely on environmental water delivery	• Lengthy periods of high flows and floods with major spills from storages, resulting in widespread inundation of the floodplain and inundating most wetlands • Some reliance on environmental water delivery to achieve target water levels
Potential environmental watering – tier 1 (high priorities)	• Brickworks Billabong • Cardross Lake • Lake Koorlong	• Brickworks Billabong • Cardross Lake • Lake Koorlong • Lock 15 wetlands • Lake Hawthorn • Burra Creek South	• Brickworks Billabong • Cardross Lake • Lake Koorlong • Lock 15 wetlands • Lake Hawthorn • Burra Creek South • Nyah floodplain • Vinifera floodplain • Burra Creek South Proper • Neds Corner East and Central • Carina Bend • Liparoo East • Liparoo West • Margooya Lagoon • Cowanna Billabong	• Brickworks Billabong • Cardross Lake • Lake Koorlong • Lock 15 wetlands • Lake Hawthorn • Burra Creek South • Nyah floodplain • Vinifera floodplain • Burra Creek South Proper • Neds Corner East and Central • Carina Bend • Liparoo East • Liparoo West • Margooya Lagoon • Cowanna Billabong • Bullock Swamp • Psyche Bend Lagoon • Woorlong floodplain • Burra Creek North • Butlers Creek • J1 Wetland • Yungera Wetland • Outlet Creek (Karadoc Swamp) • Bridge Creek
Potential environmental watering – tier 2 (additional priorities)	• Lake Hawthorn	• Nyah floodplain • Vinifera floodplain • Carina Bend • Liparoo East • Liparoo West • Margooya Lagoon • Cowanna Billabong	• Bullock Swamp • Psyche Bend Lagoon • Woorlong floodplain • Burra Creek North • Butlers Creek	• N/A
Possible volume of environmental water required to meet objectives[1]	• 950 ML (tier 1) • 1,500 ML (tier 2)	• 3,750 ML (tier 1) • 6,000 ML (tier 2)	• 10,200 ML (tier 1) • 2,300 ML (tier 2)	• 15,050 ML (tier 1)
Priority carryover requirements	• 2,450 ML	• 9,750 ML	• 12,500 ML	• 15,050 ML

1 Environmental water requirements for tier 2 actions are additional to tier 1 requirements.

Risk management

In preparing its seasonal watering proposal, Mallee CMA considered and assessed risks and identified mitigating strategies relating to the implementation of environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 5.2.15 shows the partners and stakeholder organisations with which Mallee CMA engaged when preparing the lower Murray wetlands seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional waterway strategies, environmental water management plans and environmental flow studies, which include environmental, cultural, social and economic considerations.

Table 5.2.15 Partners and stakeholders engaged in developing the lower Murray wetlands seasonal watering proposal

Partner and stakeholder engagement
• Goulburn-Murray Water
• Commonwealth Environmental Water Office
• Murray–Darling Basin Authority
• Department of Environment, Land, Water and Planning
• Parks Victoria
• Lower Murray Water
• Mildura Rural City Council
• Swan Hill Rural City Council
• Victorian Environmental Water Holder
• Mallee CMA Water Technical Advisory Committee (an advisory group to Mallee CMA comprising community members)

5.2.6 Lindsay, Wallpolla and Mulcra islands

Environmental values

The Mullaroo and Potterwalkagee creeks are renowned for holding very large Murray cod. These creeks provide superior fish habitat compared to the nearby weir pools in the River Murray, and large breeding fish in the creeks are an important source of juveniles to the Murray system. The waterways also support several other threatened fish species, such as the freshwater catfish, silver perch, Murray–Darling rainbowfish and unspeckled hardyhead.

The vast scale of the Lindsay, Mulcra and Wallpolla islands site is noteworthy because it provides very large expanses of habitat to support wetland-dependent and terrestrial species. Several rare and threatened vegetation types occur on the floodplain and in the wetlands as well as more common types of woodlands (such as black box and river red gum).

When flooded, waterways and wetlands within this system provide excellent habitat for waterbirds, 40 species of which are threatened in Victoria including the great egret and red-necked stint. Terrestrial animals also benefit from the improved productivity and food resources when flooding occurs.

Social and economic values

The islands offer recreation opportunities in a remote location with camping, boating and fishing popular for residents of nearby communities and long-distance travellers.

The floodplain and wetland systems have many sites with valuable Aboriginal heritage including shell middens, burial sites and scar trees. Lindsay Island is noteworthy due to the presence of many archaeological sites and the floodplain and wetland systems continue to be places of importance for Traditional Owners and their Nations in the region.

Environmental watering objectives in Lindsay, Wallpolla and Mulcra islands	
	Increase the diversity, extent and abundance of wetland plant life
	Provide feeding and breeding habitat for a range of waterbird species including threatened and migratory species and colonial species (such as the egret)
	Increase abundance, diversity and movement of native fish Provide flows for large-bodied fish (including Murray cod and perch) to swim, feed and breed

System overview

Lindsay, Mulcra and Wallpolla islands cover over 26,100 hectares of River Murray floodplain, forming part of the Chowilla floodplain and Lindsay–Wallpolla Island Living Murray icon site. The floodplain is characterised by a network of permanent waterways, small creeks and wetlands. The larger, permanent waterways–Lindsay River, Potterwalkagee Creek and Wallpolla Creek–form the southern boundaries of the site and create large floodplain islands with the River Murray to the north.

Naturally, these waterways and wetlands would flow and fill in response to high water levels in the River Murray. However, the regulation of the River Murray has reduced its influence on the Lindsay, Mulcra and Wallpolla system.

Although large floods can still occur, flows through the system are mostly regulated by the River Murray locks 6 to 9. Regulators and containment structures have been built throughout the Lindsay, Mulcra and Wallpolla floodplain and are used to help protect the environmental values at the site.

Recent conditions

Floods in 2010 and 2011 provided the first large-scale floodplain watering event in 15 years, but there have not been flows high enough for widespread floodplain watering since. Local conditions have been hot and dry in recent years, causing high evaporation and wetland drying.

The weir pools at River Murray locks 6 to 9 have been managed to add greater variability in water levels to improve environmental outcomes in the waterways, floodplains and wetlands in the system. The raising and lowering of these weir pools has been managed to facilitate delivery of preferred baseflows and freshes to Potterwalkagee and Mullaroo creeks in 2015–16. The events also facilitated the commissioning of newly completed infrastructure on Mullaroo Creek.

High flows and flushes in the Lindsay River were provided to stimulate fish movement and to facilitate pumping of water into surrounding floodplain wetlands. During these high flows, 8,000 ML was pumped into Lake Wallawalla and 600 ML into Wallpolla East Wetland to improve vegetation condition and provide habitat for waterbirds to feed and breed.

Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 5.2.16.

Table 5.2.16 Potential environmental watering actions and objectives for Lindsay, Wallpolla and Mulcra islands

Potential environmental watering	Environmental objectives
Lindsay Island	
Year-round baseflows in Mullaroo Creek (greater than 400 ML/day)	• Maintain flowing water habitat for native fish species such as the Murray cod, silver perch and golden perch
Year-round baseflows in the northern Lindsay River (greater than 40 ML/day year-round)	
Spring freshes in Mullaroo Creek (up to 1,000 ML/day in September to November)	• Stimulate golden perch spawning and movement, and seasonal Murray cod movement • Maintain flows to assist in recruitment and survival of fish
Spring and summer high flows in the northern and southern Lindsay River (up to 450 ML/day in September–February)	
Year-round high flows in Mullaroo Creek (up to 1,000 ML/day year-round)	
Mulcra Island	
Year-round baseflows in lower Potterwalkagee Creek (up to 100 ML/day year-round)	• Maintain flowing water habitat for large-bodied native fish, particularly golden perch
Spring freshes and high flows in lower and upper Potterwalkagee Creek (up to 500 ML/day year-round)	• Stimulate large-bodied native fish movement and spawning
Floodplain inundation of lower Potterwalkagee Creek	• Improve condition of lignum shrublands • Provide floodplain habitat for small-bodied fish to reproduce
Wallpolla Island	
Spring inundation of Wallpolla East, Sandy Creek and floodplain, Finnegans Creek and Wallpolla Horseshoe (filling flows in September–November)	• Provide temporary habitat for plants and animals and increase wetland productivity
Wetland drying	
Lake Wallawalla	• Lake Wallawalla will not be actively watered in 2016–17 • Drying will assist in maintaining a diversity of habitats to support a wide range of wetland-dependent birds and animals and promote the growth and establishment of vegetation in and surrounding the wetland

Scenario planning

Table 5.2.17 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

Watering at Lindsay, Mulcra and Wallpolla islands in 2016–17 will focus on providing variable flows in the major waterways and anabranches of the systems (including Lindsay River) and Mullaroo and Potterwalkagee creeks. These flow events will again be coordinated with weir pool operations.

Baseflows are generally provided in these waterways by consumptive water. Under drought and dry conditions spring freshes will also be provided to maintain habitat and provide migration opportunities for native fish. Wetland watering actions are not planned under drought conditions but will become a priority for delivery as conditions improve.

Table 5.2.17 Potential environmental watering for Lindsay, Wallpolla and Mulcra islands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected catchment conditions	• No unregulated flows in the River Murray year-round • No natural inflows expected into wetlands or floodplain		• Short periods of high flows in the River Murray in late winter and early spring will provide minor filling of wetlands and the floodplain	• Lengthy periods of high flows and floods with major spills from storages resulting in widespread inundation of the floodplain and inundating most wetlands
Potential environmental watering – Lindsay and Mulcra Islands	• Year-round baseflows in Mullaroo Creek and Potterwalkagee Creek • Spring freshes in Mullaroo Creek	• Year-round baseflows in Mullaroo Creek and Potterwalkagee Creek • Spring freshes in Mullaroo Creek	• Spring freshes and high flows in Mullaroo Creek and Potterwalkagee Creek • Spring and summer high flows in northern and southern Lindsay River	• Year-round high flows in Mullaroo Creek • Spring and summer high flows in northern and southern Lindsay River • Floodplain inundation above the lower Potterwalkagee regulator
Possible volume of environmental water required to meet objectives	• 2,000 ML[1]			
Potential environmental watering – Wallpolla Island	• N/A	• Spring inundation of Wallpolla East, Sandy Creek and floodplain, Finnegans Creek and Wallpolla Horseshoe	• Spring inundation of Wallpolla East, Sandy Creek and floodplain, Finnegans Creek and Wallpolla Horseshoe	• Spring inundation of Wallpolla East, Sandy Creek and floodplain, Finnegans Creek and Wallpolla Horseshoe • Increased flows in all systems and large-scale floodplain inundation
Possible volume of environmental water required to meet objectives	• N/A	• 2,100 ML	• 2,700 ML	• 4,000 ML

1 Volume includes the estimated volume of environmental water required to underwrite the losses associated with the delivery of consumptive water en route (for flows within the Mullaroo Creek, Lindsay River and Potterwalkagee Creek).)

Risk management

In preparing its seasonal watering proposal, Mallee CMA considered and assessed risks and identified mitigating strategies relating to the implementation of environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 5.2.18 shows the partners and stakeholder organisation with which Mallee CMA engaged when preparing the Lindsay, Wallpolla and Mulcra islands seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional waterway strategies, environmental water management plans and environmental flow studies, which include environmental, cultural, social and economic considerations.

Table 5.2.18 Partners and stakeholders engaged in developing the Lindsay, Wallpolla and Mulcra islands seasonal watering proposal

Partner and stakeholder engagement
• Commonwealth Environmental Water Office
• Goulburn-Murray Water
• Murray–Darling Basin Authority
• Parks Victoria
• Department of Environment, Land, Water and Planning
• Victorian Environmental Water Holder
• Mallee CMA Water Technical Advisory Committee (an advisory group to Mallee CMA comprising community members)

Potterwalkagee creek, by Mallee CMA

5.3 Ovens system

Waterway manager – North East Catchment Management Authority

Storage manager – Goulburn-Murray Water

Environmental water holder – Commonwealth Environmental Water Holder

Environmental values

The Ovens system supports a wide range of native fish species including the Murray cod, trout cod, golden perch and fly-specked hardyhead. The Buffalo River is important for large fish species during part of their breeding cycle while trout cod are found as far up the King River as Whitfield. The Ovens system has been the focus of a successful recovery project for trout cod, with efforts to reintroduce Macquarie perch underway.

Frogs (such as the giant bullfrog and growling grass frog) are abundant in the lower Ovens River and associated wetlands and in the King River upstream of Cheshunt. The lower wetlands support birds such as egrets, herons, cormorants, bitterns and treecreepers while the vegetation along the rivers is mostly river red gums and is among the healthiest examples in north-east Victoria.

Social and economic values

Recreational activities include fishing, boating, kayaking, waterskiing, swimming and bushwalking while irrigation supports the food and wine industries that attract many tourists to the region. The lower Ovens/ River Murray weir pool associated with Lake Mulwala is another tourist drawcard. There are also significant Aboriginal cultural heritage values with scar trees and artefact scatters as the physical evidence of Aboriginal people living along the river. The Ovens River continues to be a place of significance for Traditional Owners and their Nations in the region.

Environmental watering objectives in the Ovens system
Provide flows for native fish to move between pools and over rocky or shallow parts of the river
Maintain the form of the river bank and channel plus a range of different river bed surfaces to support all stream life
Scour silt build-up and clean cobbles in river bed pools to maintain habitat for native plants and animals
Maintain water quality for all river life
Provide habitat for a wide range of waterbugs which provide energy, break down dead organic matter and support the river's food chain

System overview

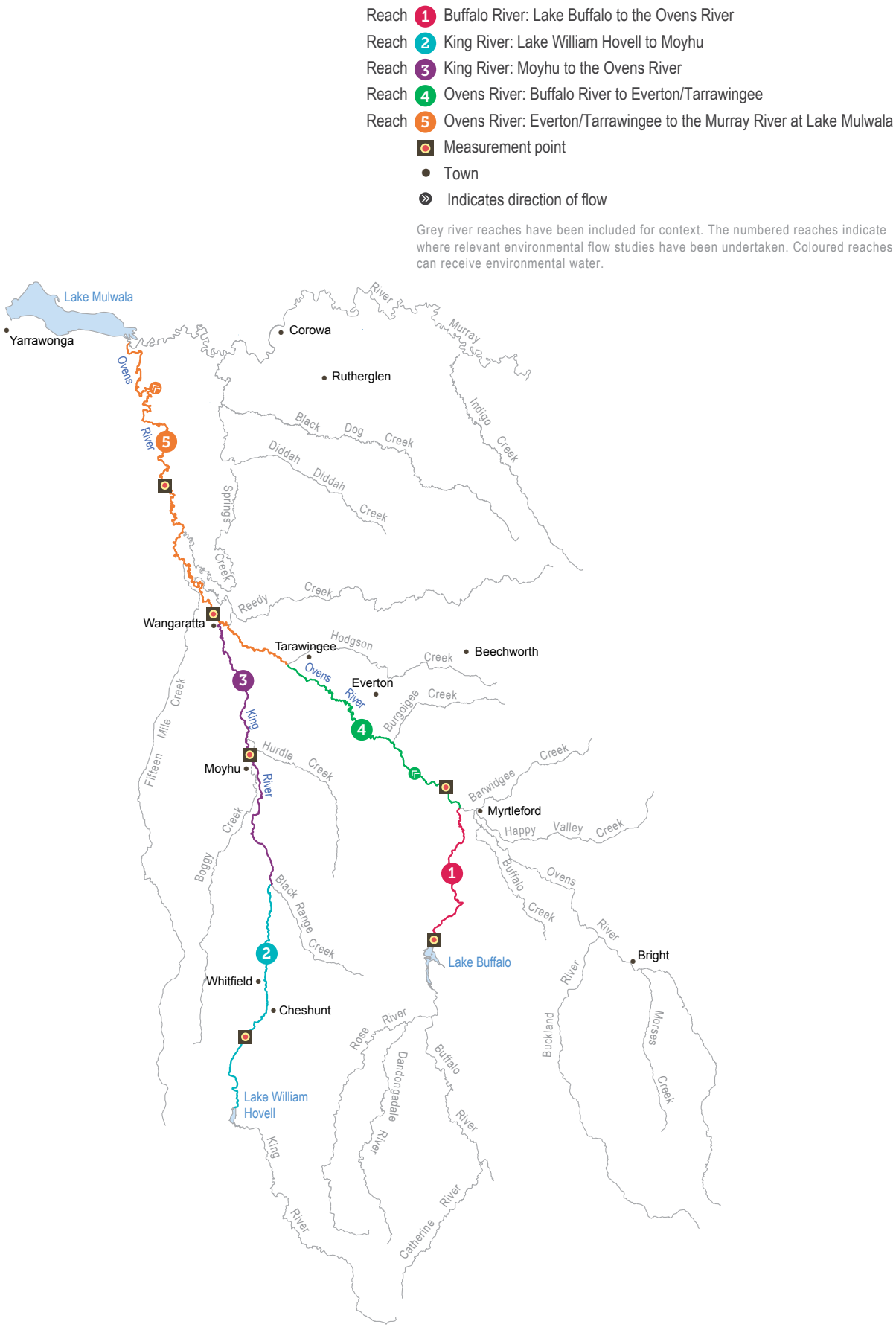
The Ovens system rises in the Great Dividing Range near Mount Hotham and flows about 150 km to join the River Murray in the backwaters of Lake Mulwala. Two small water storages have been constructed in the system: Lake Buffalo on the Buffalo River and Lake William Hovell on the King River. The regulated reaches of the Ovens system include the Buffalo River below Lake Buffalo, the King River below Lake William Hovell and the Ovens River from its confluence with the Buffalo River to the River Murray (as shown in Figure 5.3.1).

The Ovens system maintains quite good natural flows (particularly in winter-spring), compared to other regulated rivers. This is a result of relatively small storages that spill regularly and allow unregulated flows to the rivers.

The Ovens system contributes significantly to the water resources of the River Murray. The water that flows out of the Ovens River is regulated by the largest weir pool (Lake Mulwala) on the Murray regulated system. Ovens River flows contribute to the reliability and the variability of the flow regime for the River Murray and support many downstream uses including irrigation, urban supply and watering of iconic sites (such as Barmah Forest).

Environmental water is held in Lake Buffalo and in Lake William Hovell and can be released under regulated conditions when the storages are not spilling. Five reaches in the Ovens system can benefit from environmental water releases. While all are important, there are relatively small environmental holdings available in the system to meet the needs of all reaches. When water is only available from the holdings, outcomes in the reaches immediately downstream of the storages are targeted. When paired with consumptive water on its way to the Murray system, additional benefits are likely to be achieved downstream in the lower Ovens River.

Figure 5.3.1 The Ovens system



Recent conditions

Some unregulated flows occurred in the Ovens system in winter and spring 2015. Climatic conditions continued the recent trend of the past four years of reduced rainfall: consequently, inflows to the storages were also very low. Releases from storage generally remained at low, stable levels during the irrigation season.

The releases from Lake William Hovell presented an opportunity to add some flow variability by releasing 50 ML of water over two days in early April.

The bulk drawdown of water—a large release from Lake Buffalo to deliver consumptive water downstream and make additional space in the storage—did not occur due to the dry conditions in 2015–16. Consequently, 20 ML of water was released at the end of April to provide some variability downstream of the storage.

Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 5.3.1.

Table 5.3.1 Potential environmental watering actions and objectives for the Ovens system

Potential environmental watering	Environmental objectives
Summer/autumn low-flow fresh in reach 5 (1 fresh of 130–260 ML/day for at least 3 days in April–May)	• Maintain flow cues to stimulate movement of native fish • Maintain short-term fluctuations in discharge to move sediment and maintain waterbug habitat • Maintain connectivity between pools and riffles • Scour biofilm from river bed
Supporting variability[1] of summer/autumn low flows targeting reaches 1, 2 and 3	• Maintain natural connectivity between pools and riffles • Maintain short-term fluctuations in discharge to move sediment and maintain waterbug habitat

1 Operational releases from storage can vary, with environmental water used to provide some variability over one or two days.

Scenario planning

Table 5.3.2 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

The climatic conditions and inflows into storages have a large effect on how environmental water is likely to be used. Under dry conditions, environmental water aims to provide low-flow variability below the storages.

As conditions become wetter, there are increased opportunities to piggyback environmental releases on the bulk drawdown of water from Lake Buffalo and achieve environmental outcomes for the length of the regulated river. Environmental water cannot be released if the storages are spilling and under wet conditions the additional risk of overbank flows may result in environmental water not being released at all. However, the desired flows through the Ovens system are likely to be achieved naturally under wet conditions. The Commonwealth environmental water holdings in the Ovens system have a high level of security and are expected to be available under all scenarios except for an extreme dry scenario, where perhaps rights to environmental water could be qualified and therefore not available for release.

Table 5.3.2 Potential environmental watering for the Ovens system under a range of planning scenarios

Planning scenario	Dry	Average	Wet
Expected river conditions	• Possible winter/early spring unregulated flows • Highly likely low summer/autumn flows • Bulk water release unlikely	• High winter/spring unregulated flows • Possible summer/autumn low flows • Bulk water release likely	• High unregulated flows throughout most of the year • Bulk water release likely
Expected availability of environmental water		• 50 ML Lake William Hovell • 20 ML Lake Buffalo • 70 ML total	
Potential environmental watering	• Summer/autumn low flows	• Summer/autumn low-flow freshes	• All objectives achieved naturally • Spill conditions and/or risk of overbank flows mean environmental water may not be released
Possible volume of environmental water required to meet objectives	• 70 ML	• 70 ML	• 70 ML

Risk management

In preparing its seasonal watering proposal, North East CMA considered and assessed risks and identified mitigating strategies relating to the implementation of environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 5.3.3 shows the partners with which North East CMA engaged when preparing the Ovens system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional waterway strategies, environmental water management plans and environmental flow studies, which incorporate environmental, cultural, social and economic considerations

Table 5.3.3 Partners engaged in developing the Ovens system seasonal watering proposal

Partner engagement
• Commonwealth Environmental Water Office • Goulburn-Murray Water • Victorian Environmental Water Holder

5.4 Goulburn system

Waterway manager – Goulburn Broken Catchment Management Authority

Storage manager – Goulburn-Murray Water

Environmental water holders – Commonwealth Environmental Water Holder, Victorian Environmental Water Holder, Murray–Darling Basin Authority (the Living Murray program)

The Goulburn is Victoria's largest river basin, covering over 1.6 million hectares or 7.1 percent of the state. The Goulburn River flows for 570 kilometres from the Great Dividing Range upstream of Woods Point to the River Murray east of Echuca. It is an iconic heritage river because of its environmental, recreational and Aboriginal cultural heritage values. It supports large areas of intact river red gum forest and provides habitat for threatened and endangered bird and fish species. It also contains important cultural heritage sites, provides water for Victoria's largest irrigation district and supports recreational activities such as fishing and canoeing. There are several wetlands within the Goulburn Broken catchment formally recognised for their conservation significance.

Engagement

Table 5.4.1 shows the partners and stakeholder organisation with which Goulburn Broken CMA engaged when preparing the Goulburn system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional waterway strategies, environmental water management plans and environmental flow studies, which incorporate environmental, cultural, social and economic considerations.

Table 5.4.1 Partners and stakeholders engaged in developing the Goulburn system seasonal watering proposal

Partner and stakeholder engagement
• Commonwealth Environmental Water Office
• Goulburn-Murray Water
• Parks Victoria
• Victorian Environmental Water Holder
• Yorta Yorta Nation Aboriginal Corporation
• Goulburn Environmental Water Advisory Group (includes recreational users, local environment groups and landholders)

5.4.1 Goulburn River

Environmental values

The Goulburn River supports a range of native fish species including golden perch, silver perch, Murray cod, trout cod, Macquarie perch and freshwater catfish. Its aquatic vegetation and submerged logs provide great diversity of habitat to support adult and juvenile fish. The bank vegetation is dominated by river red gums which provide habitat for many species including the squirrel glider. Birds such as egrets, herons and cormorants use trees along the river to roost and feed while frogs benefit from shallow areas.

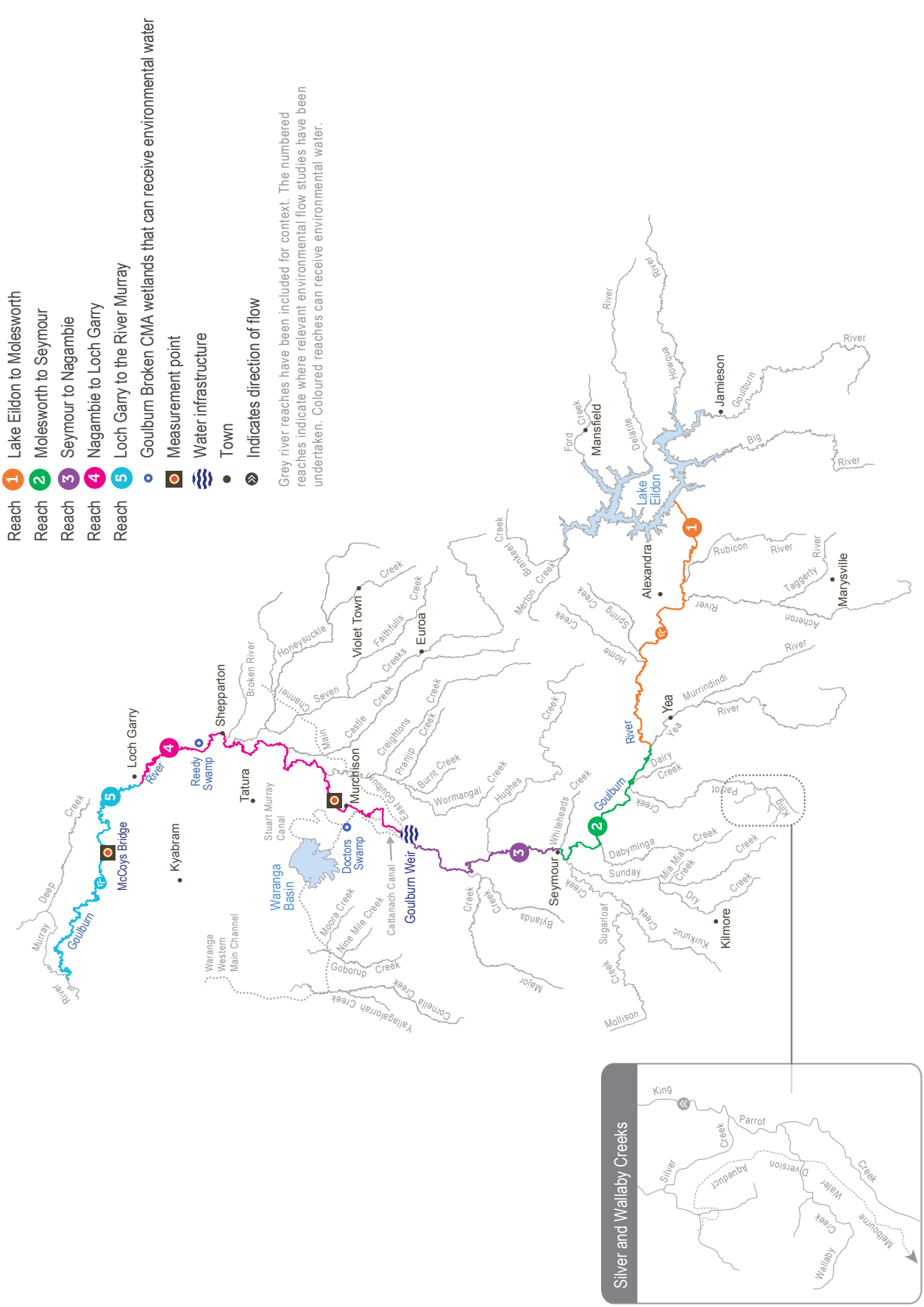
Mid-Goulburn River tributaries between Lake Eildon and Goulburn Weir are important for Macquarie perch habitat while freshwater catfish can be found in lagoons connected to the Goulburn River. The lower Goulburn River below the Goulburn Weir is a significant source of golden perch recruitment, and monitoring shows successful spawning in response to environmental flows.

Social and economic values

The Goulburn River contributes a large proportion of water for use in the Murray–Darling Basin. As part of the Goulburn Broken catchment, it covers two percent of the area of the basin and contributes 11 percent of the water for use in the basin. The majority of this water is used by irrigated agriculture. The Goulburn River is popular for recreation, fishing and boating. Fishing in particular provides substantial economic and social benefits to the region and the river supplies water for towns and stock and domestic users. The river's floodplain also has many important Aboriginal cultural heritage sites such as scar trees, mounds, stone artefact scatters and middens. The Goulburn River continues to be a place of importance for Traditional Owners and their Nations.

Environmental watering objectives in the Goulburn River	
	Increase aquatic and flood-tolerant plants within the river channel and lower banks to provide shelter and food for organisms further up the food chain and to stabilise the river bank
	Protect and boost populations of native fish (including golden perch) by providing habitat flows and encouraging fish to migrate and spawn
	Maintain the form of the river bank and channel and a diversity of riverbed surfaces to support all stream life
	Provide habitat and nourishment for waterbugs which provide energy, break down organic matter and support the river's food chain

Figure 5.4.1 The Goulburn River system



System overview

Lake Eildon and Goulburn Weir have significantly modified the Goulburn River's flow pattern. Due to the impact of water harvesting, lower flows now occur in the Goulburn River in winter and spring while higher flows occur in summer and autumn due to releases to meet irrigation and consumptive demands. This reverses what would happen naturally. The river flow regime is also affected by land use changes and by the construction of small dams and drainage schemes. Levees and other structures prevent water inundating the floodplain. Tributaries downstream of major infrastructure (such as Seven Creeks and the Broken River) help contribute natural flows to the Goulburn River in the lower reaches downstream of Goulburn Weir.

Environmental water in the Goulburn system is held by the VEWH, CEWH and MDBA as part of the Living Murray program. The CEWH is the largest holder of environmental water in the Goulburn system. Availability and use of Commonwealth environmental water is critical to achieving outcomes in the Goulburn River. Environmental water held on behalf of the Living Murray program may also assist in meeting objectives in the Goulburn system en route to icon sites in the Murray system (see section 1.4.2).

Environmental water may need to be delivered through the Goulburn system to meet a downstream environmental objective. Where possible, these releases are managed to achieve outcomes in the Goulburn system before being reused downstream.

Environmental targets can also be met by water delivered from Lake Eildon to meet downstream demands in the River Murray (known as inter-valley transfers). Goulburn inter-valley transfers occur at times during the irrigation season, from spring to autumn. These flows may assist in achieving the desired environmental objectives without the need to release environmental water.

The priority reaches are reaches 4 and 5 in the lower Goulburn River as they are the most flow-stressed sections of the river. Delivery of environmental flows to these target reaches also provides benefits and meets some environmental targets in upstream reaches. The use of environmental water to target objectives above the Goulburn Weir (reaches 1–3) is limited as they receive significant flows for the purpose of transferring consumptive water from Lake Eildon to Waranga Basin. These flows often meet or exceed environmental flow targets in this part of the system for most of the year.

Recent conditions

The dry conditions of 2014–15 became even more severe in 2015–16. Only very small fluctuations in river level occurred from unregulated flows, meaning environmental water deliveries provided the only significant higher flows and flow variability in the lower Goulburn River (reaches 4 and 5). Water released from Lake Eildon and extracted from the river at Goulburn Weir met or exceeded some environmental targets in the mid-Goulburn River (reaches 1, 2 and 3).

Environmental water was delivered downstream of Goulburn Weir through winter and spring to provide baseflows which supported fish and waterbug habitat. One spring fresh and one autumn fresh were delivered to support the recovery of bank vegetation, and some significant improvements in vegetation growth on the lower bank were observed. Some of the environmental water delivered down the Goulburn River was primarily targeted to meet environmental needs in Gunbower Forest and South Australia. No environmental water was released between November and mid-March due to the delivery of consumptive (mainly irrigation) water to the River Murray. Close collaboration between waterway and storage managers resulted in these flows also meeting environmental flow targets.

Monitoring found continued improvement of bank vegetation with an excellent response of mostly native plants establishing on the lower bank. A second spring fresh was not delivered in 2015–16 as a result of reduced water availability and consequently spawning of golden and silver perch was not recorded. However, perch are a long-lived fish and spawning was achieved in the previous two years so this was a lower priority under drier conditions and lower water availability.

Fish surveys continued to record native species such as the Murray cod, Australian smelt, golden and silver perch, trout cod and Murray–Darling rainbowfish. The introduced European carp are also prevalent. Of note, while in past years perch spawning has been successful, recruitment has not been found in the Goulburn River, with an absence of young fish (one to two years old). The reason for this is unclear, though there is a high possibility that the eggs/juvenile fish move into the River Murray. If wet conditions occur in 2016–17, a trial of a summer pulse is proposed to determine if increased flows at this time will attract perch into the Goulburn.

All environmental water deliveries are managed to protect damage to the river banks. This is done by adding variation to stable flows and carefully controlling the rate of rise and fall of freshes. Monitoring of bank condition is showing very positive results with some areas showing thin layers of sediment left on the banks from the delivery of environmental water. This material is supporting the germination and growth of new bank vegetation.

Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 5.4.2.

Table 5.4.2 Potential environmental watering actions and objectives for the Goulburn River

Potential environmental watering[1]	Environmental objectives
Year-round baseflows (500 ML/day in reach 4 and/or 540 ML/day in reach 5)	• Maximise habitat and movement opportunities for large- and small-bodied native fish • Provide conditions that support waterbug habitat and food resources including maintaining suitable water quality, encouraging the establishment of aquatic vegetation, submerging snags and encouraging planktonic production
Spring fresh (1 fresh of up to 15,000 ML/day with flows above 5,600 ML/day for 14 days in reach 4 and reach 5 in September–November)	• Support establishment of flood-tolerant bank vegetation • Maintain macrophyte, waterbug and fish habitat by mobilising fine sediments, submerging snags and replenishing slackwater habitat • Initiate spawning and pre-spawning migration and support recruitment of golden perch
Winter fresh (1 fresh of up to 15,000 ML/day with flows above 6,600 ML/day for 14 days in reach 4 and reach 5 in June–August 2017)	• Maintain macrophyte, waterbug and fish habitat by mobilising fine sediments, submerging snags and replenishing slackwater habitat
Summer/autumn fresh (1 fresh of up to 5,600 ML/day for 2 days in reach 4 and reach 5 in February–April)	• Maintain macrophyte, waterbug and fish habitat by mobilising fine sediments, submerging snags and replenishing slackwater habitat • Support establishment of flood-tolerant bank vegetation
Spring/summer fresh (1 fresh of up to 15,000 ML/day for 2 days in reach 4 and reach 5 in November–December)	• Initiate spawning and pre-spawning migrations and recruitment of golden perch • Maintain macrophyte, waterbug and fish habitat by mobilising fine sediments, submerging snags and replenishing slackwater habitat
Increased baseflows (830 ML/day in reach 4 and/or 940 ML/day in reach 5 year-round)	• As for 500–540 ML/day baseflows, plus ... • Submerge additional snags for waterbug food and habitat • Maintain pool depths and sediment distribution • Provide area of slackwater habitat in spring/summer to support spring-spawned larvae and juvenile fish
Summer/autumn pulse (up to 5,000 ML/day in reach 4 and/or reach 5 for 10 days between January–March)	• Attractant flows for fish migration

1 Environmental water may be used to slow the recession of unregulated flows or operational releases to reduce damage to banks and vegetation from rapid drops in water levels. This also helps prevent waterbugs and fish from being stranded in small pools on river banks or benches following higher flows.

Scenario planning

Table 5.4.3 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Various triggers for action are applied as part of the adaptive management of environmental water in the Goulburn system. For example, the second of the two proposed spring freshes that target golden perch spawning may not be delivered if monitoring shows spawning was achieved during the first, longer-duration spring fresh.

The highest priority for environmental watering in 2016–17 will be providing year-round baseflows and the long-duration spring fresh and summer/autumn fresh. These provide improved habitat for animals in the river channel and support vegetation on the river banks and margins. Under drought or dry conditions the freshes are likely to be smaller due to less water being available. If better conditions occur, additional freshes and increased baseflows become achievable, targeting spawning and migration of golden and silver perch, waterbug and fish habitat and additional enhancement of bank vegetation.

Under drier scenarios, environmental water objectives focus on maintaining the health of the system. Under wetter scenarios, unregulated flows and water allocations are expected to increase, providing a greater opportunity to improve the health of the river as additional objectives can be achieved. Tier 2 actions are included as desirable objectives if more water becomes available.

In determining potential watering actions for 2016–17, consideration was given to critical carryover into 2017–18. Under a dry or below-average scenario, carryover is a priority to ensure baseflows can be provided from July–September 2017. Under drought conditions the benefits of using all available water to maintain the health of the river are greater than keeping some for the next year. If average or wet conditions occur, the increase in water availability for 2017–18 would mean this carryover would not be essential.

Table 5.4.3 Potential environmental watering for the Goulburn system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No unregulated flows	• Unregulated flows expected to provide some baseflows between winter to mid-spring and likely winter-spring freshes	• Unregulated flows expected to provide baseflows in winter to mid-spring and likely winter-spring freshes	• Unregulated flows expected to provide high baseflows and multiple overbank flows events in winter/spring
	• Normal minimum passing flows at reach 5 of 400 ML/day from July–October and 350 ML/day from November–June			
Expected availability of environmental water	• 74,000 ML carryover • 15,000 ML VEWH • 58,000 ML CEWH • 8,000 ML Living Murray • 155,000 ML total	• 74,000 ML carryover • 15,000 ML VEWH • 149,000 ML CEWH • 21,000 ML Living Murray • 259,000 ML total	• 74,000 ML carryover • 15,000 ML VEWH • 276,000 ML CEWH • 39,000 ML Living Murray • 404,000 ML total	• 74,000 ML carryover • 15,000 ML VEWH • 276,000 ML CEWH • 39,000 ML Living Murray • 404,000 ML total
Potential environmental watering – tier 1 (high priorities)	• Year-round baseflows • Spring fresh (partial event) • Summer/autumn fresh (partial event)	• Year-round baseflows • Spring fresh • Summer/autumn fresh (partial event)	• Year-round baseflows • Spring fresh • Summer/autumn fresh • Increased baseflows (year-round) • Spring/summer fresh • Recession flow management	• Year-round baseflows • Spring fresh • Summer/autumn fresh • Increased baseflows (year-round) • Spring/summer fresh • Summer/autumn pulse • Recession flow management • Winter 2017 fresh (partial-full event)
Potential environmental watering – tier 2 (additional priorities)	• Increased baseflows (year-round) • Spring/summer fresh • Summer/autumn pulse • Recession flow management • Winter 2017 fresh	• Increased baseflows (year-round) • Spring/summer fresh • Summer/autumn pulse • Recession flow management • Winter 2017 fresh	• Summer/autumn pulse • Winter 2017 fresh	• Winter 2017 fresh (full event)
Possible volume of environmental water required to achieve objectives[1]	• 135,000 ML (tier 1) • 400,000 ML (tier 2)	• 237,000 ML (tier 1) • 400,000 ML (tier 2)	• 378,000 ML (tier 1) • 193,000 ML (tier 2)	• 378,000 ML (tier 1) • 0–120,000 ML (tier 2)
Critical carryover into 2017–18	• 0 ML	• 23,000 ML	• 23,000 ML	• 0 ML

1 Environmental water requirements for tier 2 actions are additional to tier 1 requirements.

Risk management

In preparing its seasonal watering proposal, Goulburn Broken CMA considered and assessed risks and identified mitigating strategies relating to the implementation of environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

5.4.2 Goulburn wetlands

Environmental values

There are a large number of natural wetlands across the Goulburn catchment including a number that are formally recognised for their conservation significance (such as Reedy Swamp and Doctors Swamp). The wetlands contain vegetation communities ranging from swamps dominated by river red gums to cane grass wetlands.

Reedy Swamp contains a mosaic of vegetation types including tall marsh, floodway pond herbland and rushy riverine swamp. It is an important drought refuge and nesting site for colonial waterbirds. It is also an important stopover site for migratory birds (such as sharp-tailed and marsh sandpipers).

Doctors Swamp is a bioregionally significant swamp and is considered one of the most intact red gum swamps in Victoria.

Social and economic values

Visitor activities enjoyed at the wetlands include bird watching, picnicking, camping and walking. Doctors Swamp is a state game reserve.

The Goulburn wetlands are identified as a culturally sensitive area under the *Victorian Aboriginal Heritage Act 2006*. The Goulburn wetlands have been, and continue to be, places of significance for Traditional Owners. The area traditionally supported a rich and diverse supply of plant and animal resources for food, medicines, shelter, clothing and tools.

Environmental watering objectives in the Goulburn wetlands

Improve the range of native plant life including river red gum and grassy wetland species

Provide drought refuge, habitat and breeding and feeding opportunities for migratory and colonial nesting waterbirds

System overview

Both Doctors Swamp and Reedy Swamp can receive environmental water via irrigation supply infrastructure within the Shepparton and Central Goulburn irrigation districts. The volume delivered at any one time depends on available capacity in the irrigation supply network.

Reedy Swamp is naturally inundated during high flows (of about 20,000 ML per day) in the Goulburn River. Doctors Swamp can only receive environmental water if the Cattanach Canal is running at 2,500 ML per day and there is available capacity after irrigation demand is met, which is also influenced by the operation of Waranga Basin. Due to this the opportunity to deliver environmental water is greater in autumn and winter.

Recent conditions

Significantly low rainfall and high temperatures meant that there were minimal natural inflows to Reedy Swamp and Doctors Swamp in winter and early spring of 2015.

In 2015–16 environmental water was delivered to Reedy Swamp and Doctors Swamp to support a large diversity of waterbirds and wetland plant species. Large rainfall events between October and December 2015 produced some natural flows into Reedy Swamp, which supported the outcomes of the spring watering.

Wetland plants including river red gums responded very well to the spring watering. Monitoring showed an increase in waterbird species (including ducks, swans, yellow-billed spoonbills and ibis) feeding and roosting at both swamps. This included some species listed in the *Victorian Flora and Fauna Guarantee Act 1988* (such as the eastern great egret).

Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 5.4.4.

Table 5.4.4 Potential environmental watering actions and objectives for the Goulburn wetlands

Potential environmental watering	Environmental objectives
Reedy Swamp (fill in late winter/spring and provide top-ups in spring/summer as required)	• Maintain as a drought refuge for waterbirds • Improve the diversity of wetland vegetation • Provide waterbird breeding and feeding habitat particularly for migratory and colonial nesting species
Doctors Swamp (fill in autumn/winter 2017)	• Maintain the diversity of wetland vegetation • Provide waterbird breeding and feeding habitat

Scenario planning

Table 5.4.5 outlines potential environmental watering and expected water usage under a range of planning scenarios.

Goulburn Broken CMA has planned wetland watering to ensure there is a diversity of habitat types to support waterbirds and other water-dependant animals in the region at any point in time.

Reedy Swamp has been identified as a significant drought refuge for waterbirds. It has a high ecological value due to the diverse community of water-dependent plants and animals it supports. It is known to be a large rookery for Australian white ibis, straw-necked ibis and royal spoonbills. In wetter conditions Reedy Swamp will mostly fill from natural inflows, although it is planned to receive environmental water in autumn if it doesn't fill naturally in winter/spring.

Doctors Swamp is a highly valued site for waterbird habitat and wetland plant diversity. Under wetter conditions Doctors Swamp is planned to receive environmental water either in winter/spring 2016 or late autumn/winter 2017. If Doctors Swamp does not fill from natural inflows in winter/spring the priority is to fill the wetland in late autumn/winter to support the optimum watering regime for river red gums.

In drier periods (when irrigation demand is high), there may be capacity constraints in the irrigation networks that may affect environmental water deliveries in the Goulburn wetlands. These potential constraints will be assessed to inform delivery.

In wetter periods, the ecological and hydrological objectives of these wetlands may be largely met by natural inflows. Only small volumes of environmental water may be required to extend the duration or extent of natural flooding.

The decision to deliver environmental water to Goulburn wetlands will be based on their hydrological condition and waterbird breeding activity, and on the potential effect of environmental watering on wetland vegetation communities.

Table 5.4.5 Potential environmental watering for the Goulburn wetlands under a range of planning scenarios

Planning scenario[1]	Drought	Dry	Average	Wet
Expected catchment conditions	• Catchment run-off and unregulated flows into the wetlands is highly unlikely	• Catchment run-off and unregulated flows into the wetlands is unlikely	• Some catchment run-off and unregulated flows into some of the wetlands is likely, particularly in winter/spring	• Catchment run-off and unregulated flows into the wetlands may significantly contribute to water levels in the wetlands, particularly in winter/spring
Potential environmental watering – tier 1 (high priorities	• Reedy Swamp	• Reedy Swamp	• Doctors Swamp (winter/spring)	• Doctors Swamp (winter/spring)
Potential environmental watering – tier 2 (additional priorities)[2]	• N/A	• N/A	• Doctors Swamp • (autumn/winter) • Reedy Swamp	• Doctors Swamp • (autumn/winter) • Reedy Swamp
Possible volume of environmental water required to achieve objectives[3]	• 1,235 ML (tier 1)	• 1,235 ML (tier 1)	• 500 ML (tier 1) • 1,120 ML (tier 2)	• 500 ML (tier 1) • 1,120 ML (tier 2)
Priority carryover requirements	• 1,235 ML	• 1,235 ML	• 500 ML	• 500 ML

1 If any of the wetlands support significant waterbird breed events in spring/summer environmental water deliveries may be considered to support bird habitat until fledging.
2 If tier 2 wetlands have exceeded their optimum drying periods within the 2016–17 water year and not received any natural inflows, they would be increased to a tier 1 priority for autumn/winter in 2017 to protect their ecological values.
3 Environmental water requirements for tier 2 actions are additional to tier 1 requirements.

Risk management

In preparing its seasonal watering proposal, Goulburn Broken CMA considered and assessed risks and identified mitigating strategies relating to the implementation of environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

5.5 Broken system

Waterway manager – Goulburn Broken Catchment Management Authority

Storage manager – Goulburn-Murray Water

Environmental water holders – Victorian Environmental Water Holder, Commonwealth Environmental Water Holder

The Broken system (including the Broken River, lower Broken Creek, upper Broken Creek and wetlands) supports threatened plant and animal species. These include six native fish species of Victorian and national conservation significance (such as the iconic Murray cod). The system also supports a diverse range of habitats for fish and waterbirds, especially in cane grass wetlands that provide important brolga breeding habitat. The lower Broken Creek forms an important part of the irrigation distribution system, delivering water from the Murray and Goulburn systems into the Murray Valley and Shepparton irrigation districts. It contains important Aboriginal cultural heritage sites and is also popular for recreation.

Engagement

Table 5.5.1 shows the partners and stakeholder organisations with which Goulburn Broken CMA engaged when preparing the Broken system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term plans such as regional waterway strategies and environmental water management plans. These longer-term plans incorporate a range of environmental, cultural, social and economic perspectives.

Table 5.5.1 Partners and stakeholders engaged in developing the Broken system seasonal watering proposal

Partner and stakeholder engagement
• Broken Environmental Water Advisory Group (comprising community members)
• Commonwealth Environmental Water Office
• Goulburn Broken Catchment Wetland Advisory Group (with representation from Goulburn Valley Landcare, Field and Game Australia, Goulburn-Murray Water, Moira Shire, Council of Greater Shepparton, Turtles Australia, Parks Victoria, Trellys Fishing and Hunting and Kinnairds Wetland Advisory Committee)
• Murray–Darling Basin Authority (River Murray Water)
• Victorian Environmental Water Holder
• Yorta Yorta Nation Aboriginal Corporation

5.5.1 Upper Broken Creek

Environmental values

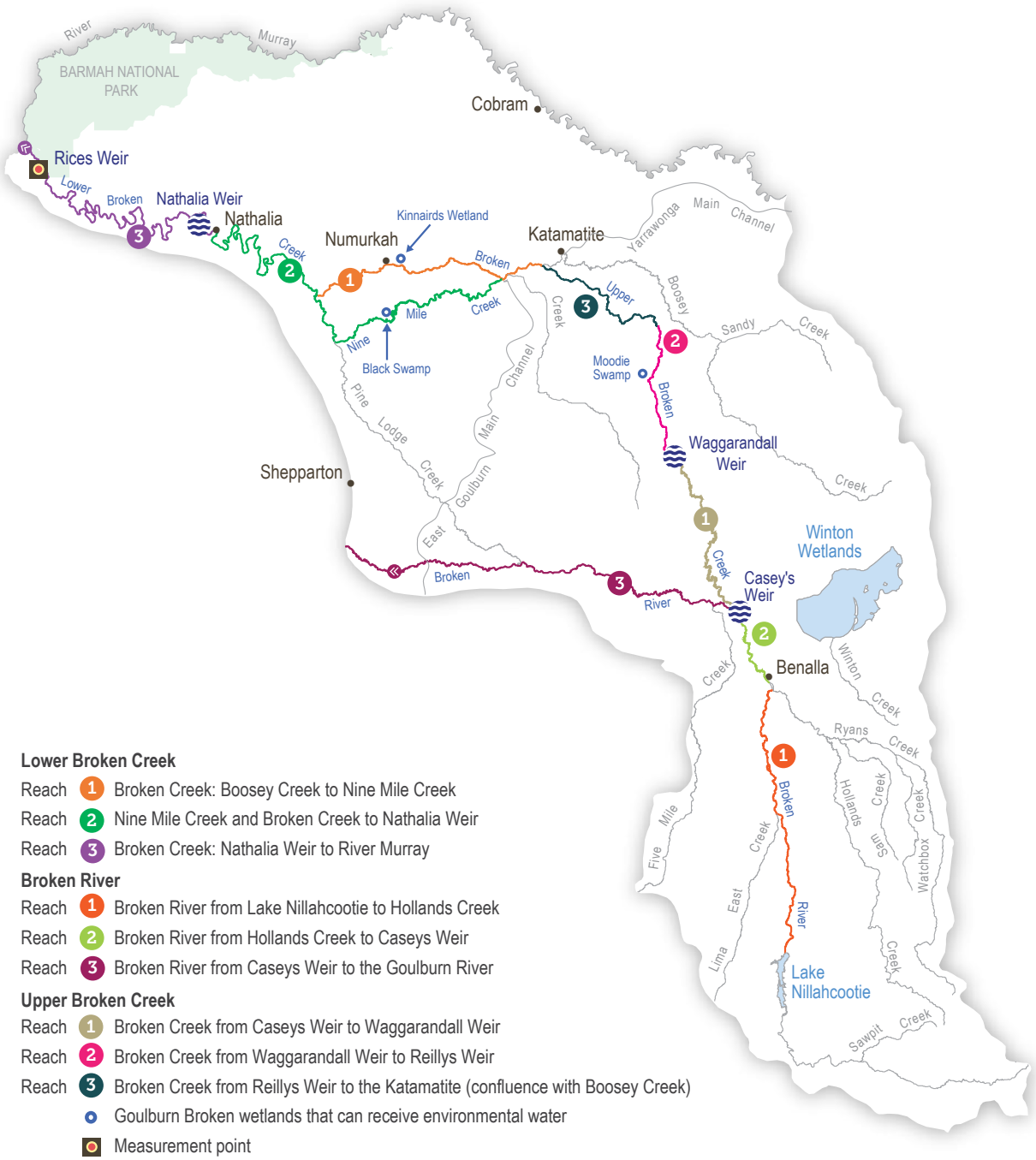
The upper Broken Creek area is dominated by unique box riparian vegetation and supports remnant plains grassy woodland. Much of this area also lies in the Broken–Boosey State Park, which contains high-quality native vegetation. The creek supports a variety of threatened animals including fish species such as the carp gudgeon, Murray cod, golden perch and Murray–Darling rainbowfish.

Social and economic values

Most of upper Broken Creek is in the Broken–Boosey State Park which contains a range of Aboriginal cultural heritage values including scar trees and sites of significance for Traditional Owners. The system also support a range of recreational and tourism values, providing opportunities for bushwalking, fishing and bird watching. Upper Broken Creek is an important source of water and a delivery mechanism for some stock and domestic and irrigation customers.

Environmental watering objectives in the upper Broken Creek system	
	Move built-up sand and clay material to restore deep pools and provide habitat for water animals
	Improve and maintain plants on the riverbank and in the river channel
	Protect and boost populations of native fish (including threatened Murray cod and golden perch) by improving pool habitat
	Maintain water quality
	Support a wide range of waterbugs to provide energy, break down dead organic matter and support the river's food chain

Figure 5.5.1 The Broken system



Lower Broken Creek

Reach 1 Broken Creek: Boosey Creek to Nine Mile Creek
Reach 2 Nine Mile Creek and Broken Creek to Nathalia Weir
Reach 3 Broken Creek: Nathalia Weir to River Murray

Broken River

Reach 1 Broken River from Lake Nillahcootie to Hollands Creek
Reach 2 Broken River from Hollands Creek to Caseys Weir
Reach 3 Broken River from Caseys Weir to the Goulburn River

Upper Broken Creek

Reach 1 Broken Creek from Caseys Weir to Waggarandall Weir
Reach 2 Broken Creek from Waggarandall Weir to Reillys Weir
Reach 3 Broken Creek from Reillys Weir to the Katamatite (confluence with Boosey Creek)

Goulburn Broken wetlands that can receive environmental water
Measurement point
Water infrastructure
Town
Indicates direction of flow

Grey river reaches have been included for context. The numbered reaches indicate where relevant environmental flow studies have been undertaken. Coloured reaches can receive environmental water.

System overview

The Broken Creek diverges from the Broken River downstream of Benalla and flows to the River Murray near Barmah Forest. The creek is located on a flat riverine plain and has naturally low run-off from its local catchment. It also receives flood flows from the Broken River, although these are much less frequent than occurred naturally due to earthworks and road construction.

Upper Broken Creek is the section of creek from Caseys Weir to Katamatite which extends about 65 kilometres. The creek has been used for water supply from the Broken River for more than 100 years, although irrigation entitlements have been significantly reduced (by more than 80 percent) as part of water savings projects in the last ten years. There are now low flows all year round at the top of the creek (Caseys Weir to Waggarandal Weir) as water can only be supplied from Broken River based on orders from customers in the creek. In the lower reaches (Waggarandal Weir to Reillys Weir and Reillys Weir to Katamatite), the system is most influenced by rainfall and catchment run-off which provides infrequent flow variability. Diverting water from the Broken River to the top reach may achieve some environmental objectives.

Recent conditions

Over the last ten years, flows in the upper Broken Creek have not exceeded 70 ML per day with minimal high-flow variability. No environmental water was delivered to the upper Broken Creek in 2015–16, although an autumn delivery to Moodie Swamp provided some benefit to the creek through increased flows on the way to the wetland.

Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 5.5.2.

Table 5.5.2 Potential environmental watering actions and objectives for the upper Broken Creek system

Potential environmental watering	Environmental objectives
Summer/autumn fresh (1 fresh of up to 200 ML/day for 2 days in December–May)	• Rehabilitate deep pool habitats and facilitate the movement of sediments • Maintain and enhance riparian and in-channel vegetation (water ribbons and river red gum communities) with variable wet and dry zones • Maintain water quality, particularly in refuge pools • Maintain and restore waterbug habitat by providing occasional freshes to complete life cycles

Scenario planning

Table 5.5.3 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

If there is any allocation made available in the Broken system, the use of Commonwealth environmental water is considered available for use in the creek, but it may need to be prioritised against delivery to Moodie Swamp (see section 5.5.3). More water is required to achieve the identified potential watering actions with an extra 147 ML required to deliver a summer/autumn fresh.

Table 5.5.3 Potential environmental watering for the upper Broken Creek system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No unregulated flows	• Minimal unregulated flows	• Some contribution of unregulated flows in upper Broken Creek, particularly in winter/spring	
Expected availability of environmental water	• 0 ML	• 10 ML	• 253 ML	
Potential environmental watering	• Summer/autumn fresh			
Possible volume of environmental water required to achieve objectives	• Up to 400 ML			

Risk management

In preparing its seasonal watering proposal, Goulburn Broken CMA considered and assessed risks and identified mitigating strategies relating to the implementation of environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

5.5.2 Lower Broken Creek

Environmental values

Lower Broken Creek and Nine Mile Creek support a diverse and abundant native fish community including the threatened Murray cod, golden perch, silver perch, unspecked hardyhead and Murray–Darling rainbowfish. The associated floodplain and wetland habitats support box-dominated grassy woodland communities and numerous threatened species of state and national conservation significance including buloke, the bush stone-curlew and the brolga.

Social and economic values

The lower Broken and Nine Mile creeks and associated floodplain and wetland habitats contain many important Aboriginal cultural heritage sites, provide water for agriculture and urban centres and support a variety of recreational activities such as fishing and bushwalking.

Environmental watering objectives in the lower Broken Creek system

	Control excessive build-up of azolla, a native aquatic plant that can lower water quality in the creek when significant blooms occur
	Protect and boost populations of native fish (including the threatened Murray cod, golden perch and silver perch) by providing habitat flows and encouraging fish to migrate and spawn
	Maintain healthy water oxygen levels

System overview

The lower Broken and Nine Mile creeks have been regulated for over 100 years, significantly altering their flow regimes. Pre-regulation, the creeks would have mainly flowed in winter and spring and the adjacent floodplain would have received more regular flooding from overbank flows. In summer and autumn, the creeks would have had much less flow, even reducing to pools and drying out completely. The creeks now flow at a relatively constant level from mid-August until mid-May with numerous weirs that support adjacent irrigated farming. This has resulted in changes to the way native animals use the creek. Previously, native fish would have moved into the creek when it was flowing and moved back out into the River Murray when it dried. The creek now provides year-round habitat for native fish, permanently holding water and with fish passage structures through all the weirs. Consequently, environmental water is used to support this permanent native fish habitat.

The lower Broken Creek is operated separately to the upper Broken Creek and Broken River because regulated water is delivered to the lower Broken Creek from the Goulburn and Murray systems via the irrigation channel network, rather than from the Broken River.

Environmental water provided in the lower Broken Creek can be sourced from both the Goulburn and Murray systems. Environmental water is released from the Goulburn system through the East Goulburn main channel and from the Murray system through the Yarrawonga main channel. The priority river reach for environmental watering is reach 3 (from Nathalia Weir Pool to the River Murray), with flows to this reach expected to also deliver the desired flows in reaches 1 and 2. The measurement point for target flows in lower Broken Creek is at Rices Weir.

Recent conditions

Unregulated winter flows were significantly lower in July–August 2015 than in the previous winter. There were no further significant rainfall events that triggered unregulated flows in the systems for the remainder of the irrigation season.

Between the opening of the irrigation season on 15 August and the end of August, flows at Rices Weir averaged 240 ML per day. This was higher than normally targeted at this time of year and was a result of the delivery of the Goulburn system water quality reserve to dilute and flush irrigation channels of residual herbicide applied for the treatment of arrowhead, an aquatic weed. There were no negative effects recorded and the flows helped flush a build-up of azolla from the creek that developed during the low pre-irrigation-season flows.

Environmental watering commenced slightly later than normal in early September following the completion of the delivery of water from the Goulburn system water quality reserve. Flows reduced in September, averaging 162 ML per day, which helped minimise further azolla build-up.

Between October and the end of April the flow target was 250 ML per day, and flows generally ranged between 200 ML per day and 350 ML per day. As well as environmental water, Goulburn inter-valley transfer and Murray choke bypass flows contributed a significant proportion of the flows. The coordination of environmental and operational water deliveries helped achieve both environmental outcomes and delivery of water to downstream users.

In February a blue-green algae outbreak occurred in the Murray and made its way into the lower Broken Creek. In early March, a local heatwave increased water temperatures to close to 30oC. These two factors combined to result in low dissolved oxygen levels at Rices Weir for about a week. A proactive fish relocation project was initiated, capturing native fish and relocating them downstream of Rices Weir. All fish moved were in good condition and no other signs of stress (such as fish gulping for air at the surface) were observed. This indicates that either the fish were able to move to find better water quality in the immediate area or up and down the creek—there are fish ladders allowing passage along the creek and into the River Murray—or they were able to cope with the low dissolved oxygen levels until they improved.

The target flow at Rices Weir was reduced to 150 ML per day in May but with local rain and reduced irrigation demand it remained around 250 ML per day before ceasing at the end of the irrigation season on 15 May.

Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 5.5.4.

Table 5.5.4 Potential environmental watering actions and objectives for the lower Broken Creek

Potential environmental watering	Environmental objectives
Year-round low flows (40 ML/day)[1]	• Provide native fish passage
Winter/spring medium flows (120 ML/day in August–November)	• Minimise azolla growth
Spring/summer/autumn medium flows (150–250 ML/day in October–May)	• Maintain water quality, including dissolved oxygen levels above 5 mg/L
Winter/spring freshes (120–250 ML/day for up to 14 days in August–November)	• Remove large azolla blooms
Spring/summer high flows (250 ML/day in September–December)	• Increase native fish habitat during migration and breeding seasons

1 Primarily during the irrigation season between mid-August and mid-May, but it may be delivered year-round subject to supply constraints.

Scenario planning

Table 5.5.5 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

Due to regulation of the lower Broken and Nine Mile creeks, their environmental water needs are relatively fixed from year to year and independent of annual climatic conditions.

During the season, the environmental water flows of the lower Broken Creek can vary and focus on maximising the habitat and movement of fish, maintaining water quality and flushing azolla through the system. The required volume to meet these objectives decreases from a dry to a wet scenario as unregulated flows would contribute a greater amount under wetter conditions.

Risk management

In preparing its seasonal watering proposal, Goulburn Broken CMA considered and assessed risks and identified mitigating strategies relating to the implementation of environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Table 5.5.5 Potential environmental watering for the lower Broken Creek under a range of planning scenarios

Planning scenario	Dry	Average	Wet
Expected river conditions	• Some unregulated flows in winter • No unregulated flows throughout the irrigation season (mid-August–May) • No diversion of unregulated River Murray flows available	• Unregulated flows in winter/spring • No unregulated flows from October–May • Diversion of unregulated River Murray flows available mid-August–October	• Unregulated flows in winter/spring • No unregulated flows from November–May • Diversion of unregulated River Murray flows available mid-August–November
Potential environmental watering	• Year-round low flows • Winter/spring medium flows • Summer/autumn medium flows • Winter/spring freshes	• Year-round low flows • Winter/spring medium flows • Summer/autumn medium flows • Winter/spring freshes • Spring/summer high flows	
Possible volume of environmental water required to achieve objectives	• 62,000 ML	• 61,000 ML	• 50,000 ML

5.5.3 Broken wetlands

Environmental values

The Broken wetlands (which include Moodie Swamp, Kinnairds Wetland and Black Swamp) support a diversity of vegetation communities ranging from swamps dominated by river red gums to cane grass wetlands. The wetlands contain state and nationally threatened species and communities including rigid water milfoil and river swamp wallaby grass. The wetlands also provide food resources and breeding habitat for bird species listed in international agreements and conventions (such as the brolga and royal spoonbill).

Social and economic values

The Broken wetlands have been and continue to be places of significance for the Traditional Owners of the Yorta Yorta Nation. The wetlands traditionally provided a rich and diverse supply of plant and animal resources for food, medicines, shelter, clothing and tools. Some of the sites have artefacts and scar trees recorded in or adjacent to them.

The wetlands support a range of recreational activities including bird watching, bike riding, bush walking and camping. Moodie Swamp and Black Swamp are state game reserves.

Environmental watering regime objectives in the Broken wetlands

- Maintain or improve the diversity of wetland vegetation
- Maintain populations of nationally threatened plant species (such as ridged water milfoil, slender water milfoil and river swamp wallaby grass)
- Promote feeding and breeding habitat for waterbirds, particularly for brolga

System overview

Of some 2,000 natural wetlands in the Goulburn Broken area, only three in the Broken catchment (Black Swamp, Kinnairds Wetland and Moodie Swamp) can receive environmental water. The natural water regimes of these wetlands have been greatly influenced by their positions in the surrounding Shepparton, Central Goulburn and Murray Valley irrigation districts, which have changed the timing, frequency, volume and duration of inundation. Environmental watering aims to replace some of the more natural patterns of wetting and drying of the wetlands. Water is delivered to the wetlands using irrigation supply infrastructure.

Recent conditions

Significantly low rainfall and high temperatures meant that there were no natural inflows to Black Swamp, Kinnairds Wetland and Moodie Swamp in winter and early spring of 2015.

Environmental watering in 2015–16 included a winter/spring fill in Black Swamp and Kinnairds Wetland to promote a diversity of wetland vegetation following fires in 2014 and also to support waterbird breeding and feeding. A late-autumn fill was provided to Moodie Swamp to promote the growth of wetland vegetation to provide habitat for brolga and Australasian bittern.

Black Swamp watering resulted in significant growth of the river swamp wallaby grass, listed in the *Environmental Protection and Biodiversity Conservation Act 1999*. A state-listed rare water nymph was also found for the first time at Black Swamp. The near-threatened magpie geese also roosted at Black Swamp for the first time on record following the spring watering. Unfortunately, the delivery regulator at Black Swamp was tampered with several times (in October 2015 and March 2016) which resulted in the drowning of young plants that had germinated in spring following environmental water delivery and also the drowning of newly planted wetland vegetation.

Native vegetation at Kinnairds Wetland responded positively to the watering, and for the second time magpie geese were recorded at the wetland. Additional top-ups were provided in late spring and summer to maintain habitat to support magpie geese feeding, roosting and breeding.

Moodie Swamp received a delivery in late autumn 2016. The delivery was to encourage the growth of important wetland vegetation species including southern cane grass and rigid water milfoil and to provide feeding and breeding habitat for waterbirds including brolga and Australasian bittern.

Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 5.5.6.

Table 5.5.6 Potential environmental watering actions and objectives for the Broken wetlandss

Potential environmental watering	Environmental objectives
Moodie Swamp (fill in late winter/spring and provide top-ups as required)	• Maintain the diversity of wetland vegetation • Maintain populations of the nationally threatened rigid water milfoil • Provide waterbird feeding and breeding habitat, particularly for Brolga
Kinnairds Wetland (fill in late autumn/winter if it has remained dry and the maximum drying regime has been reached; provide top-ups as required)	• Improve the diversity of wetland vegetation • Maintain populations of the nationally threatened rigid water milfoil and slender water milfoil • Provide waterbird feeding and breeding habitat, particularly for royal spoonbills and the Australasian shoveler
Black Swamp (fill in late autumn/winter if it has remained dry and the maximum drying regime has been reached; provide top-ups as required)	• Improve the diversity of wetland vegetation • Maintain populations of the nationally threatened rigid water milfoil and slender water milfoil • Provide waterbird feeding and breeding habitat, particularly for royal spoonbills and the Australasian shoveler

Scenario planning

Table 5.5.7 outlines potential environmental watering and expected water usage under a range of planning scenarios.

Landscape-scale planning for these wetlands has been undertaken by the Goulburn Broken CMA to ensure a diversity of habitat types are available to support waterbirds and other water-dependant animals in the region.

Moodie Swamp has been identified as very high priority in all planning scenarios as it supports important cane grass habitat for brolga and Australasian bittern. It also supports a diverse community of water-dependent plants and animals. Watering in winter/spring of 2016–17 is important to build on the vegetation outcomes from the 2016 autumn watering.

Both Kinnairds Wetland and Black Swamp have been identified as providing important habitat for waterbirds and wetland vegetation communities (including ridged water milfoil and river swamp wallaby grass). If natural inflows do not occur in the wetlands in autumn/winter 2016, environmental water is planned to be delivered to inundate the wetlands to provide conditions that promote vegetation growth and feeding and breeding opportunities for waterbirds.

In wetter conditions, the ecological objectives at these wetlands are typically met by natural inflows, and only small volumes of environmental water are required to extend the duration or extent of natural flooding. In average to wet conditions autumn top-ups in Moodie Swamp, Kinnairds Wetland and Black Swamp are a priority to support the ecological characteristics of the wetlands.

The decision to deliver environmental water to Broken wetlands will be based on their hydrological condition and waterbird breeding activity, and on the potential impact of environmental watering on wetland vegetation communities.

Risk management

In preparing its seasonal watering proposal, Goulburn Broken CMA considered and assessed risks and identified mitigating strategies relating to the implementation of environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Table 5.5.7 Potential environmental watering for the Broken wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected catchment conditions	• Catchment run-off and unregulated flows into the wetlands is highly unlikely	• Catchment run-off and unregulated flows into the wetlands is unlikely	• Some catchment run-off and unregulated flows into some of the wetlands is likely, particularly in winter/ spring	• Catchment run-off and unregulated flows into the wetlands may significantly contribute to water levels in the wetlands, particularly in winter/spring
Potential environmental watering – tier 1 (high priorities)	• Moodie Swamp	• Moodie Swamp	• Moodie Swamp (winter/ spring)	• Moodie Swamp (winter/ spring)
Potential environmental watering – tier 2 (additional priorities)[2]	• N/A	• N/A	• Moodie Swamp (autumn/winter) • Kinnairds Wetland • Black Swamp	• Moodie Swamp (autumn/ winter) • Kinnairds Wetland • Black Swamp
Possible volume of environmental water required to achieve objectives[1]	• 500 ML (tier 1)	• 500 ML (tier 1)	• 500 ML (tier 1) • 1,060 ML (tier 2)	• 500 ML (tier 1) • 1,060 ML (tier 2)

1 Environmental water requirements for tier 2 actions are additional to tier 1 requirements.
2 If tier 2 wetlands have exceeded their optimum drying periods within the 2016–17 water year and have not received any natural inflows, they would be increased to a tier 1 priority for autumn/winter in 2017 to protect their ecological values.

5.6 Campaspe system

Waterway manager – North Central Catchment Management Authority

Storage manager – Goulburn-Murray Water, Coliban Water

Environmental water holders – Victorian Environmental Water Holder, Commonwealth Environmental Water Holder, the Murray-Darling Basin Authority (the Living Murray program)

The Campaspe River catchment extends from the Great Dividing Range in the south to the River Murray in the north, a total distance of about 150 kilometres. The major waterways of the catchment are the upper Campaspe River and the Coliban River (both upstream of Lake Eppalock) and the lower Campaspe River (downstream of Lake Eppalock). Major tributaries are McIvor and Pipers creeks upstream of Lake Eppalock, and Mount Pleasant and Axe creeks downstream of Lake Eppalock.

Malmsbury Reservoir on the Coliban River provides water for towns and stock and for domestic consumption. Lake Eppalock was constructed in 1965 on the Campaspe River below its confluence with the Coliban River. The storage is an important source of water for downstream irrigated agriculture; of town water for Bendigo, other local towns and more recently Ballarat (via the Goldfields Superpipe); and for the environment.

Engagement

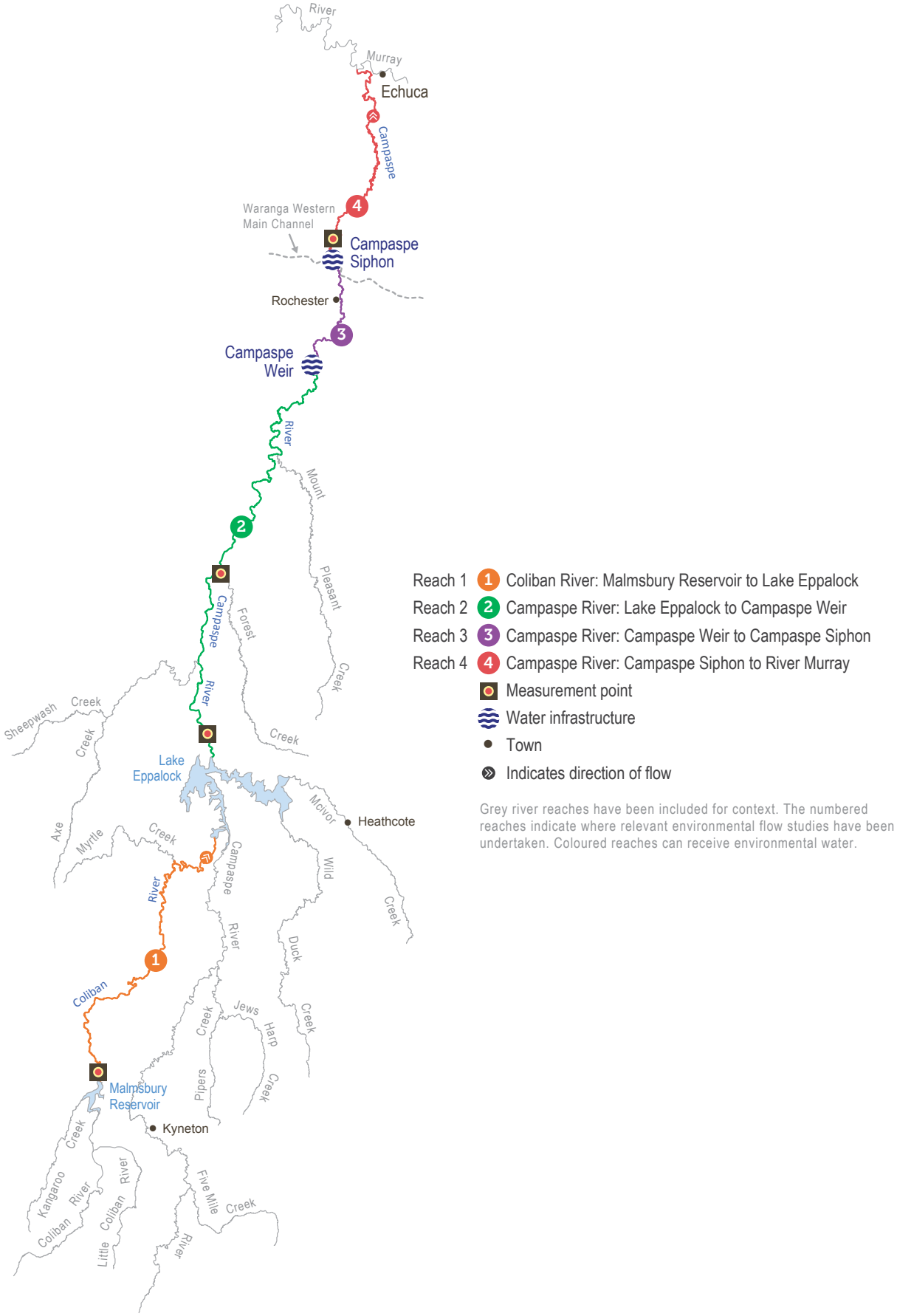
Table 5.6.1 shows the partners and stakeholder organisations with which North Central CMA engaged when preparing the Campaspe system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional waterway strategies, environmental water management plans and environmental flow studies, which incorporate environmental, cultural, social and economic considerations.

Table 5.6.1 Partners and stakeholders engaged in developing the Campaspe system seasonal watering proposal

Partner and stakeholder engagement
• Campaspe Environmental Water Advisory Group (comprising community members, Department of Environment, Land, Water and Planning, Goulburn-Murray Water, North Central CMA, the VEWH and the Commonwealth Environmental Water Office)
• Coliban Water
• Commonwealth Environmental Water Office
• Goulburn-Murray Water
• North Central CMA Community Consultation Committee, a committee of the North Central CMA providing community and local perspectives on North Central CMA projects and functions that have direct public benefits
• North Central CMA Board
• Victorian Environmental Water Holder

Figure 5.6.1 The Campaspe system



5.6.1 Campaspe River

Environmental values

The Campaspe River below Lake Eppalock provides important habitat for several fish species including the Murray cod, silver perch, golden perch, Murray–Darling rainbowfish and flat-headed gudgeon. Maintaining flows is important for migration opportunities and dispersal of juveniles for platypus as well as fish. Turtles and frogs are also present and there is a highly connected, intact river red gum canopy along the river banks that supports terrestrial species (such as the squirrel glider).

Social, cultural and recreational values

The Campaspe River is an important source of water and a delivery mechanism for irrigation and town water. Popular recreational activities along the Campaspe River include camping, boating, kayaking, fishing, swimming, bush walking, picnicking and bird watching. These activities draw locals and tourists alike, providing economic benefit to towns along the river. The Campaspe River is culturally significant with Aboriginal cultural heritage sites such as shell deposits, scar trees, mounds and some artefacts recorded along the banks.

Environmental watering objectives in the Campaspe River system	
	Sustain adult river red gums and encourage the growth of new plants Maintain and increase the cover of in-stream and riverside plants
	Provide habitat to help protect and boost populations of native fish Promote the return of native fish species (such as the trout cod, river blackfish and Macquarie perch)
	Support the resident platypus population by providing places to rest, breed and feed, as well as dispersal opportunities to the River Murray
	Provide connection along the length of the Campaspe River and into the River Murray
	Control salinity and maintain healthy levels of oxygen in deep pools
	Support a wide range of waterbugs to provide energy, break down dead organic matter and support the river's food chain

System overview

The construction and operation of Lake Eppalock has significantly altered downstream river flows and reversed the seasonal flows. The storage captures rainfall run-off and reduces natural winter and spring flows downstream, which is then released as increased flows over summer and autumn. Environmental water is held and released from Lake Eppalock, with some limited ability to regulate flows further downstream at the Campaspe Weir.

Higher flows in summer can mean less suitable habitat for juvenile fish. Delivering water to users downstream in the River Murray when they need it over summer is essential, and storage managers and the CMA have been working cooperatively to do this in an environmentally sensitive manner. This cooperation results in deliveries to downstream users having as little negative effect on native plants and animals as possible.

Providing the target flows in all reaches below Lake Eppalock is important. Environmental watering usually targets reach 4 which will also achieve the desired flow objectives in reaches 2 and 3. Primary measurement points are at Barnadown (reach 2) and downstream of the Campaspe siphon (reach 4). In specific circumstances, water can be delivered to reach 4 from the Goulburn system via the Waranga western main channel.

Recent conditions

Rainfall was below-average in 2015–16 and the traditional storage inflow period of August–November recorded about 40 percent less than the long-term average. Consequently, streamflows into Eppalock for the year to the end of April 2015 were very low, equating to the driest three percent of years.

Environmental water was delivered in accordance with the dry conditions with low flows targeting minimum levels to support the native plants and animals that depend on the river. Where releases from storage for downstream users met the low-flow objective, environmental water was kept in the storage for later in the year.

Monitoring showed continuing improvement in native fish (with increased numbers of golden perch and Murray–Darling rainbowfish) while dwarf flathead gudgeon were recorded for the first time in 2015. To support native fish, environmental water was used to provide minimum flows during the year to maintain their habitat and allow movement of fish up and down the river, including to or from the River Murray. Small freshes in summer and autumn helped maintain water quality, trigger fish movement and support plants. One of the three freshes occurred following a summer storm in January, which resulted in rainfall run-off briefly increasing flows in the river. This natural event meant environmental water was not needed to deliver this fresh.

Vegetation surveys found that in-channel aquatic vegetation recovery following the millennium drought and subsequent flood is continuing. A range of species were identified, particularly in reaches 2 and 3 below the storage. Fringing vegetation has also continued to recover in these reaches. These vegetation improvements are not as great downstream between Rochester and Echuca (reach 4), possibly due to the heavier clay banks making it harder for new plants to establish, impacts such as stock access or a lack of seed from upstream.

Larger freshes delivered in winter helped support successful platypus breeding in the Campaspe. A number of landholders along the river shared their stories of sightings of the (often elusive) platypus.

Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 5.6.2.

Table 5.6.2 Potential environmental watering actions and objectives for the Campaspe River

Potential environmental watering	Environmental objectives
Summer/autumn low flows (10–50 ML/day in December–May)	• Maintain aquatic vegetation • Maintain fish habitat and reinstate slack waters (areas with minimal water movement) • Limit the effect of cold water pollution from Lake Eppalock on fish • Maintain access to riffle habitat and water quality for waterbugs • Maintain permanent connectivity for water quality • Maintain permanent connectivity for platypus movement
Winter/spring high flows (up to 2 events at 1,000–1,800 ML/day for up to 7 days each in June–November)	• Reduce encroachment of exotic and terrestrial vegetation • Enhance river red gum recruitment • Stimulate fish movement, allow movement to downstream reaches and provide spawning triggers • Flush and mix river pools for water quality • Flush organics from bank and benches to reduce the risk of blackwater events in summer • Mix and flush river pools for waterbugs • Inundate additional snags and flush sediment off biofilms (groups of microorganisms) for waterbugs • Support platypus habitat and breeding, including triggers for burrow selection
Winter/spring low flows (50–200 ML/day [or natural[1]], in June–November)	• Provide longitudinal connectivity for fish • Maintain access to riffle habitat and water quality for waterbugs • Maintain permanent longitudinal connectivity of river for improved water quality • Facilitate platypus habitat and breeding opportunities
Summer/autumn freshes (up to 3 freshes of 50–200 ML/day for up to 3 days each in December–May)	• Maintain riparian and in-channel recruitment vegetation • Increase extent of / maintain in-stream aquatic vegetation • Provide longitudinal connectivity for fish in periods of low flows • Maintain waterbug habitat and wash organic matter into the river to drive aquatic food webs • Respond to blackwater events as required

1 'Or natural' means that flow rates may be above or below the specified target rates depending on inflows and climatic conditions.

Scenario planning

Table 5.6.3 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

Potential watering actions in 2016–17 range from those considered essential under extreme drought conditions through to those seeking to improve the ecological health of the river under wetter conditions, making it better-placed to withstand future stress events. The potential watering actions are similar across scenarios but the target magnitude and duration of the flows increase under wetter conditions, resulting in more environmental water being required as conditions become wetter.

Under continued dry conditions, it may not be possible for the storage manager to deliver water from Lake Eppalock, including environmental water. Without good inflows into storages from April to June 2016, not enough water will be available to enable the storage manager to operate the system to deliver water carried over into 2016–17. Under this scenario, allocations will start at zero and carryover from 2015–16 may not be able to be accessed until sufficient inflows occur or alternate arrangements are negotiated.

Protecting the environment under such conditions is a very high priority to prevent critical environmental loss. There is some possibility that water could be delivered to the lower part of the river (reach 4) from the Goulburn system via the Western Waranga main channel using environmental water or water from the Goulburn being delivered to meet demands in the Murray.

No critical carryover requirements have been identified for the Campaspe system into 2017–18: allocations available on 1 July 2017 from a very high-reliability component of the environmental entitlement will meet the highest-priority summer low flows in 2017–18. The best environmental outcomes are achieved by meeting 2016–17 demand rather than reserving water for the following year.

Table 5.6.3 Potential environmental watering for the Campaspe River under a range of planning scenarios

Planning scenario	Drought[1]	Drought	Dry	Below-average
Expected river conditions	• No unregulated flows • No consumptive water deliveries except for minimal stock and domestic	• No unregulated flows • Low consumptive water deliveries in reach 2 and low-to-no deliveries in reaches 3 and 4 in summer	• Minimal unregulated flows in winter/spring • Low consumptive water deliveries in reach 2 and low deliveries in reaches 3 and 4 in summer	• Some unregulated river flows particularly in winter/spring • Moderate summer consumptive water deliveries in reach 2 and low deliveries in reaches 3 and 4 in summer
Expected availability of environmental water	• 0 ML VEWH • 0 ML CEWH • 0 ML Living Murray • 0 ML carryover • 0 ML withheld passing flows • 0 ML total	• 1,656 ML VEWH • 0 ML CEWH • 0 ML Living Murray • 9,500 ML carryover • 2,000 ML withheld passing flows • 13,156 ML total	• 3,900 ML VEWH • 980 ML CEWH • 20 ML Living Murray • 9,500 ML carryover • 2,000 withheld passing flows • 16,400 ML total	• 19,500 ML VEWH • 6,000 ML CEWH • 100 ML Living Murray • 9,500 ML carryover • 2,000 ML withheld passing flows • 37,100 ML total
Potential environmental watering – tier 1 (high priorities)	• Summer/autumn low flows (reach 4 only) • Emergency pulse flows to avoid critical loss of species/habitat (by preventing or responding to a low-dissolved-oxygen event and by maintaining pool habitat)	• Summer/autumn low flows • Winter/spring high flow (1 event) • Winter/spring low flows • Summer/autumn fresh (1 event)	• Summer/autumn low flows • Winter/spring high flow (1 event) • Winter/spring low flows • Summer/autumn freshes (3 events)	• Low range summer/autumn low flows • Winter/spring high flows (2 events) • Winter/spring low flows • Summer/autumn freshes (3 events)
Potential environmental watering – tier 2 (additional priorities)	• Winter/spring high flow (1 event) • Top-up winter/spring low flows	• Summer/autumn freshes (2 additional events) • Top-up winter/spring low flows	• Winter/spring high flow (1 additional event) • Top-up low flows year-round	• Increased magnitude and duration of winter/spring high-flow events
Possible volume of environmental water required to achieve objectives[2]	• 1,800 ML (tier 1) • 6,800 ML (tier 2)	• 13,100 ML (tier 1) • 5,600 (tier 2)	• 15,200 ML (tier 1) • 7,500 ML (tier 2)	• 25,800 ML (tier 1) • 7,500 ML (tier 2)

1 Under this drought scenario it is assumed delivery of carryover and allocation is not available. Watering to protect plants and animals from critical loss is expected to be negotiated with relevant stakeholders.
2 Environmental water requirements for tier 2 actions are additional to tier 1 requirements.

Risk management

In preparing its seasonal watering proposal, North Central CMA considered and assessed risks and identified mitigating strategies relating to the implementation of environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

5.6.2 Coliban River

Environmental values

The Coliban River contains a diverse range of waterbugs supported by stands of emergent and submergent aquatic vegetation. It is bordered by remnant patches of streambank shrubland vegetation providing habitat for a diverse range of terrestrial species. Historical records show that a diverse range of native freshwater fish species (including the Murray cod, river blackfish, Macquarie perch and Australian smelt) inhabited the river, as do populations of platypus and native water rats.

Social and economic values

iLocal communities highly value the Coliban River including those in Malmsbury, Taradale and Metcalfe. Of particular interest are the aesthetic and recreational values of the river (including Ellis Falls and the Cascades). Popular recreational activities in the area include camping, fishing and bird watching. The storages supply urban, stock and domestic demands in the surrounding area.

Environmental watering objectives in the Coliban system

- Maintain water, riverside and in-stream plants
- Protect and boost populations of native fish by providing flows for them to move upstream and downstream, encouraging spawning
- Improve water quality
- Maintain habitat for waterbugs which provide energy, break down dead organic matter and support the river's food chain

System overview

Reach 1 of the Coliban River below Malmsbury Reservoir to Lake Eppalock can benefit from environmental watering. An important distinction between the Coliban River and other regulated Victorian systems is the lack of irrigation demand in the river, as Coliban Water deliver water from the Malmsbury Reservoir via a pipe-and-channel network. Therefore, the river below this point is not subject to the high summer flows that other regulated systems experience: delivering summer flows relies on environmental water releases.

The VEWH does not have any environmental entitlements in the Coliban system but the ability to flexibly manage passing flows in the system provides an opportunity to help mitigate summer low-flow risks. There is a small volume of Commonwealth environmental water held in the system but the high cost of delivery means it is not planned to be used in 2016–17.

Recent conditions

In 2015–16, conditions were dominated by below-average rainfall in most months and corresponding very low volumes of inflows to the storage (around 11 percent of the long-term average).

A portion of passing flows was withheld in spring to reserve water to support the river over summer/autumn. A summer storm provided a flush through the river in January. The withheld flows were then used to deliver a fresh in March to refill and flush remaining pools, with the river having stopped flowing at Lyal.

The flows delivered were generally well below the environmental flow recommendations for the system. However, water availability in 2015–16 was limited and management aimed to protect native species under drought conditions, particularly following cease-to-flow periods in summer.

Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 5.6.4.

Table 5.6.4 Potential environmental watering actions and objectives for the Coliban system

Potential environmental watering	Environmental objectives
Summer/autumn pulsed flows (5–15 ML/day for up to 2 weeks in December–May as required)[1]	• Maintain water quality (including dissolved oxygen levels) and habitat for aquatic animals
Summer/autumn low flows (2.5–5 ML/day in December–May)	• Maintain aquatic vegetation • Maintain fish habitat • Maintain permanent connectivity of river for improved water quality • Maintain aquatic habitat for waterbugs • Maintain habitat for platypus
Summer/autumn freshes (of 50–100 ML/day for 3 days each in December–May)	• Maintain riparian and in-channel recruiting vegetation • Provide native fish habitat, movement and spawning • Provide connectivity for water quality • Maintain aquatic habitat for waterbugs • Maintain habitat for platypus

1 The actual volume and duration of pulsed flows will depend on available water resources, climatic conditions and conditions within the river.

Scenario planning

Table 5.6.5 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

Water availability in the Coliban system relies on withheld passing flows in winter/spring for use in the high-risk summer period when issues such as poor water quality are more likely and providing constant low flows and/or short pulses/freshes can maintain habitat below the reservoir.

The volume of water available will vary depending on inflows and the volume of passing flows available, with a lower volume likely to be available under a drought/dry scenario. Water is therefore not likely to be available to provide summer/autumn freshes except under average or wet conditions. The target flows and duration of freshes to manage a potentially catastrophic water quality problem will vary depending on water availability and climate and river conditions. There is insufficient water available to meet all the environmental water requirements of the Coliban system.

Campaspe River, by Victoria Penko, Victorian Environmental Water Holder

Table 5.6.5 Potential environmental watering for the Coliban system under a range of planning scenarios

Planning scenario	Drought/Dry	Average/Wet
Expected river conditions	• Little-to-no unregulated flows	• Some unregulated river flows from tributary inflows
Expected availability of environmental water	• Minimal passing flows and low volume to withhold for use at other times in the season	• Moderate-to-high passing flows with good volumes available but reduced ability to reserve flows due to possible storage spills • Withheld flows for use at other times in the season
Potential environmental watering – tier 1 (high priorities)	• Summer/autumn pulsed flows • Summer/autumn low flows	• Summer/autumn low flows • Summer/autumn freshes
Potential environmental watering – tier 2 (additional priorities)[1]	• Increased magnitude of summer/autumn low flows	• N/A
Possible volume of environmental water required to achieve objectives	• 900 ML (tier 1) • 250 ML (tier 2)	• 1,200 ML (tier 1)
Priority carryover requirements	• Reserve passing flows for 2017–18	

1 Only a priority after 2017–18 critical requirements have been set aside
2 Environmental water requirements for tier 2 actions are additional to tier 1 requirements.

Risk management

In preparing its seasonal watering proposal, North Central CMA considered and assessed risks and identified mitigating strategies relating to the implementation of environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

5.7 Loddon system

Waterway manager – North Central Catchment Management Authority

Storage manager – Goulburn-Murray Water

Environmental water holders – Victorian Environmental Water Holder, Commonwealth Environmental Water Holder

The Loddon system includes the Loddon River, Serpentine Creek, Tullaroop Creek, Birchs Creek, Pyramid Creek and the Boort wetlands. The system supports a wide range of environmental values as well as tourism and irrigation industries.

River blackfish are found in the upper reaches of the Loddon River and in parts of Serpentine Creek. There is a regionally important population of blackfish in Birchs Creek. The middle and lower reaches of the Loddon River support bony herring, Murray–Darling rainbowfish, golden perch and Murray cod. Pyramid Creek is a tributary of the lower Loddon River that enters the system near Kerang and provides passage through which fish can swim to and from the River Murray system.

The Boort wetlands on the floodplain of the Loddon River are regionally important for waterbird habitat and provide breeding opportunities for birds and turtles when there is water. During wet phases the aquatic plants provide habitat for frogs which in turn provide food for birds like herons and egrets. During temporary dry phases the diversity of plants at most lakes increases and rare and threatened species can grow.

Engagement

Table 5.7.1 shows the partners and stakeholder organisations with which North Central CMA engaged when preparing the Loddon system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional waterway strategies, environmental water management plans and environmental flow studies, which include environmental, cultural, social and economic considerations.

Table 5.7.1 Partners and stakeholders engaged in developing the Loddon system seasonal watering proposal

Stakeholder engagement
• Birchs Creek Environmental Water Advisory Group (comprising community members and representatives of Goulburn-Murray Water and the VEWH)
• Commonwealth Environmental Water Office
• Goulburn-Murray Water
• Loddon Environmental Water Advisory Group (comprising community members and representatives of Field and Game Victoria, Department of Environment, Land, Water and Planning, Goulburn-Murray Water, North Central CMA, the VEWH and Commonwealth Environmental Water Office)
• North Central CMA Natural Resource Management Committee, an advisory group to North Central CMA Board comprising community members
• Victorian Environmental Water Holder

5.7.1 Loddon River system (including Tullaroop, Serpentine and Pyramid creeks)

Environmental values

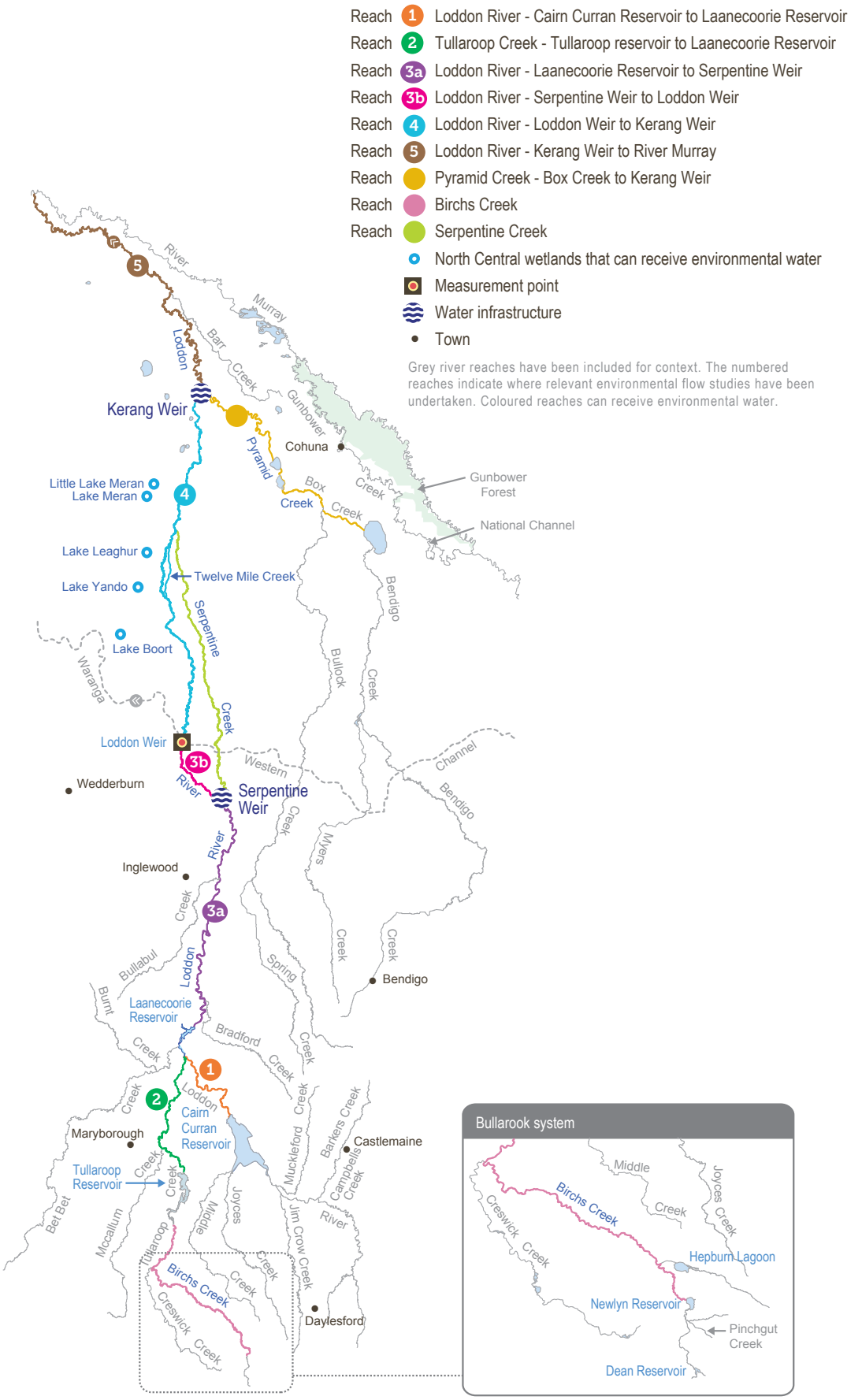
The Loddon River system contains platypus, river blackfish and lots of small native fish (such as flat-headed gudgeon, Australian smelt and mountain galaxias). While fish are most abundant and diverse in the upper reaches of the Loddon River and in Tullaroop Creek, river blackfish are also found in Serpentine Creek and Murray–Darling rainbow fish are in the middle and lower sections of the Loddon River. Pyramid Creek supports large-bodied fish (such as golden perch) and is an important pathway for fish migration to and from the Loddon and Murray systems.

Streamside vegetation condition varies from bad to good depending on several factors such as the recent water regime, the extent of clearing that has occurred, adjacent land use practices and weed invasions. Woodland birds and other native animals are abundant where there is good-quality riparian vegetation providing diverse habitats.

Social and economic values

The Loddon River supplies the Boort irrigation district and is essential for prosperity in the region. Murray cod and golden perch are stocked in the Loddon River and are an important recreational fishing species. Bridgewater on Loddon attracts visitors to waterskiing and triathlon competitions held on the Loddon River. The Loddon River is also rich in Aboriginal heritage, and there are scarred trees and shell middens commonly found throughout the system.

Figure 5.7.1 The Loddon system



Environmental watering objectives in the Loddon River system	
	Maintain river red gum, tea tree and lignum and provide opportunities for new plants to germinate and grow
	Protect and boost populations of native fish by providing flows for them to move upstream and downstream and encourage spawning
	Create opportunities for young platypus to disperse to new, high-quality habitat so they are not competing for space and food and become more resilient to threats (such as predation from foxes)

System overview

The Loddon River flows north from the Great Dividing Range in central Victoria to the River Murray (as Figure 5.7.1 shows). The major storages are Cairn Curran, Tullaroop and Laanecoorie reservoirs.

Environmental water can be delivered to the Loddon River from the Loddon or the Goulburn systems due to the Loddon River's connection with the Goulburn system via the Waranga western channel. Water is provided to Pyramid Creek from the Murray system via the national channel. Water is diverted from the Loddon River to Serpentine Creek, mainly for irrigation.

The highest-priority reach for environmental watering is from Loddon Weir to Kerang Weir where there are good opportunities to improve vegetation condition and fish abundance and because this reach doesn't receive any flows for irrigation deliveries. The upper Loddon River and Tullaroop Creek are also a priority because of the river blackfish and platypus that live there.

Due to the significant modifications to the natural waterways for irrigation supply, the water distribution system in the Loddon is very complicated. This provides both challenges and opportunities for effective environmental water management. It is possible to manipulate the timing and location of releases to accomplish environmental outcomes throughout the system. As experience in managing newly updated environmental flow recommendations is gained in coming years, we expect that water use efficiency and effectiveness will improve.

Recent conditions

The Loddon River system was extremely dry for the entire 2015–16 year and inflows to Loddon system storages were close to the lowest ever recorded.

Due to the effects of dams, weirs and river regulation, the plants and animals in the Loddon system have adapted to a near-permanent flow regime. It is natural for rivers like the Loddon to stop flowing in very low rainfall years, but it is also important to protect the aquatic life in the river during dry times so that it can quickly rebound when conditions improve.

In 2015–16 the combined volume in Cairn Curran and Tullaroop reservoirs fell below the trigger point where Loddon River passing flows are lowered to protect water supplies. Additional environmental water releases were made to maintain minimum low flows through the river and protect the gains made in fish populations and vegetation condition in previous years. Improvements in the condition of aquatic plants have occurred in the last few years. Plants such as water ribbons, eel grass and milfoil have substantially increased, particularly in reaches upstream of Laanecoorie Reservoir.

Higher flows were released to the upper and lower reaches of the Loddon River in spring and summer to improve water quality and provide a chance for fish and platypus to move and feed. These flows also gave the streamside vegetation (including river red gums, shrubs and grasses) a drink, which stabilises the banks and improves habitat for birds, lizards and other animals that live near the river.

Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 5.7.2.

Table 5.7.2 Potential environmental watering actions and objectives for the Loddon River system

Potential environmental watering	Environmental objectives
Loddon River (reach 1)	
Year-round low flows (10–80 ML/day)	• Allow fish movement through the reach and maintain depth of pool habitat for native fish • Facilitate long-distance movement of male platypus in the August–October breeding season • Maintain suitable water quality in pools in summer
Summer/autumn freshes (up to 3 freshes of 35–80 ML/day for 1–3 days in December–May)	• Promote movement of fish so they access alternate habitats • Wash organic matter into the stream to drive the aquatic food webs • Mix and re-oxygenate pools and dilute concentrated salt • Inundate lower banks to wet the soil and promote the establishment, growth and survival of sedges and reeds
Winter/spring freshes (1–2 freshes of more than 400 ML/day for 1–5 days in July–October)	• Promote recruitment of riparian vegetation • Stimulate movement of native fish and enhance Murray cod breeding • Flush accumulated leaf litter from banks and low benches into the channel to drive aquatic food webs
Tullaroop Creek (reach 2)	
Year-round low flows (5–40 ML/day year-round)	• Allow fish movement through the reach and maintain the depth of pool habitat for river blackfish • Facilitate long-distance movement of male platypus in the August–October breeding season • Maintain suitable water quality in pools in summer
Summer/autumn freshes (up to 3 freshes of 30–40 ML/day for 1–3 days in December–May)	• Promote movement of fish so they access alternate habitats • Wash organic matter into the stream to drive aquatic food webs • Mix and re-oxygenate pools and dilute concentrated salt • Inundate lower banks to wet the soil and promote the establishment, growth and survival of sedges and reeds
Winter/spring freshes (1–2 freshes of more than 200 ML/day for 1–5 days in July–October)	• Promote recruitment of riparian vegetation • Stimulate movement of native fish and enhance Murray cod breeding • Flush accumulated leaf litter from banks and low benches into the channel to drive aquatic food webs
Loddon River reach 3a and 3b	
Low flows (1–5 ML/day year-round) under a drought scenario	• Maintain adequate water quality and drought refuge habitat for native fish, platypus and waterbugs in reaches 1, 2 and 3 • Protect aquatic vegetation in reaches 1, 2 and 3
Trigger-based freshes (freshes of 30 ML/day for 7 days) under a drought scenario	
Loddon River (reach 4)	
Summer/autumn low flows (25–50 ML/day in December–May)	• Continuous flows through the reach to maintain water quality in pools • Maintain pool habitat for large-bodied fish (such as Murray cod, golden perch and bony herring) • Maintain shallow water habitats for small-bodied fish (such as flat-headed gudgeon) • Maintain connecting flows for aquatic plant propagules to disperse and establish
Summer/autumn freshes (up to 3 freshes 50–100 ML/day for 3–4 days in December–May)	• Facilitate upstream movement of juvenile golden perch • Wet submerged wood and flush silt and biofilms from hard surfaces to promote new biofilm growth and increase waterbug populations • Facilitate downstream dispersal of platypus in April–May
Spring high flow (one high flow of 450–750 ML/day with a 7-day peak in September–October)1	• Inundate banks, floodrunners and low-lying parts of the floodplain to promote growth and recruitment of riparian vegetation • Provide a cue for golden perch and Murray cod to migrate and breed • Flush leaf litter and organic material from the banks to drive aquatic food webs
Autumn high flow (1 high flow of 400 ML/day with a 6-day peak in April–May)	• Provide a cue for fish from the River Murray to swim upstream and colonise the Loddon River • Help juvenile platypus disperse from the upper Loddon River to the lower Loddon River and the River Murray
Winter/spring low flows (50–100 ML/day in June–November)	• Prevent terrestrial plants from encroaching into the channel • Assist the growth of fringing vegetation (such as sedges and reeds) • Provide foraging and resting habitat for platypus

Potential environmental watering	Environmental objectives
Serpentine Creek	
Summer/autumn freshes (2 freshes of 40 ML/day for 1–3 days in December–May)	• Allow fish, platypus and turtle to move through the reach • Inundate benches and fringing vegetation • Inundate wood and promote biofilm development • Maintain water quality and prevent low dissolved oxygen conditions
Winter fresh (1 fresh of 120–150 ML/day for 1 day in July–August)	• Flush organic material from banks to reduce risk of blackwater in summer • Inundate benches and water-fringing vegetation • Inundate wood and scour biofilms from the streambed • Inundate benches to provide breeding habitat for frogs
Pyramid Creek and Loddon River reach 5[2]	
Spring high flow (1 high flow of 900 ML/day for 10 days in September to November)	• Trigger and facilitate fish movement and breeding, particularly golden perch and silver perch • Recruitment and maintenance of riparian vegetation • Flush accumulated leaf litter from banks to provide carbon for aquatic foodwebs
Autumn high flow (1 high flow of 900 ML/day for 10 days in March–May)	• Trigger and facilitate movement of juvenile fish

1 Due to potential inundation of private land, environmental flows above 450 ML per day in reach 4 will not be provided without agreement of potentially affected landholders.
2 Potential watering actions to Pyramid Creek and Loddon River reach 5 are contingent on the operation of the Box Creek fishway that allows fish movement to and from Kow Swamp.

Scenario planning

Table 5.7.3 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Due to low inflows to the Loddon system in 2015–16, the storage manager may not have enough water available to operate the system to deliver water held by entitlement holders in Tullaroop and Cairn Curran reservoirs in early 2016–17. If conditions remain dry, allocations will start at zero, carryover from 2015–16 may not be accessible and passing flows may not be delivered. Under dry conditions, this situation will continue until sufficient inflows enable releases to be made or alternate arrangements are negotiated with all users in the system.

The VEWH can access water held in the Goulburn system for delivery to the Loddon River downstream of the Waranga western channel at Loddon Weir, so limitations on passing flows and carryover in the Loddon system mostly affect the Loddon River upstream of the channel. However, VEWH water in the Goulburn system could be unavailable from time to time due to capacity restrictions in the Waranga western channel and also when the irrigation season is closed (mid-May to mid-August).

Planning for 2016–17 has considered these operational problems and the impacts that consecutive dry years have had on the Loddon system. Under a drought scenario, low flows and a limited number of small freshes through reaches 1, 2 and 3 of the Loddon River will be provided from Loddon system storages (Cairn Curran and Tullaroop reservoirs) subject to sufficient water being available for use. The low flows will target the bottom end of reach 3b and the freshes will be delivered when required to improve water quality and help maintain riparian vegetation. Under a drought scenario there will be total reliance on water from the Goulburn system for flows to reach 4. If access to water from the Goulburn system is restricted (due to capacity restrictions in the Waranga western channel or outside the irrigation season), flows may be reduced which may affect our ability to maintain refuge habitat.

If dry to average conditions eventuate there will be increased access to water from the Loddon River storages, and the aim is to deliver flows commensurate with the seasonal conditions. Passing flow rules will largely meet low-flow requirements, but it may be necessary to supplement passing flows with additional releases to meet low-flow objectives from time to time. High flows and freshes to the Loddon River and Pyramid Creek will be delivered by coordinating water available in the Loddon, Goulburn and Murray systems.

More water will be available under the average to wet scenarios, allowing more regular deliveries that maximise environmental outcomes, focusing on increased platypus and fish movement and improving vegetation. In a very wet year most flows will happen naturally and only a small amount of environmental water will be used, placing the system in a good position for 2017–18.

Table 5.7.3 Potential environmental watering for the Loddon River system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Negligible contributions from unregulated reaches and tributaries of the Loddon River leading to lengthy cease-to-flow periods in the absence of environmental or consumptive water deliveries	• Small contributions from unregulated reaches and tributaries of the Loddon River contributing to low flows	• Unregulated flows will provide baseflows and multiple freshes, most likely in winter and spring	• Multiple spills from Loddon system storages will provide extended-duration high flows and overbank flows at any time of year
Expected availability of environmental water[1]	• 16,000 ML VEWH • 1,100 ML Commonwealth • 17,100 ML total	• 16,000 to 18,000 ML VEWH • 1,100 to 1,600 ML Commonwealth • 17,100 to 19,600 ML total	• 18,000 to 20,000 ML VEWH • 1,600 to 3,500 ML Commonwealth • 19,600 to 23,500 ML total	• 20,000 ML VEWH • 3,500 ML Commonwealth • 23,500 ML total
Loddon River (reach 1) and Tullaroop Creek (reach 2)				
Potential environmental watering	• Year-round low flows[2] • 1–2 summer/autumn freshes[2]	• Year-round low flows • 1–2 summer/autumn freshes • 1 winter/spring fresh	• Up to 3 summer/autumn freshes • 1–2 winter/spring freshes	• Up to 3 summer/autumn freshes • 2 winter/spring freshes
Loddon River (reaches 3a and 3b)				
Potential environmental watering	• Year-round low flows • Trigger-based freshes at any time of year to improve water quality and maintain riparian vegetation	• Under dry-wet scenarios reach 3 objectives will be met by environmental water delivered from Loddon storages targeting reaches 1 and 2 and en route to reach 4, or by consumptive and system operating water		
Loddon River (reach 4)				
Potential environmental watering	• Year-round low flows • 2–3 summer/autumn freshes • 1 winter/spring high flow	• Year-round low flows • 2–3 summer/autumn freshes • 1 winter/spring high flow	• Year-round low flows • 3 summer/autumn freshes • 1 winter/spring high flow • 1 autumn high flow	• Year-round low flows • 3 summer/autumn freshes • 1 winter/spring high flow • 1 autumn high flow
Serpentine Creek				
Potential environmental watering	• Low flows provided by consumptive water	• 1–2 summer/autumn freshes	• 1–2 summer/autumn freshes • 1 winter/spring fresh	
Loddon River, Tullaroop Creek and Serpentine Creek				
Possible volume of environmental water required to achieve objectives	• Up to 11,600 ML	• 11,600 ML	• 17,000 ML	• 11,000–17,000 ML
Pyramid Creek and Loddon River (reach 5)				
Potential environmental watering	• 1 spring high flow		• 1 spring high flow • 1 autumn high flow	
Possible volume of environmental water required to achieve objectives	• 12,000 ML		• 24,000 ML	

1 Does not include water available in the Goulburn and Murray systems that could be made available to support the achievement of environmental objectives in the Loddon system, subject to trading rules

2 Low flows and freshes in reaches 1 and 2 under the drought scenario will be provided by water en route to Loddon River reach 3

Risk management

In preparing its seasonal watering proposal, North Central CMA considered and assessed risks and identified mitigating strategies relating to the implementation of environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

5.7.2 Boort wetlands

Environmental values

The Boort wetlands provide habitat for a range of plant and animal species, many of which are rare and considered threatened under state and Commonwealth legislation or international agreements. Bird species that have been recorded at Lake Boort and Lake Meran include the white-bellied sea eagle, Latham's snipe and eastern great egret. At Lake Meran the largest known population of the endangered hoary scurf-pea has become well-established in recent years. There are over 2,000 hoary scurf-pea plants which are also the caterpillar food plant for the chequered swallowtail butterfly.

Social, cultural and recreational values

The Boort wetlands provide recreation opportunities for campers, anglers and bird watchers. Lake Meran and Lake Boort are state game reserves where hunting is allowed. The Boort wetlands also contain resources traditionally used by Aboriginal people and there are numerous sites that have Aboriginal cultural heritage significance.

Environmental watering objectives in the Boort wetlands
Assist growth of river red gum trees and aquatic vegetation
Restore habitat and provide breeding opportunities

System overview

The Boort wetlands are on the floodplain to the west of the Loddon River, downstream of Loddon Weir. The wetlands are comprised of the Lake Meran complex of wetlands and also lakes Boort, Leaghur and Yando.

The natural water regimes of wetlands in the Loddon system have been substantially modified. Environmental watering aims to reinstate a more favourable hydrology to the Boort wetlands by providing wet and dry phases to improve environmental condition and habitat value.

Recent conditions

The Loddon catchment was extremely dry in 2015–16 and the Boort wetlands did not receive natural inflows. Lake Meran was the only lake in the system containing water at the end of 2015–16. A top-up to Lake Meran was supplied in autumn 2016 to maintain a minimum level and protect aquatic habitat, particularly for turtles.

Other lakes (such as Lake Boort and Leaghur) have benefited from drying in recent years which has allowed some vegetation to establish on the drying lake bed. Shrubs and herbs grow profusely in the wet soil of a drying wetland and these plants provide habitat for non-aquatic animals to complete life cycles.

Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 5.7.4.

Table 5.7.4 Potential environmental watering actions and objectives for the Boort wetlands

Potential environmental watering	Environmental objectives
Wetland watering	
Lake Boort (partial fill in spring/summer)	• Restore river red gum distribution and the associated plant community including rehabilitation of southern cane grass populations • Restore and rehabilitate vegetation species diversity typical of aquatic and semi-aquatic environments • Promote native vegetation growth to reduce the likelihood of recolonisation by mustard weed
Lake Meran (fill targeting 80.5–81.0 m AHD in spring or autumn)	• Provide breeding opportunities for colonial nesting waterbirds around wetland verges and the southern basin of Lake Meran • Provide feeding and breeding opportunities for wetland birds including black swans, grebes and white-bellied seas eagles • Maintain the condition of adult and juvenile river red gum trees • Rehabilitate understory plant species in the intermittent swampy woodland
Lake Meran (partial fill in autumn to maintain minimum water level 77.3–77.8 m AHD)[1]	• Provide habitat and refuge for turtles and native fish, particularly the Murray River turtle • Rehabilitate the extent of mudflat and flood-tolerant herbland vegetation associated with the lake bed herbland vegetation type (for example, hoary scurf-pea and downy swainson-pea)
Wetland drying	
Lake Leaghur, Little Lake Meran and Lake Yando (promote natural drawdown and drying)	• These wetlands will be in a drying phase throughout 2016–17 • The drying will help maintain a diversity of habitats to support a wide range of wetland-dependent birds and animals and to promote the establishment and growth of vegetation in and around the wetland

1 A partial fill is not required if a fill of 80.5–81.0 m AHD is provided in spring or autumn.

Scenario planning

Table 5.7.5 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

Environmental watering is planned for lakes Boort and Meran in 2016–17.

Lake Boort is approaching its maximum recommended dry interval and therefore a partial fill is planned under all climatic conditions. The fill will provide water for river red gums already established in the lake bed. Watering of Lake Boort will also increase soil moisture and enable germination of river red gum seedlings as the water begins to recede over summer. The partial fill of Lake Boort is planned to start in spring. A top-up in early summer will be considered, depending on conditions at the time and environmental responses that are observed (for example, a top-up may be needed to support bird breeding).

If conditions are dry Lake Meran may be topped up to maintain the minimum target water level of 77.3–77.8 m AHD. Under average to wet conditions (and depending on water availability and an assessment of the condition of wetland values), Lake Meran may be surcharged 80.5–81.0 m AHD in spring or autumn. A complete fill of Lake Meran will optimise conditions for river red gums and aquatic vegetation in the southern basin and set the lake up for a dry phase in the following years.

In all climatic scenarios the delivery of water to Boort wetlands may be limited from time to time due to system operating constraints. If it is a dry year there will be heavy reliance on Goulburn-sourced water via the Waranga western channel, but access to this water may be limited due to irrigation water delivery. In a wet year wetlands might be filled naturally and very little environmental water might be used, depending on the timing and magnitude of floods.

Table 5.7.5 Potential environmental watering for the Boort wetlands under a range of planning scenarios

Planning scenario	Dry	Average	Wet
Expected catchment conditions	• No contribution from unregulated flows	• No substantial unregulated flows with localised catchment contributions expected to provide minor inflows	• Multiple spills from Loddon system storages will provide extended durations of high flows and overbank flows at any time of year • There may be an opportunity to divert flood flows into the Boort wetlands • Top-ups from environmental water are unlikely to be needed
Potential environmental watering	• Lake Boort (partial fill in spring/summer) • Lake Meran (partial fill in autumn to maintain minimum water level 77.3–77.8 m AHD)	• Lake Boort (partial fill in spring/summer) • Lake Meran (fill in spring targeting 80.5–81.0 m AHD)	• Lake Boort (partial fill in spring/summer) • Lake Meran (fill in spring targeting 80.5–81.0 m AHD)
Possible volume of environmental water required to achieve objectives	• 4,000 ML	• 4,800 ML	• 6,300 ML

Risk management

In preparing its seasonal watering proposal, North Central CMA considered and assessed risks and identified mitigating strategies relating to the implementation of environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

5.7.3 Birchs Creek

Environmental values

Birchs Creek supports native fish including a significant population of the regionally vulnerable river blackfish as well as mountain galaxias, flat-headed gudgeon and Australian smelt. Platypus are present in the creek in low numbers.

Social and economic values

Birchs Creek is popular among the nearby community for its aesthetic appeal and intrinsic value. Water in the Birchs Creek system supports irrigated agriculture of crops, particularly potatoes.

Environmental watering regime objectives in Birchs Creek

Maintain suitable water quality to support river blackfish and other native fish

System overview

Birchs Creek is a tributary of Tullaroop Creek. There are two main storages in the system—Newlyn Reservoir and Hepburn Lagoon—which regulate streamflows for urban and irrigation supply. Environmental water is held in and delivered from Newlyn Reservoir. The target reach for environmental water is reach 3 because it contains the vulnerable river blackfish population, and most irrigation supply is diverted before reaching this most downstream reach.

Recent conditions

In 2015–16 the Birchs Creek catchment was very dry. Rainfall was substantially below-average in winter and spring and as a consequence inflows to storages were extremely low.

The trigger for allocating water to the VEWH's environmental entitlement was not met in the Birchs Creek system in 2015–16, and environmental water releases were therefore not possible. Water to the creek was supplied from localised surface and groundwater inflows through small allocations of consumptive water delivered through the system and through storage management that reserved water for delivery for critical human and environmental needs.

Scope of environmental watering

Potential environmental watering actions and their environmental objectives are shown in Table 5.7.6.

Table 5.7.6 Potential environmental watering actions and objectives for Birchs Creek

Potential environmental watering	Environmental objectives
One summer/autumn fresh (27 ML/day for 3 days in December–May)	• Support native fish (including river blackfish) population structure, composition, age classes and abundance • Minimise risks to fish associated with low dissolved oxygen and high water temperature

Scenario planning

If average or wet conditions eventuate in spring, 100 ML of water in Newlyn Reservoir may be reserved and called on to provide a summer/autumn fresh if required.

If conditions remain dry in winter and spring 2016 it is unlikely that environmental water will be available for use later in the year. If water availability in the system is again very low, the only water able to be delivered in the creek will be for irrigation supply and to meet critical needs (for example, for domestic and stock supply and critical environmental flows).

Table 5.7.7 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

Table 5.7.7 Potential environmental watering for Birchs Creek under a range of planning scenarios

Planning scenario	Drought-Dry	Average-Wet
Priority watering actions	• Nil: some water provided for critical environmental needs	• 1 summer/ autumn fresh
Possible volume of environmental water required to achieve objectives	• 0	• 100 ML

Risk management

In preparing its seasonal watering proposal, North Central CMA considered and assessed risks and identified mitigating strategies relating to the implementation of environmental watering. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Campaspe River, by Victoria Penko, Victorian Environmental Water Holder

Section 6

Further information

6.1 Acronyms

AHD – Australian Height Datum (also see Glossary entry)

CEWH – Commonwealth Environmental Water Holder

CMA – Catchment management authority

MDBA – Murray–Darling Basin Authority

ML – Megalitre (also see Glossary entry)

NVIRP – Northern Victoria Irrigation Renewal Project

VEWH – Victorian Environmental Water Holder

6.2 Glossary

Acid sulphate soils – Naturally occurring soils containing high quantities of iron sulphates. When these soils remain underwater they are stable, but if they are exposed to air sulphuric acid is generated and can result in severe environmental impacts.

Adaptive management – An iterative decision-making process based on continuous learning that aims to reduce uncertainty over time.

Allocation (of water) – The specific volume of water allocated to water entitlements in a given water year or allocated as specified within a water resource plan.

Australian Height Datum (AHD) – Height above sea level.

Azolla – A native aquatic fern which grows in waterways in dense patches. Its presence usually indicates high levels of nutrients.

Bank erosion – The wearing away of the banks of a stream or river (as distinct from erosion of the bed) that can occur in extensively dry conditions.

Bank slumping – A form of mass wasting in a river or stream that occurs when a coherent mass of loosely consolidated materials or rock layers moves a short distance down a slope.

Bankfull flows – Flows of sufficient size to reach the top of the river bank with little flow spilling onto the floodplain.

Baseflows – A relatively stable, sustained and low flow in a river, generally being its minimum natural level.

Biodiversity – The variety or abundance of plant and animal species in a particular habitat or environment.

Biofilms – Slimy films of bacteria, other microbes and organic materials that cover underwater surfaces including rocks and snags.

Biota – The animal or plant life of a particular region, habitat or geological period.

Blackwater – A natural occurrence caused by the breakdown of plant matter causing the water to discolour. The water turns black and can have very low dissolved oxygen levels which can cause stress to fish and other animals that breathe underwater.

Brackish water – Water that is moderately salty but not as salty as sea water. It may result from the mixing of seawater with freshwater, as in estuaries.

Carryover – Allows entitlement holders to retain ownership of unused water into the following season, according to specified rules.

Catchment management authority – A statutory authority established to manage river health and regional and catchment planning and to manage waterways, floodplains, salinity and water quality.

Cease-to-flow – The period in which there is no discernible flow in a river and partial or total drying of the river channel.

Cold water pollution – Is caused by cold water being released into rivers, primarily from large dams, in warmer months.

Commonwealth Environmental Water Office – Manages the water entitlements recovered by the Australian Government through a combination of investments in water-saving infrastructure, water purchases and other water recovery programs. The entitlements are held by the CEWH.

Confluence – The point where a tributary joins a larger river (called the main stem) or where two streams meet to become the source of a river of a new name.

Consumptive water – Water owned by water corporations or private entitlement holders held in storages and actively released to meet domestic, stock, town and irrigation needs.

Shared benefits – The many recreational, Aboriginal cultural, social and economic benefits of environmental watering.

Drawdown – Water released from a body of water (such as a reservoir) at the end of the irrigation season for dam operation and maintenance purposes.

Ecological vegetation communities – Components of a vegetation classification system, these are groups of vegetation communities based on floristic, structural and ecological features.

Environmental watering regime – The timing, frequency, duration and magnitude of flows for the environment.

Environmental flow study – A scientific study of the flow requirements of a particular basin's river and wetland systems used to inform decisions about the management and allocation of water resources.

Environmental water – Water available for environmental purposes including entitlements held by the VEWH, passing flows and unregulated flows.

Environmental water entitlement – An entitlement to water to achieve environmental objectives in waterways. It covers an environmental entitlement, environmental bulk entitlement, water share, section 51 licence or supply agreement.

Environmental water management plan – A plan developed by a waterway manager outlining long-term environmental objectives based on consultation with key stakeholders, local community and advisory groups to inform the seasonal watering proposal for the particular system.

Estuary – A partially enclosed body of water along the coast where freshwater from rivers and streams meets and mixes with saltwater from the sea.

Fishway – A series of pools built like steps to enable fish to travel through a particular waterway, dam or waterfall.

Fledging – The care of a young bird until it can fly.

Flow components – Components of a river system's flow regime that can be described by magnitude, timing, frequency and duration (for example, cease-to-flow and overbank flows).

Freshes – Small or short-duration peak-flow events which exceed the baseflow and last for a small number of days.

Geomorphology – The scientific study of landforms and the processes that shape them.

Groundwater – Water held underground in the soil or in pores and crevices in rock.

Headwater – A tributary stream of a river close to or forming part of its source.

Headworks system – A system including various storage infrastructure (such as reservoirs and diversion weirs) to enable connection of multiple waterways.

Heritage rivers – Rivers listed under the Heritage Rivers Act 1992 and parts of rivers and river catchment areas in Victoria which have significant nature conservation, recreation, scenic or cultural heritage attributes.

High-reliability entitlement – Legally recognised, secure entitlement to a defined share of water: full allocations are expected in most years.

Hydrology – The study concerned with the properties of the water and its movement in relation to land.

Inter-valley transfers – The transfer of water between river systems to meet demands as a result of water trade between river systems.

Irrigation releases – Release of water for irrigation purposes.

Juvenile – Animals and plants not yet fully mature.

Land manager – Agency or authority responsible for conserving natural and cultural heritage on public land, including parks and reserves (includes Parks Victoria and Department of Environment, Land, Water and Planning).

Low-reliability entitlement – Legally recognised, secure entitlement to a defined share of water: full allocations are expected only in some years.

Macroinvertebrates – Animals without a backbone and which can be seen with the naked eye including worms, snails, mites, bugs, beetles, dragonflies and freshwater crayfish.

Macrophytes – Aquatic plants that are either emergent (growing out of the water, for example phragmites), submergent (growing under the water, for example ribbonweed) or floating (for example floating pond weed).

Managed releases – Release of environmental water which is stored in major reservoirs and used for priority watering actions to achieve environmental outcomes.

Megalitre – One million (1,000,000) litres.

Midden – A site of cultural significance where Aboriginal people left the remains of their meals and other domestic waste.

Millennium drought – One of the worst droughts recorded since settlement, it went from about 1995 to 2012.

Operational releases – Releases made from major storages to enable the water distribution system to operate or make water available to consumptive water users.

Overbank flows – The portion of a flood flow that flows outside the main river channel at relatively small depths over part of or the full width of the waterway and in a direction essentially parallel with the direction of the main channel.

Passing flows – Water released from storages to operate river and distribution systems (often to assist the delivery of water for environmental or consumptive uses) and maintain environmental values and other community benefits. The volume of passing flows is generally determined by inflows to those storages.

Permanent trade – Transfer of ownership of a water share or licence.

Potential environmental watering – Environmental flow components that have been identified for a particular system in a particular year.

Pulse – A gradual build in the flow of water, typically to replicate optimal conditions for water species such as fish to travel and spawn.

Ramsar-listed wetland – A wetland listed as internationally significant under the Convention on Wetlands signed in Ramsar, Iran in 1971.

Reach – A stretch or section of a river, generally defined in an environmental flows study.

Recruitment – When plants or animals survive to settlement or maturity stage.

Regional waterway strategy – an eight-year action plan prepared by a CMA for the rivers, wetlands and estuaries in its area. It provides a single regional planning document for waterways in the area.

Remnant vegetation – Patches of native trees, shrubs and grasses still remaining following disturbance.

Return flows – Any flows that are delivered for environmental purposes and then returned to the downstream system to be reused for other purposes. Returned flows may be captured and stored downstream for later reuse although most commonly they remain within the waterway for in-stream reuse.

Riffle – Relatively shallow section of stream where water flows at a higher velocity with increased turbulence, causing many ripples to be formed in the water surface.

Riparian vegetation – Vegetation located in the area of land that adjoins, regularly influences or is influenced by a river.

Salt wedge – The transition zone of saltwater and freshwater environments which occurs when a freshwater river flows directly into saltwater.

Seasonal watering plan – The VEWH's annual operational document which outlines potential environmental watering across the state in the forthcoming water year.

Seasonal watering proposal – An annual proposal outlining the regional priorities for environmental water use in each water year and submitted by waterway managers to the VEWH for consideration in its seasonal watering plan.

Seasonal watering statement – A statement by the VEWH authorising a CMA to apply or use water from its environmental water entitlements consistent with the seasonal watering plan.

Slackwater habitat – Habitat in a body of water that has little or no flow, typically formed in areas where the current is restricted by obstructions.

Spawning – The process of species releasing eggs and sperm to reproduce.

Storage manager – Appointed by the Minister for Environment, Climate Change and Water to operate major water storages in a particular river basin to deliver to entitlement holders.

System operating water – Water managed by storage managers and held in storages that is actively released to ensure the system can deliver consumptive water and water to meet other needs.

Temporary trade – Transfer of a seasonal allocation.

Terrestrial vegetation – Land-based plants.

The Living Murray program – An intergovernmental program which holds an average of 500,000 ML of environmental water per year for use at six iconic sites along the River Murray.

Trade – Water shares, allocations and take-and-use licences that can be traded in Victoria under rules set by the Minister for Environment, Climate Change and Water.

Translocation – The movement of living organisms from one area to another area where they are given free release.

Tributary – A smaller river or creek that flows into a larger river.

Unregulated (entitlement) – An entitlement to water declared in periods of unregulated flow in a river system (that is, flows that cannot be captured in storages).

Unregulated flows – Natural streamflows that cannot be captured in major reservoirs or storages.

Victorian Environmental Water Holder (VEWH) – An independent statutory body responsible for holding and managing Victorian environmental water entitlements and allocations.

Victorian environmental watering program – The overarching program by which all environmental watering actions are planned for and delivered and in which all key environmental watering partners are involved.

Water Act 1989 – The legislation that governs water entitlements and establishes the mechanisms for managing Victoria's water resources.

Water entitlement – The right to a volume of water that can (usually) be stored in reservoirs and taken and used under specific conditions.

Water trade – The process of buying or selling or exchanging water allocation or entitlements.

Water allocation – see Allocation (of water).

Water year – the same as a financial year, from 1 July to 30 June the next year.

Waterway manager – Agency or authority responsible for the environmental management of catchments and waterways (includes CMAs and Melbourne Water).

Waterways – Includes rivers, wetlands, creeks, floodplains and estuaries.

6.3 Contact details

For further information about the *Seasonal Watering Plan 2016–17*, please contact the Victorian Environmental Water Holder.

Victorian Environmental Water Holder
Ground floor, 8 Nicholson St, East Melbourne, Victoria 3002
PO Box 500, East Melbourne, Victoria 3002
(03) 9637 8951
general.enquiries@vewh.vic.gov.au
www.vewh.vic.gov.au

For specific information about each system and details about specific seasonal watering proposals, please contact the relevant waterway manager.

Corangamite Catchment Management Authority
64 Dennis Street, Colac, Victoria 3250
PO Box 159, Colac, Victoria 3250
(03) 5232 9100
info@ccma.vic.gov.au
www.ccma.vic.gov.au

East Gippsland Catchment Management Authority
574 Main Street, Bairnsdale, Victoria 3875
PO Box 1012, Bairnsdale, Victoria 3875
(03) 5152 0600
egcma@egcma.com.au
www.egcma.com.au

Glenelg Hopkins Catchment Management Authority
79 French Street, Hamilton, Victoria 3300
PO Box 502, Hamilton, Victoria 3300
(03) 5571 2526
ghcma@ghcma.vic.gov.au
www.ghcma.vic.gov.au

Goulburn Broken Catchment Management Authority
168 Welsford Street, Shepparton, Victoria 3630
PO Box 1752, Shepparton, Victoria 3630
(03) 5822 7700
reception@gbcma.vic.gov.au
www.gbcma.vic.gov.au

Mallee Catchment Management Authority
DPI Complex, Corner Koorlong Avenue and Eleventh Street, Irymple, Victoria 3498
PO Box 5017, Mildura, Victoria 3502
(03) 5051 4377
reception@malleecma.com.au
www.malleecma.vic.gov.au

Melbourne Water
990 La Trobe Street, Docklands, Victoria 3008
PO Box 4342, Melbourne, Victoria 3001
131 722
enquiry@melbournewater.com.au
www.melbournewater.com.au

North Central CMA
628–634 Midland Highway, Huntly, Victoria 3551
PO Box 18, Huntly, Victoria 3551
(03) 5448 7124
info@nccma.vic.gov.au
www.nccma.vic.gov.au

North East CMA
Level 1, 104 Hovell Street, Wodonga, Victoria 3690
PO Box 616, Wodonga Victoria 3689
1300 216 513
necma@necma.vic.gov.au
www.necma.vic.gov.au

West Gippsland CMA
16 Hotham Street, Traralgon, Victoria 3844
PO Box 1374, Traralgon, Victoria 3844
1300 094 262
westgippy@wgcma.vic.gov.au
www.wgcma.vic.gov.au

Wimmera CMA
24 Darlot Street, Horsham, Victoria 3400
PO Box 479, Horsham, Victoria 3402
(03) 5382 1544
wcma@wcma.vic.gov.au
www.wcma.vic.gov.au

For specific information about the other environmental water holders in Victoria, please contact one of the following organisations.

Murray-Darling Basin Authority
Level 4, 51 Allara Street, Canberra City, ACT 2601
GPO Box 1801, Canberra City, ACT 2061
(02) 6279 0100
inquiries@mdba.gov.au
www.mdba.gov.au

Commonwealth Environmental Water Office
John Gorton Building, King Edward Terrace, Parkes, ACT 2600
GPO Box 787, Canberra, ACT 2061
1800 218 478
ewater@environment.gov.au
www.environment.gov.au/water/cewo


CORANGAMITE CMA


EAST GIPPSLAND
CATCHMENT
MANAGEMENT
AUTHORITY


Glenelg Hopkins
CMA


GOULBURN
BROKEN
CATCHMENT
MANAGEMENT
AUTHORITY


malee
catchment management authority


Melbourne
Water


NORTH CENTRAL
Catchment Management Authority
Connecting Rivers, Landscapes, People


NORTH EAST
CATCHMENT
MANAGEMENT
AUTHORITY


West Gippsland
Catchment Management Authority


Wimmera CMA

Johnson Swamp, by Erin Round, Victorian Environmental Water Holder

VICTORIAN
ENVIRONMENTAL
WATER HOLDER

VICTORIA
State
Government