



Upper Barwon River Seasonal Watering Proposal 2023-24

April 2023



*healthy and productive lands and waters
cared for by thriving communities*

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Acknowledgement of Country

The Corangamite Catchment Management Authority works on the lands, waters and seas of the Wadawurrung People of the Kulin Nation and the Kirrae Whurrong, Djagurd Woorroong, Gulidjan and Gadubanud People of the Maar Nation and acknowledge them as the Traditional Owners. We commit to continuing to work with all Traditional Owners to ensure their knowledge and culture is included and valued in Corangamite CMA planning and delivery.

Executive Summary

This Seasonal Watering Proposal (SWP) outlines Corangamite Catchment Management Authority's proposed priorities for the use of environmental water from the West Barwon Reservoir within the Upper Barwon River system in 2023-24, as required under section 192A of the *Water Act 1989*. The Victorian Environmental Water Holder (VEWH) will use the SWP to inform the development of the Seasonal Watering Plan 2023-24.

The Barwon River rises in the Otway Ranges and flows close to the townships of Forrest, Birregurra, Winchelsea and Inverleigh, before flowing through Geelong and the Lower Barwon Wetlands, joining the coast at Barwon Heads. The current environmental water entitlement held in the West Barwon Reservoir can only provide environmental water to the Upper Barwon east branch, the Upper Barwon west branch, with diminishing effect to reaches downstream in the main Barwon River channel.

The Upper Barwon River system is facing environmental challenges due to a lack of environmental flow, largely due to the ongoing impact of the West Barwon Reservoir, and insufficient environmental entitlement. There are other contributing factors including land use change, physical constrictions, a drying climate and groundwater extraction by a range of users. Two key issues have been raised by the Upper Barwon Surface Water Advisory Group (UBSWAG) for acknowledgement in preparing previous proposals.

1. Potential impacts of historical Barwon Downs ground water extraction – Barwon Water has acknowledged potential impacts to the flows in the upper reaches and committed to monitoring to confirm impact, and remediation if required.
2. The river appears to have been disappearing to ground in the mid-Barwon between Winchelsea and Inverleigh gauges; the cause is unknown, but it is likely the water is going underground.

This SWP has been developed in consultation with the UBSWAG. The Traditional Owners of the Upper Barwon, represented by the Eastern Maar Aboriginal Corporation (EMAC) were consulted on the elements of the document relating to Eastern Maar Country only. The upper reaches of the Barwon on Eastern Maar Country tend to benefit the most from environmental releases. The Wadawurrung Traditional Owner Aboriginal Corporation (WTOAC) were engaged on the elements of the document relating to Wadawurrung Country, starting below Winchelsea township and culminating at Barwon Heads, via the Lower Barwon Wetlands.

The environmental watering objective for the Upper Barwon, developed by UBSWAG in 2017, is:

'To improve the Barwon River's flow-dependent ecological values and services through the provision of environmental water. The delivery of environmental water will also provide for social and cultural values for future generations.'

In line with this objective, Corangamite CMA proposes to use the entitlement of approximately 1,000ML/year of water (on average) in 2023-24 for ecological outcomes and to realise shared benefits wherever possible, without compromising those ecological outcomes.

The experience gained from previous releases has informed delivery planning in subsequent years, including the 2022-23 water year. Weed constrictions continue to pose a significant problem for environmental flows in both branches of the Upper Barwon. The Corangamite CMA has identified the Upper Barwon River as the focus for investment as part of our *Barwon Flagship* project. The initial

focus of the Barwon Flagship Project in the Upper Barwon is about working together with landholders, key agencies and community groups to develop and trial strategies that can be applied to priority Willow and *Glyceria* chokes using riparian management practices. This will improve the delivery of environmental water within the Upper Barwon and further down the Barwon River.

In 2022-23 the Upper Barwon system experienced higher than average rainfall. High rainfall in spring led to the West Barwon Reservoir spilling through most of September, October and November. This meant that wet period low flows in the west branch were achieved 80% of the time with little contribution from environmental water. High flows in the upper Barwon River in winter, spring and early summer 2022, eroded parts of the Barwon River west branch. In December 2022, this erosion resulted in river flows breaking out of the main river channel and re-joining the main channel approximately 6km downstream. The diversion lasted about a month, during which no environmental water could be released. For the remainder of the dry season, low flow watering actions were able to be achieved on the east and west branch.

The Upper Barwon, Yarrowee and Leigh rivers FLOWS study update (Alluvium, 2021) recommends that an additional 44GL/year of water is required to return the Barwon system to within 75% of the natural flow regime and allow for the provision of all environmental flow recommendations. This includes 29GL for the Upper Barwon section (excluding the Yarrowee-Leigh). An additional 2.34GL/year is required just to meet dry period low and dry period fresh recommendations for the Upper Barwon. The current allocation of approximately 1GL/year is drastically insufficient to meet the river's health requirements, even when just considering the reaches that are immediately downstream of where the entitlement is held.

As the entitlement cannot meet all flow recommendations for the Upper Barwon east and west branches, watering actions have been prioritised, as summarised in Table 1 below.

Table 1. A summary of the priority watering actions for 2023-24

Environmental allocation: ~1,000ML/year	Is this in line with the FLOWS study update?
Priority 1: Upper Barwon east branch low flows of 0.5-5 ML/day between December–May	Yes. The recommendation is 0.5 ML/day but a higher volume may be required to achieve the recommendation in the reach.
Priority 2: 2 x 6-9ML/day freshes in the Upper Barwon east branch over two days between December–May	No, the FLOWS study recommends 35ML/day, however the current flow constrictions don't allow this.
Where water is available:	
Priority 3: Upper Barwon west branch low flows of 3 to 30ML/day between December–May	Yes
Priority 4: Upper Barwon east branch low flow of 1-9ML/day (or natural if available) between June-November	No, the FLOWS study recommends 10ML/day, however the current flow constrictions don't allow this.
Priority 5: 5 x 20-30 ML/day freshes in the Upper Barwon west branch over 6 days, between December-May	No, the FLOWS study recommends 100ML/day, however the flow constrictions and the current entitlement do not allow this.
Priority 6: Maintain Upper Barwon west branch low flow of 20-30ML/day between June-November	No, the FLOWS study recommends 100ML/day or natural, however the flow constrictions and the current entitlement do not support this.

1. Introduction

The SWP outlines Corangamite CMA 's proposed priorities for the use of environmental water in the Upper Barwon River system in 2023-24, as required under section 192A of the *Water Act 1989*. The Seasonal Watering Proposal has been prepared using the Seasonal watering proposal 2023-24 Guidelines (VEWH, 2022). The VEWH will use the SWP to inform the development of the Seasonal Watering Plan 2023-24 (the Plan). The Plan will outline the full scope of state-wide priorities for use of the Water Holdings.

The Corangamite CMA has identified the Upper Barwon River as the focus for investment as part of our *Barwon Flagship* project. Flagship waterways are large-scale rehabilitation projects happening across the state of Victoria, made possible through the Victorian Government's investment into waterway and catchment health. The Barwon Flagship project will be delivered as a large scale, long-term (30 year) project, with the Upper Barwon prioritised due to the significant impact of Willows (*Salix spp*) and Reed sweet grass (*Glyceria maxima*) in the river system. The initial focus of the Barwon Flagship Project in the Upper Barwon is about working together with landholders, key agencies and community groups to develop and trial strategies that can be applied to priority Willow and *Glyceria* chokes using riparian management practices. This will improve the delivery of environmental water within the Upper Barwon and further down the Barwon River.

1.1 System Overview

The Barwon River rises in the Otway Ranges and flows close to the townships of Forrest, Birregurra, Winchelsea and Inverleigh before flowing through Geelong and the Lower Barwon wetlands, joining the coast at Barwon Heads. The Leigh River, a major tributary, rises near Ballarat and joins the Barwon River at Inverleigh. Two other tributaries, Birregurra and Boundary Creeks, flow into the Barwon from the western part of the catchment. The Barwon River flows through both Eastern Maar Country and Wadawurrung Country. For Wadawurrung people it is known as *Parwan (magpie)* in language. Barre Warre Yulluk (Wadawurrung language)/Parreeyt (Eastern Maar language) is a living and integrated entity: the rivers, creeks and wetlands and the landscapes through which they flow. Flowing from the uplands to the sea, supporting and bringing life to the region. The river carries great cultural significance for both Traditional Owner groups.

The Barwon River is a major water supply for greater Geelong and the smaller urban centres; and farm water supply for the region. The system is significantly altered due to on-stream reservoirs, extensive farm dam storages, and many diversion licenses. Inter-basin transfers can potentially occur from Lake Colac (via the Lough Calvert drainage scheme) and Lake Corangamite (via the Woady Yaloak drainage scheme) into the Barwon River. Parts of the landscape zone near the headwaters of the Barwon River and several of its tributaries include the Otway Ranges. Parts of both the Great Otway National Park and Otway Forest Park are in the catchment.

The Upper Barwon is facing environmental challenges due to a lack of environmental flow, largely due to the ongoing impact of the West Barwon Reservoir, and insufficient environmental entitlement. There is a range of other contributing factors including land use change, physical constrictions, a drying climate and groundwater extraction by a range of users. Two key issues have been raised by the UBSWAG for acknowledgement in preparing previous proposals.

1. Potential impacts of historical Barwon Downs ground water extraction – Barwon Water has acknowledged potential impacts to the flows in the upper reaches and committed to monitoring to confirm impact, and remediation if required.
2. The river appears to have been disappearing to ground in the mid-Barwon between Winchelsea and Inverleigh gauges; the cause is unknown, but it is likely the water is going underground.

1.2 Environmental Entitlement

The Upper Barwon Environmental Entitlement was established in 2018 to provide water for the environment in the Upper Barwon River system in Victoria. The Victorian Environmental Water Holder (VEWH) is entitled to a 2,000ML share of storage capacity in the West Barwon Reservoir, and 3.8% of inflows. This results in approximately 1,000ML per year specific to the West Barwon Reservoir.

The Upper Barwon, Yarrowee and Leigh rivers FLOWS study update (Alluvium, 2021) was undertaken to identify the flow requirements of freshwater reaches of these river systems. It replaces an earlier study. The new study divides the Barwon River downstream of the West Barwon Reservoir into seven reaches above the confluence with the Leigh River, based on geomorphology, hydrology, system operation and natural values, as outlined below in Figure 1. The current entitlement in the West Barwon Reservoir can provide environmental water directly to two reaches: the Upper Barwon east branch and the Upper Barwon west branch. The entitlement has a diminishing impact on reaches in the main Barwon channel past the confluence of the Upper Barwon east and west branches. It should be noted that although the West Barwon Reservoir is situated on the Upper Barwon west branch, water can be released down the Upper Barwon east branch (through a diversion tunnel) as well as to the Upper Barwon west branch.



Figure 1. The Upper Barwon River System showing adopted study reaches and locations

The 2021 FLOWS study update recommends that an additional 44GL/year of water is required to return the Barwon system to within 75% of the natural flow regime and allow for the provision of all environmental flow recommendations. This includes 29GL down the Upper Barwon section (excluding the Yarrowee-Leigh). An additional 2.34GL/year is required just to meet dry period low and dry period fresh recommendations down the Upper Barwon. The current allocation of approximately 1GL/year is drastically insufficient to meet the river's health requirements, even when just considering the reaches that are immediately downstream of where the entitlement is held. The Central Gippsland Region Sustainable Water Strategy (DELWP, 2022) acknowledges that the allocation of 1GL/year delivers only a small portion of the recommended summer flows for the east and west branches of the upper Barwon River and in Policy 8-3 states that by 2032, the Victorian Government will return up to 5GL of water for the environment in the Barwon River to improve waterway health.

Passing flows are an important source of water for the Upper Barwon River and where opportunity exists, the environmental entitlement will be used to enhance these flows. Passing flow rules for the Upper Barwon are outlined in Table 2. Barwon Water must provide an instantaneous flow below the diversion weirs of the lesser of the minimum passing flow as specified in Table 2 and the natural flow.

Table 2. Passing flow rules for the Upper Barwon

Minimum passing flows, April to December (inclusive)		
System storage volume is less than 40,000ML		System storage volume is greater than 40,000ML
West Barwon River	4 ML/day	5 ML/day
East Barwon River	1 ML/day	5 ML/day except during September. September 15 ML/day

Minimum Passing Flows, January to March (inclusive)		
System storage volume is less than		System storage is greater than
for January - 26,100ML for February - 22,900ML for March - 20,900ML		for January - 26,100ML for February - 22,900ML for March - 20,900ML
West Barwon River	4 ML/d	4 ML/d
East Barwon River	1 ML/d	Pass natural Flow

The FLOWS study update (Alluvium, 2021) states that effective delivery of environmental water to achieve flow objectives in relevant reaches will only be possible through an integrated program of complementary actions and environmental water delivery. Importantly, these complementary actions must include management of flow limiting infrastructure and choking weed infestations in the upper reaches, as captured in Figure 2 below. Flow limitations have been experienced down both the east and west branches. These issues are further outlined below in *Section: 7 Delivery Constraints* and *Section 8 Confounding Factors*.

**Figure 2. A typical section of the Upper Barwon east branch constrained by willows**

2. Engagement

Corangamite CMA has engaged with the Upper Barwon Surface Water Advisory Group (UBSWAG) during the development of this plan. The UBSWAG was established by Corangamite CMA in 2017 to support the development of SWPs. The group also supports other important scientific studies relating to flows in the river. The UBSWAG is a passionate and dedicated group of individuals, community groups and government representatives with a broad combination of skills including technical knowledge, historical information and an understanding of government policy and community values. In 2018, UBSWAG played a key role in determining the ecological values, objectives, threats, and opportunities for the Upper Barwon River to inform the new Upper Barwon-Yarrowee Leigh FLOWS study update (Alluvium, 2021). The group also has a key role in informing the watering priorities in the SWP each year.

Together with the UBSWAG, Corangamite CMA engages with Traditional Owners through the Eastern Maar Aboriginal Corporation (EMAC) and Wadawurrung Traditional Owners Aboriginal Corporation (WTOAC) on activities relating to the management of environmental water in the Barwon River on Eastern Maar and Wadawurrung Country, including this SWP. WTOAC collaborated on the technical panel of the FLOWS study update 2021, a state first. The partnership that Corangamite CMA has with WTOAC has led to the recognition of the cultural values of rivers on Wadawurrung Country and the concern Wadawurrung have for their Yulluk and Parwan and ongoing role in caring for them. The Corangamite CMA has received a Letter of Support from WTOAC (Appendix 6) for this Seasonal Watering Proposal 2023-24. The UBSWAG is notified of all environmental flow releases throughout the year, and Corangamite CMA also works with stakeholders individually on specific issues related to the management of environmental water as they arise.

In 2020, EMAC acquired Registered Aboriginal Party (RAP) status. Corangamite CMA reached out to EMAC to incorporate their views and priorities into the management of environmental water in the upper reaches of the Barwon River; and met online using Microsoft Teams in January 2023 to discuss this SWP.

Traditional Owner and community knowledge and input has added significant value to this document and planned watering actions, in particular:

- Feedback and advice on the landscape characteristics of the reaches and any other localised considerations or observations relating to the rivers
- The realities and feasibility of water delivery volumes and timing
- Anecdotal observation and accounts of environmental watering
- New and emerging shared benefits because of the watering.

In line with the Victorian Government best practice for public participation guidelines, Table 3 below defines the level of participation, timing and method of engagement with stakeholders during the development of the SWP. The International Association for Public Participation (IAP2, 2018) spectrum of public participation is designed to assist with the selection of the level of participation that defines the public's role in any community engagement program and can be found in Appendix 3.

Table 3. Stakeholder engagement for the Upper Barwon River SWP 2023-24

Who	Stakeholders	IAP2 level	Engagement method	Engagement purpose
Community groups and environment groups	<ul style="list-style-type: none"> Friends of the Barwon Land and Water Resources Otway Catchment (LAWROC) Geelong Field Naturalists Club Otway Agroforestry Network Winchelsea Landcare Group Upper Barwon Landcare Network Environment Victoria 	Involve	<p>Representation on UBSWAG</p> <ul style="list-style-type: none"> Meeting to discuss and seek input to draft proposal Review of draft proposal and opportunity to provide formal feedback. Response to stakeholders on how their feedback influenced the SWP and why. <p>Direct engagement (one-on-one).</p> <p>Attendance at community forums.</p>	<ul style="list-style-type: none"> Seek user input to the development of the proposal. Review previous environmental watering actions, seek feedback on any outcomes and capture observations. Provide an opportunity for individuals, agencies and groups to contribute to the proposed watering actions and intended outcomes. Identify opportunities to achieve shared benefits. Assist in increasing awareness and understanding of the purpose and objectives of the environmental watering program
Government agencies	<ul style="list-style-type: none"> Department of Energy, Environment and Climate Action (Water & Catchments) Barwon Water Southern Rural Water VEWH 	Involve	<p>Representation on UBSWAG</p> <ul style="list-style-type: none"> Meeting to discuss and seek input to draft proposal Review of draft proposal and opportunity to provide formal feedback. Response to stakeholder on how their feedback influenced the SWP and why. Partnership meetings with links or relevance to seasonal water proposal development. <p>Direct engagement (one-on-one) (UBSWAG).</p> <p>Attendance at community forums.</p>	
Landholders /farmers & recreational users	<ul style="list-style-type: none"> Individual owners and users 	Involve	<p>Membership of UBSWAG</p> <ul style="list-style-type: none"> Meeting to discuss and seek input on draft proposal Review of draft proposal and opportunity to provide formal feedback. 	

Who	Stakeholders	IAP2 level	Engagement method	Engagement purpose
			<ul style="list-style-type: none"> Response to stakeholder on how their feedback influenced the SWP and why. <p>Direct engagement (one-on-one).</p> <p>Attendance at community forums.</p>	for the Upper Barwon River.
Traditional Owners	Wadawurrung Traditional Owners Aboriginal Corporation (WTOAC)	Involve	<ul style="list-style-type: none"> Directly engaged on the applicable cultural aspects within the 2023-24 SWP draft. Invited to attend community forums. Face to face meeting to discuss and seek input to draft proposal. Review of relevant sections of draft proposal and opportunity to provide formal feedback. Partnering to create the FLOWS study update (Alluvium, 2021), which underpins the SWP. 	
	Eastern Maar Aboriginal Corporation (EMAC)	Inform/c onsult (working towards a higher IAP2 level)	<ul style="list-style-type: none"> Directly consulted on the applicable cultural aspects within the 2023-24 SWP draft. Invited to attend community forums. Meeting on Microsoft Teams to discuss and seek input on draft proposal. Review of relevant sections of draft proposal and opportunity to provide formal feedback. 	
Local Government	Colac Otway Shire Council	Consult	<p>Representation on UBSWAG</p> <ul style="list-style-type: none"> Meeting to discuss and seek input to draft proposal Review of draft proposal and opportunity to provide formal feedback. Response to stakeholder on how their feedback influenced the SWP and why. <p>Direct engagement (one-on-one).</p> <p>Attendance at community forums.</p>	

2.1 Notable feedback

The Upper Barwon Seasonal Watering Proposal 2023-24 was presented and distributed to the UBSWAG and other community and agency members in March 2023. Individuals had two weeks to provide feedback to Corangamite CMA.

A member of the UBSWAG commented on how there were several references made in the Seasonal Watering Proposal about data gaps. They wondered if there are new gauging techniques and investigative processes that utilise any new technology available that will better or more efficiently measure instream flow and provide information on how and where water is being lost from the river system (but maybe not the hydraulic cycle) to gain a greater understanding of how we are meeting the intention and targets in returning water back to the Barwon River. Corangamite CMA responded with information about the West Barwon River@ Compensation Weir Spillway gauge. The gauge can be used when there are gaps in data at West Barwon River@ Boundary Road Forrest. This can assist Corangamite CMA in determining if flow recommendations are being met on the west branch. Corangamite CMA and Barwon Water work collaboratively to find a solution to data gaps in the Upper Barwon River. Corangamite CMA will continue to review the data required to deliver the Upper Barwon Environmental Entitlement effectively and will work closely with Barwon Water when there are proposed upgrades to flow gauges or funding opportunities to install additional flow gauges.

A letter of support for the seasonal watering proposal was received from Wadawurrung Traditional Owners Aboriginal Corporation. This can be found in Appendix 6.

Corangamite CMA will work with the Eastern Maar Aboriginal Corporation to build mutual understanding and trust, and to incorporate relevant values and uses, prior to requesting a Letter of Support for future environmental releases.

Detail of the comments received, and Corangamite CMA responses can be found in the Upper Barwon SWP 2023-24 Comments Register.

Detail of the comments received (other than letters of support) and Corangamite CMA responses are provided to the UBSWAG. Other individuals or organisations can contact the Corangamite CMA at info@ccma.vic.gov.au to request a copy of the Upper Barwon SWP 2023-24 Comments Register.

3. Values and uses of waterways

The primary purpose of the environmental water entitlement is to achieve environmental outcomes. However, the delivery of environmental water is likely to provide other benefits that depend on the condition of our waterways, such as supporting social and cultural values. Shared benefits are the many recreational, social or economic benefits that occur because of environmental watering, such as fishing, boating, bird watching or community events. Traditional Owner values and events may also be supported by maintaining flows. Opportunities for shared benefits are incorporated into planning and watering decisions if they do not compromise environmental outcomes.

Corangamite CMA is flexible in its delivery approach and aspires to realise shared benefits that arise from the delivery and use of the water, where possible. The Upper Barwon system is split into the east and west branches and the east branch is prioritised over the west branch.

As part of the management of the Upper Barwon Environmental Entitlement 2018, Corangamite CMA consults with stakeholders to ensure that consideration is given to social, cultural and economic matters relevant to water management for the Upper Barwon. Figure 3 illustrates the shared benefit of a flowing waterway. A flowing river as a result of environmental water releases can have benefits to those walking, running or bike riding alongside the river.



Figure 3. Walking track on the Upper Barwon where River red gums and Platypus can be seen. (CCMA, 2023)

3.1 Aboriginal cultural values and uses of waterways

The Barwon River has important social, cultural and economic values. Both Eastern Maar and Wadawurrung Traditional Owners have a strong connection and consider waterways like the Barwon River to be sacred. Many Eastern Maar and Wadawurrung people in the region have a connection and a long history with the river. The Barwon River forms an integral part of Wadawurrungs' Barre Warre Yulluk. Yulluk (great river) that runs from the Barre (mountains) to the Warre (ocean), and their stories tell of these connections. Whilst some tribes lived and farmed along rivers, the waterways also provided their highways, to move around country. Traditional Owners gathered, made important decisions, gathered food, caught eels and other fish and waterbirds to eat.

The reaches of the Barwon River that can be most influenced by water delivered from the West Barwon Reservoir sit in Eastern Maar Country, upstream of Winchelsea. In February 2020, EMAC received RAP status over a large portion of land in south-west Victoria, which includes the Barwon River upstream of Winchelsea. This status recognises Eastern Maar as the primary guardians, keepers and knowledge holders for the management and protection of Aboriginal cultural heritage within the determined area. EMAC's (2015) Country Plan (Meerreengeeye ngakeepoorryeeyt) identifies healthy country and sustainable use of natural resources as a goal.

These extracts from the Eastern Maar Nation Statement, Water is Life (DELWPa, 2022) describe the relationship Eastern Maar have with Parreeyt (water).

Firstly, Eastern Maar law/lore requires us to question the how, why and when any new interaction with parreeyt is required and/or the appropriateness of that interaction.

As a higher end foundation of these laws/lore, we know Meerreeng, Parreeyt, Moornong, pa Maar (land, water, sky, and people) to be intrinsically co-dependent upon the other to sustain high levels of health and prosperity. This reciprocating co-dependency and co-beneficiary relationship model is akin to that of a family and thought of as so, in the highest order. Together we are each of the same and inseparable. Unable to be compartmentalised and segmented. Any interaction should not be to the detriment of the values we are obliged to consider.

Secondly, Eastern Maar relationship with parreeyt is further underpinned by our understanding of life & death and what happens to our Spirit when the body is no longer required. It is a fundamental belief of the Maar, that our Spirit comes from Meerreeng, and our Spirit goes back to Meerreeng. Collectively, our Meerreeng, Parreeyt, Moornong, Allam Meen, Bunjil, pa Maar (Land, Water, Sky, Ancestors, Creator and People) are collectively, the Dreaming. A creative force of a self-perpetuating omnipresence. The Spirit of our ancestors is in the Meerreeng we walk upon, and parreeyt being the medium used to travel through meerreeng. This knowledge of parreeyt heightens its significance and underpins our relationship, with a sacredness rarely paralleled by other natural elements.

It is in this relationship with parreeyt that we relate to it as we would a family member, as with individual relationships with an Elder and/or a newborn infant. With a sense of concern, caution, reverence, and calm optimism. Therefore Parreeyt is Sacred. And with that sacredness comes an obligation to act as its advocate, its guardian, its community, its family.

Wadawurrung Traditional Owners through WTOAC released their *Paleert Tjaara Dja* – let's make Country good together 2020-2030 – Wadawurrung Country Plan in 2020 (WTOAC, 2020). *Yulluk* – waterways, rivers, estuaries and wetlands, along with warre (sea country) are important values identified in the plan to be looked after. Engagement is ongoing, and meetings are held regularly with the Wadawurrung to help progress future projects and work together to expand on the opportunities for shared benefits.

The following Wadawurrung cultural values and recommendations are applicable across all sites within Wadawurrung Country, including the Barwon River south of Winchelsea:

- Maintaining watering requirements for healthy, thriving, culturally significant species is crucial
- Protection of totem species is priority
- Recognition of confluences as places of meeting, ceremony and trade
- Identifying Clan boundaries with confluences
- Maintain deep/permanent waterholes and refuge pools
- Maintain access to culturally important sites – story places, ceremonial places
- Protection of all Wadawurrung cultural heritage
- Use of appropriate Wadawurrung language for places of cultural importance on Wadawurrung Country
- Increased opportunities for Wadawurrung Traditional Owners to be involved in monitoring and evaluation activities on Wadawurrung Country
- Increased opportunities for Wadawurrung Traditional Owners in all communications of environmental water releases and activities on Wadawurrung Country
- Increased opportunities for Wadawurrung Traditional Owners to build knowledge of the use of interventions in the *yulluk* such as reservoirs and dam storage and how they harm the river and affect cultural flows.

Corangamite CMA continues to work with Eastern Maar and Wadawurrung Traditional Owners to support their values and uses of the Upper Barwon River, and to refine our understanding of how environmental watering can support their needs and wants and strengthen self-determination and access to cultural flows.

Key Wadawurrung cultural objectives and values as identified in Upper Barwon Yarrowee and Leigh River FLOWS study update (Alluvium, 2021) are found below in Table 4.

Table 4. Traditional Owner values and uses

River	Traditional Owner group	Category	Objectives & opportunities	Values & uses	How will this opportunity be considered in environmental watering in 2023-24?
Mid - Barwon (below Winchelsea)	Wadawurrung Traditional Owner Aboriginal Corporation (WTOAC)	Culturally significant species	Maintain or improve abundance, breeding and recruitment of <i>Wad-dirring/ Perridak</i> (platypus).	Meat and pelt.	Environmental watering will aim to provide pool habitat and connectivity between reaches where possible.
			Maintain or improve abundance of <i>Buniya</i> (Eels).	Meat, important food source sometimes smoked.	Where possible, environmental watering aims to provide for pools, habitat and food sources, as well as providing water over riffles to allow eels to migrate.
			Maintain or improve abundance of <i>Turrapurt</i> (Native trout <i>galaxias spp.</i>)	Meat	Where possible environmental watering aims to provide for pools, habitat and food sources, provide water over riffles to allow fish to move between pools and breed, feed and find new habitats.
			Maintain or improve abundance of <i>Ware-rap</i> (Blackfish).	Meat	
			Maintain or improve abundance of <i>Polango/ Warngare</i> (Water ribbons <i>Triglochin procera</i>).	Plant food; finger shaped tubers are crisp and sweet. Cooked in ground oven.	Environmental watering aims to maintain adequate depth of water in channel where possible.
			Maintain or improve condition, extent and abundance of <i>Tark</i> (common reed)	<i>Tark</i> : Weapon-stems used for spear shafts for fishing. Reed cut while still green to make necklaces, weaving-bags and baskets; also a food plant.	Where possible, environmental watering aims to maintain adequate depth of water to limit terrestrial encroachment into aquatic habitats.

River	Traditional Owner group	Category	Objectives & opportunities	Values & uses	How will this opportunity be considered in environmental watering in 2023-24?
			<i>Phragmites australis</i> , <i>Toolim</i> (Pale Rush <i>Juncus pallidus</i>), and Bal-yan (Cumbungi <i>Typha latifolia</i>)	<i>Toolim</i> : Weaving baskets. <i>Bal-yan</i> : Fluff used to pack wounds under paperbark bandage.	This will also support growth on terraces, channel edge and lower bank.
			Maintain or improve abundance of <i>Biyal</i> (River red gum <i>Eucalyptus camaldulensis</i>)	Bark removed for canoe, shelter and tools, <i>Tarnuk</i> (bowl); nectar drink; medicinal – gum or sap was used for burns to shrink or seal them, the sap is high in tannin. Leaves for steam baths.	
			Maintain or improve abundance of <i>Larrap</i> (Manna gum <i>Eucalyptus viminalis</i>) and <i>Kokibainang</i> (Swamp wallaby grass <i>Amphibromus reservatus</i>).	<i>Larrap</i> : Timber used for making club-shields called Malka. Sap-sucking lerp bug gathered each season. Young leaves were fed onto fire near patient. Poultice of well-chewed leaves applied for back ache. Quail flocks attracted to Manna. <i>Kokibainang</i> : Leaves split, dried out and re-constituted in running water. Fibres twisted into rope to make long nets for game hunting.	Environmental watering cannot consider this in 2023-24 due to various constraints such as an insufficient entitlement.
		Physical features	Deep pools	The presence of deep pools has cultural significance.	Environmental watering will supplement in filling and ensuring connectivity to pools where possible.
			Confluences	High cultural value due to historical use of site as a meeting place for three different Clans.	Where possible, environmental watering will aim to supplement adequate depth of water for connectivity.

River	Traditional Owner group	Category	Objectives & opportunities	Values & uses	How will this opportunity be considered in environmental watering in 2023-24?
		Events	Holding cultural events on the Upper Barwon	Celebration of culture, family events, fishing days, cultural festivals.	Due to a limited entitlement, fresh events to support events are not possible on Wadawurrung country due to its lack of proximity to the release point.

3.2 Social, recreational and economic values and uses of waterways

The adjacent land use of the Upper Barwon River is dominated by grazing for livestock (beef, sheep and dairy) and forestry, and is significant in terms of economic value. There is limited public access to river frontage, therefore social and recreational values and uses of the Upper Barwon are also limited. Recreational use tends to be informal and often on private land in the form of swimming and fishing. There are some public areas through towns such as Forrest, Birregurra and Winchelsea where people may gain access to frontage for camping, swimming, walking, running, fishing or events. Events such as Run Forrest (trail running) and Otway Odyssey (mountain biking) both feature the Upper Barwon River. For example, this review of the Run Forrest event was posted online: “*Conveniently located in the middle of the Otway’s, the areas surrounding are stunning.*” Claude Castro, google review (Figure 4).



Figure 4. Run Forrest (Photo: Kobus de Wet).

Corangamite CMA commissioned the Geelong Values study, which examined the social and economic benefits provided by the Barwon and Moorabool Rivers to the community of Geelong, and the importance of river flows for supporting and protecting these values (RCMG, 2021). The study found that improved river flows can help protect water quality, maintain water levels and reduce the risk of algal blooms in the lower Barwon River through Geelong. The benefits of the river through Geelong are largely driven by land use surrounding the river, for example, recreation. On an annual basis, the river and surrounding areas are visited approximately 500,000 times for recreation.

While access in some parts of the river is limited, environmental water supports a range of informal activities such as swimming, camping, bird watching and fishing. Native fish species popular with anglers such as the River Blackfish are supported through environmental water flows (Figure 5).



Figure 5. River blackfish (*Gadopsis marmoratus*) (Photo: ARI 2019).

Table 5 presents the potential social, recreational and economic benefits for the 2023-24 water year.

Table 5. Social, recreational, and economic shared benefits for the Upper Barwon River for 2023-24

Waterway	Beneficiary	Connection to the river	Values / uses / objectives / opportunities	How have these benefits been considered?
Upper Barwon River	Recreation: fishing	Recreational fishing is important for social and recreational purposes. Recreational fishers have an interest in maintaining a healthy system.	A healthy fish population is important as it provides opportunities for recreational fishing.	Environmental watering supports a healthy system. Low flow watering supports connectivity throughout the reaches and allows fish to move. Fresh events aid in maintaining and expanding migratory fish populations as they trigger migration and support their life cycle.
Upper Barwon River	Recreation: riverside eg. running, bike riding and walking	Riverside recreational activities are important for social and recreational purposes. Those who engage with the natural environment are likely to support the idea of maintaining a healthy system	Adequate water quality and flow is essential for maintaining desirable aesthetics for riverside recreational activities.	Environmental watering where possible supports a healthy system with good water quality and flow as well as supporting fringing vegetation.
Upper Barwon River	Recreation: water based e.g. canoeing, swimming	Water based recreational activities are important for social and recreational purposes. Those who engage with the natural environment are likely to support the idea of maintaining a healthy system.	Adequate water quality, depth and connectivity are important for those who engage in recreational water activities.	Environmental watering where possible supports a healthy, flowing and connected system with increased depth to create more opportunities for people engaging in recreational water activities.

Waterway	Beneficiary	Connection to the river	Values / uses / objectives / opportunities	How have these benefits been considered?
Upper Barwon River	Economic: stock and domestic use	The Upper Barwon River predominantly flows through private property which is sometimes used for farming purposes. Landholders have an interest in maintaining a healthy system.	<p>Adequate water quality, depth and connectivity are important to ensure use as a water supply catchment.</p> <p>Indirect watering and fencing stock out of the waterway has the potential to greatly improve water quality reducing erosion and nutrient load.</p>	Where possible, environmental watering supports a healthy, flowing and connected system with increased depth and water quality to ensure economic values are retained.

4. Seasonal review 2022-23

4.1 Climate

The Barwon South-West region has a temperate climate with mild to warm summers and cold winters. Summer average maximum temperatures are around 22 to 24°C near the coast and in elevated areas, and 25 to 27°C inland. Winter average maximum temperatures are around 12 to 14°C. Rainfall occurs mostly in winter and spring and is generally the result of rain-bearing weather systems coming from the west (DELWP, 2015).

The year 2022 was the 22nd warmest year on record for Australia. Nationally average rainfall was 26% above the 1961-1990 average, which makes 2022 the ninth-wettest year on record for Australia. The main climate influences active during 2022 were La Niña, which persisted through summer 2021-22, dissipated during autumn then re-developed in early September and continued through the end of 2022; a negative Indian Ocean Dipole in winter and spring; and a persistently positive phase of the Southern Annular Mode from mid-autumn onwards. (BOM, 2023a). Parts of Victoria saw flooding multiple times during the year.

Rainfall in the Upper Barwon was above average in 2022 (Figure 6), with nine months of the year being wetter than average (2000-2022) and three months being drier. 2022 Spring rainfall was significantly higher than average (2000-2022). In 2023, rainfall was below average in January and above average in February (Figure 6).

On 23rd August, the West Barwon Reservoir began to spill (Barwon Water, 2022) and continued to do so for less than a week. The reservoir started to spill again in September and continue to do so for most of October and November 2022. Corangamite CMA was not releasing environmental water during this time.

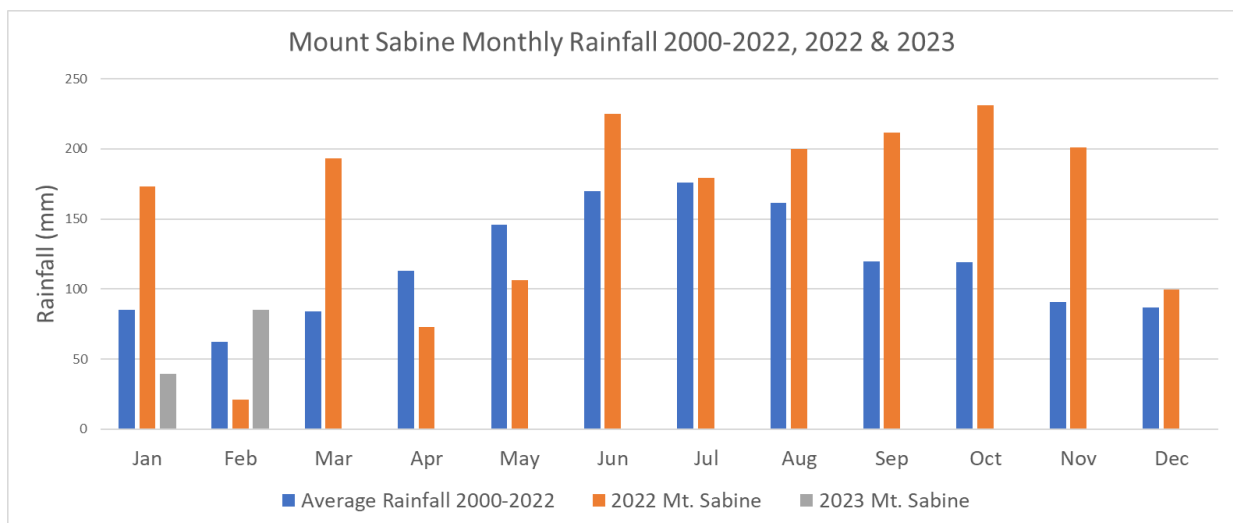


Figure 6. A comparison of monthly average rainfall (2000-2020) at Mount Sabine with 2022 and 2023 monthly rainfall

4.2 Environmental water delivery 2022-23

The FLOWS Update (Alluvium, 2021) details priorities and flow recommendations for the east and west branches of the Upper Barwon River. The east branch has priority over the west branch. Corangamite CMA does not release environmental water during Flood Watches and only releases small volumes compared to natural events. If a natural flooding event occurs, releases are cancelled, and the relative contribution of the environmental releases is minimal. This applies to both the east and west branches.

East branch

In 2022-23, the East Barwon River @ Flume gauge has been used to monitor flows on the east branch. This gauge has been installed to accurately measure low flows. When flows are high (e.g. above 200 ML/day) the stream becomes flooded, over-topping the stream banks and the gauge. When this happens the gauge reverts to zero as it can no longer measure flows. As such there are gaps in the flow data during high flow events. As flows recede back to being contained within the stream channel the gauge will recommence recording flow data. To gain an understanding of whether the east branch flow recommendations were achieved, Corangamite CMA graphed the East Barwon River @ Flume gauge data (see Figure 7).

Over the wet period, the east branch experienced high natural flows, especially in September, October and November. When reviewing the flume gauge data, over the wet period, minimum low flow recommendations for the east branch were achieved 37% of the time (Figure 8). It is possible that a wet period fresh was met, however this cannot be confirmed as the flow recommendation is higher than the range of the available gauges, and the range was exceeded during the period.

Given our understanding of the degree of channel constriction along the Upper Barwon east branch and associated risk of flooding, the dry period freshes planned were reduced from the recommended 35ML/day to 9ML/day. When this proposal was written, dry period freshes had not been achieved down the east branch. Dry period low flows (0.5ML/day) were achieved naturally (Figure 7).

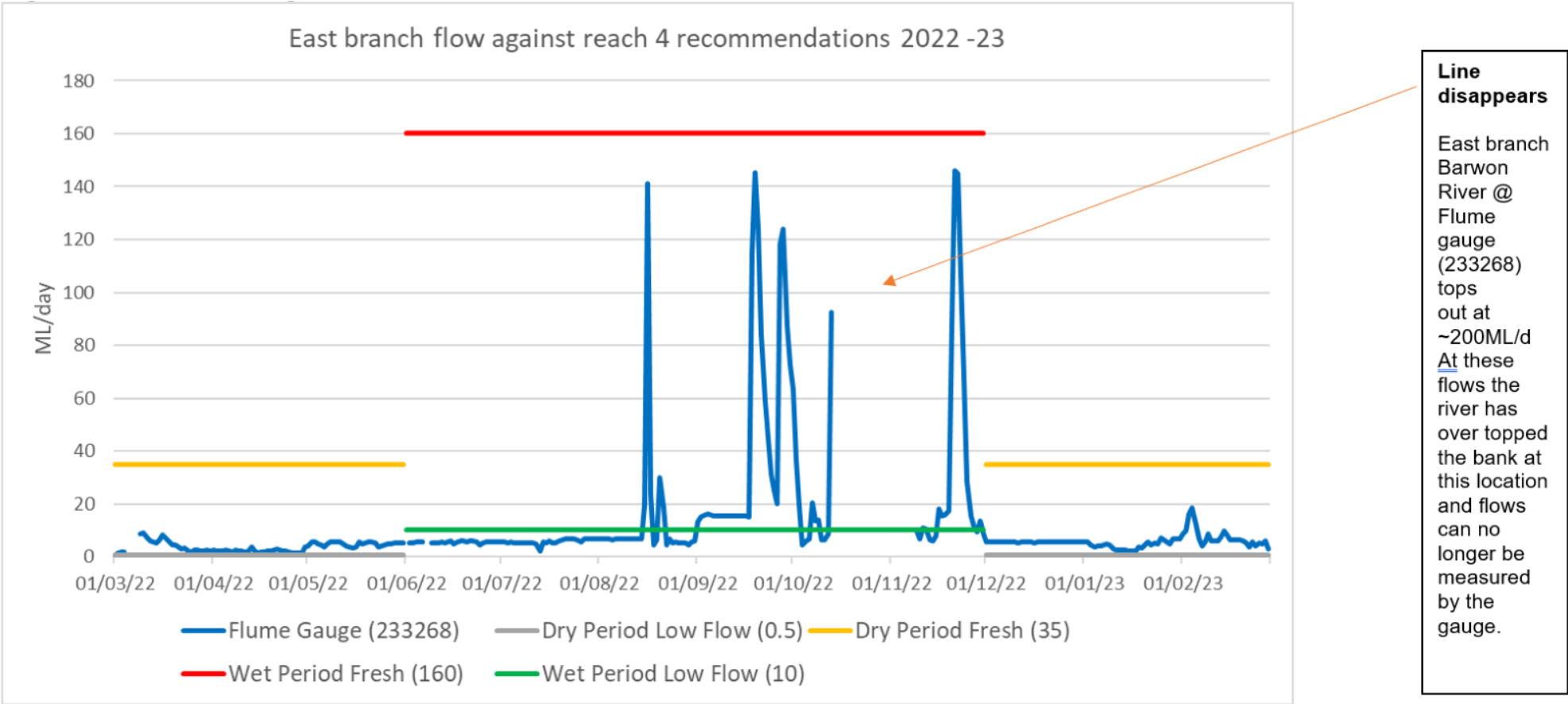


Figure 7. East branch flow against reach 4 flow recommendations achieved 2022-23.

West branch

In 2022-23 West Barwon River@Boundary Road Forrest gauge (233255) has been used to monitor flows in the west branch. This gauge has been installed to accurately measure low flows. When flows are high (e.g. above 100 ML/day) the stream becomes flooded, over-topping the stream banks and the gauge. When this happens the gauge reverts to zero as it can no longer measure flows. As such there are gaps in the flow data during high flow events. As flows recede back to being contained within the stream channel the gauge will recommence recording flow data. Where there were gaps in the data recorded at West Barwon River@Boundary Road Forrest gauge (233255), data from the West Barwon River@Compensation Weir Spillway (233245) can be used to determine what the minimum flows were likely to have been during these high flow periods (Figure 8).

Over the wet period, high rainfall in August-November allowed for some good natural flows, but overall the base flow was still well short of the low flow recommendation for this period (100ML/day) (Figure 9). Data from the West Barwon River@Compensation Weir Spillway (233245) confirms that five wet period freshes were achieved naturally with a spilling reservoir.

Environmental releases down the west branch began in July 2022 for a period of 15 days at 7-10ML/day (including passing flow). Environmental releases didn't resume again until 30th January 2023. There are two reasons for this:

1. Environmental releases were paused over spring so that they didn't contribute to flooding of public assets and private property while natural flows were high and the reservoir was spilling.
2. High flows in the upper Barwon River in winter, spring and early summer 2022, eroded the Barwon River west branch in the Boundary Rd vicinity. This erosion resulted in river flows breaking out of the main river channel in December 2022 and travelling down an old channel system on private property before re-joining the main channel approximately 6 km downstream. This change in flow resulted in low flow conditions in the main channel of the upper Barwon River west branch. While water was diverted from the main channel of the west branch, no environmental water was released down the Barwon River west branch to avoid water entering the old channel system and causing flooding of private property downstream. Remediation works were completed on 20th January 2023 allowing environmental releases to resume.

Corangamite CMA will not attempt to release a dry period fresh (100ML/day for six days each) until weed choke points have been removed in the west branch, as localised flooding would occur. The limited volume of the current environmental entitlement would also not allow for delivery of this flow component under the current order of priorities. The removal of weeds and improvements of river health are planned to continue over time with funding through the Barwon Flagship. Larger volumes of environmental water down the west branch in future years will also be dependent on recovering more water for the environment, as outlined in the Central and Gippsland Region Sustainable Water Strategy (2022).

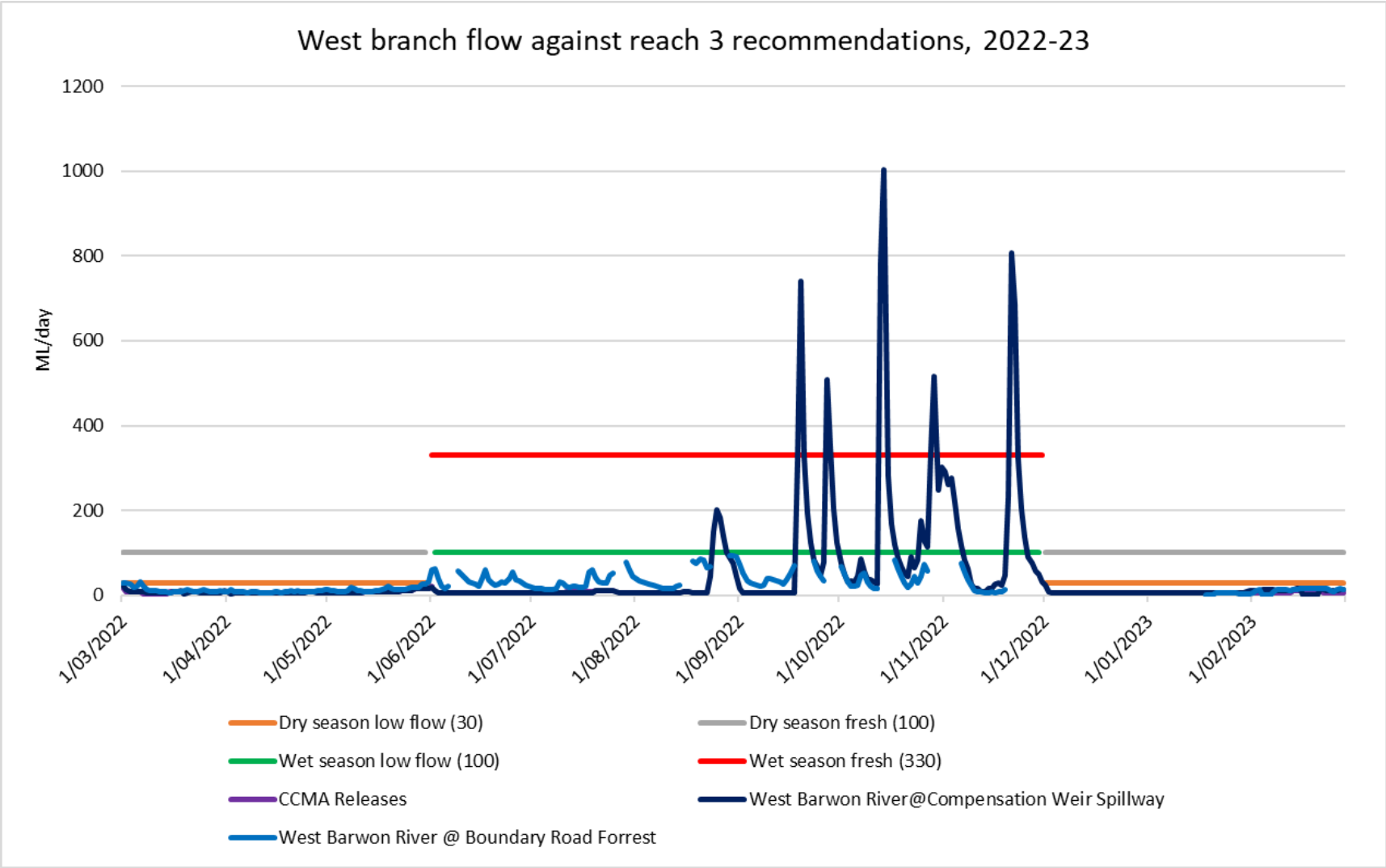


Figure 8 West branch flow (West Barwon River@Compensation Weir Spillway) against reach 3 flow recommendations.

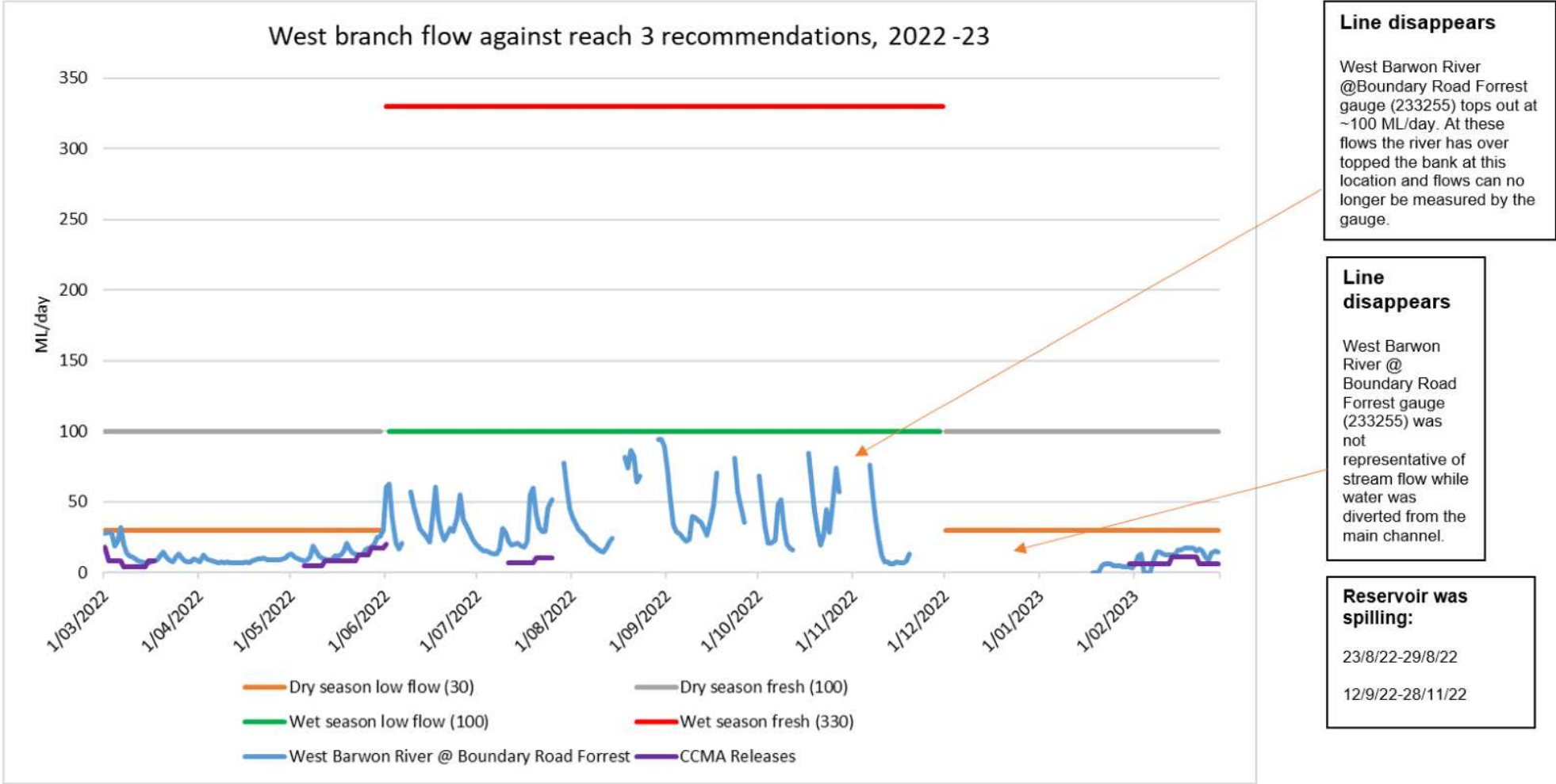


Figure 9. West branch flow against reach 3 flow (West Barwon River@Boundary Road Forrest) recommendations in 2022-23

Ricketts Marsh

The Ricketts Marsh gauge is downstream from the east and west branches. Comparing Ricketts Marsh natural flows to Winchelsea natural flows shows that the Upper Barwon received high volumes of water in 2022. Winchelsea flows were constantly higher than Ricketts Marsh. This is expected in a naturally wet year as the Winchelsea gauge is downstream from the Ricketts Marsh gauge (Figure 10) and river flows build, with surface run off and tributaries entering, moving downstream in a natural system.

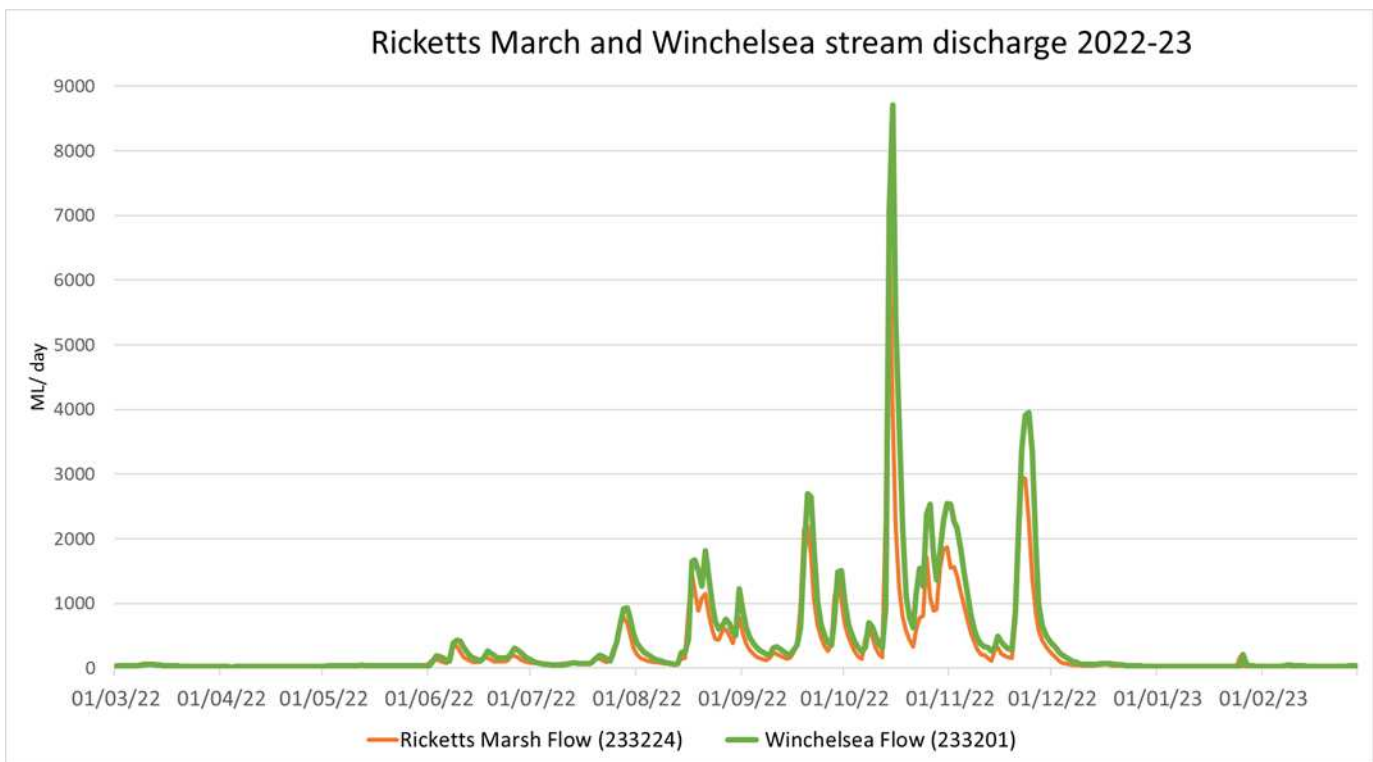


Figure 10. Daily average stream flow at Ricketts Marsh and Winchelsea, 2022-23

Due to higher than average rainfall during spring, the wet period minimum low flow recommendations for reach 7 were achieved 80% of the time (Figure 11). Dry period freshes were not achieved, and dry period low flows were partially achieved.

Interestingly, bankfull flow was achieved in reach 7 on 14th and 15th October. The average daily flow recorded on the 14th was 6478ML/Day. Bankfull flows fill the channel, but do not spill onto the floodplain. Bankfull flows every couple of years help maintain channel shape and form.

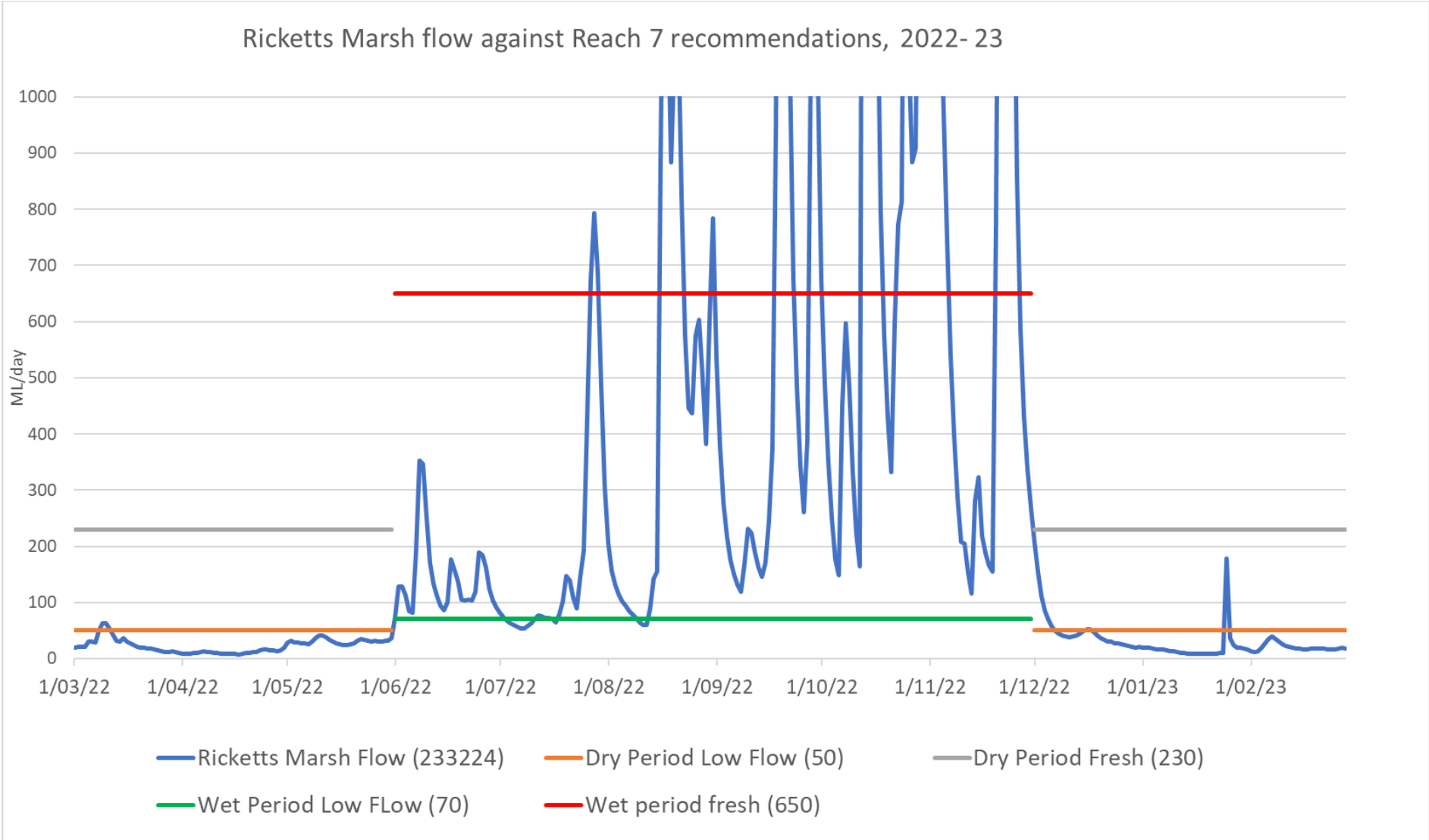


Figure 11. Daily average stream flow at Ricketts Marsh against reach 7 flow recommendations achieved 2022-23

The 2022-23 Priority Watering Actions and their compliance at the Flume Gauge (east branch) and Boundary Rd Forrest Gauge (west branch) is outlined below in Table 6.

Table 6. Environmental water program 2022-23 (as of February 20, 2023)

Flow priorities	Rate	Duration	Total released from entitlement	Achieved?	How?
Priority 1: East branch dry period low flow (Dec–May)	0.5-5ML/day	181 days	0ML	Yes.	So far this watering action has been achieved by natural flows. Corangamite CMA will continue to monitor and will commence releases from the environmental entitlement if required.
Priority 2: 1st fresh East branch dry period fresh	9ML/day + ramp days	2 days	0ML	Not yet achieved.	Planned for March. Passing flows will need to be low enough to allow for a ramp up and down.
Priority 2: 2nd fresh East branch dry period fresh	9ML/day + ramp days	2 days	0ML	Not yet achieved.	Planned for March. Passing flows will need to be low enough to allow for a ramp up and down.
Priority 3: West branch dry period low flow (Dec–May)	3-30 ML/day	181 days	219ML	Partially achieved.	Partially achieved through environmental releases and natural flows.

4.3 Hydrological achievement

Water monitoring gauges can be used to assess whether releases from the West Barwon Reservoir are meeting environmental flow recommendations downstream; and they are used to monitor compliance and inform planning and delivery. Flow compliance in the east branch is assessed using the East Barwon River @ Flume gauge. Flow compliance in the west branch is assessed using the West Barwon River @ Boundary Road Forrest gauge and reach 7 will continue to be monitored through the Barwon River @ Rickett's Marsh gauge, just downstream of Birregurra.

Although no environmental water was delivered over the wet period (June to November) during the 2022-23 water year, in the east branch a wet spring ensured that wet period low flow recommendations were partially met naturally (37% of the time). In the west branch, over the wet period, high rainfall in August-November allowed for some good natural flows, but overall, the base flow was still well short of the low flow recommendation for this period (100ML/day) (Figure 9). Data from the West Barwon River@Compensation Weir Spillway (233245) confirms that five wet period freshes were achieved naturally with a spilling reservoir (Figure 8). Flow recommendations below the confluence of the east and west branches at Ricketts Marsh were partially achieved. The wet period freshes were achieved naturally and winter baseflow was met 80% of the time. On 14th October, bankfull flow recommendations were met for a period of 2 days. Flow compliance for the current and previous years as measured at gauging points available is summarised in Table 7 (reach 4 – East Barwon River @ Flume), Table 8 (reach 3 – West Barwon River @ Boundary Rd), and Table 9 (reach 7 – Ricketts Marsh).

It should be noted that compliance for 2009-10 to 2017-18 was assessed against flow recommendations for reach 1– Upper Barwon River from the old FLOWS study (Lloyd, 2006), and during this time there was no environmental entitlement. The last four years have been assessed against the new flow recommendations for reach 7– Barwon River downstream of Boundary Creek from the FLOWS study update (Alluvium, 2021).

Table 7. Hydrological achievement of flows 2022-23 at the east branch (East Barwon River at u/s King Creek/ East Barwon River at Flume gauge)

Reach	Flow component (FLOWS, 2021)					Hydrological achievement of flow components
		19-20	20-21	21-22	22-23	
Upper Barwon east branch						Ecological outcomes/observations relating to the achievement of PWA in 2022-23
	Dry period low flow 0.5ML/day	E	E	OU	OUE	Flow achieved by passing/natural flow.
	Dry period fresh 35ML/day		OU		X	
	Wet period low flow 10ML/day		OU	OU	OU	Recommendations were achieved approximately 37% of the time naturally.
	Wet period fresh 160ML/day		OU	X	X	It is not possible to assess this component because the gauge topped out during a period of high flows (Flume gauge). It is possible that a fresh was achieved.
	Bankfull 800ML/day			X	X	It is not possible to assess this component because the gauge topped out during a period of high flows (Flume gauge). It is possible that a fresh was achieved.

	No significant part of the flow component achieved
	Flow component partially achieved
	Flow component has been completely achieved, i.e. complete duration, frequency and volume was achieved
E	Managed environmental water release
O	Consumptive water en route/other managed flow
U	Unregulated (natural)
X	Unknown at this stage

Table 8. Hydrological achievement of flows 2021-23 at the west branch (West Barwon River @ Boundary Road Forrest)

Reach	Flow component (FLOWS, 2021)			Hydrological achievement of flow components
Upper Barwon west branch		21-22	22-23	Ecological outcomes/observations relating to the achievement of PWA in 2022-23
	Dry period low flow 30ML/day			Did not achieve. Low flow releases of 6-20 ML/day for most of the dry period occurred since the start of February.
	Dry period fresh 100ML/day	X		
	Wet period low flow 100ML/day	X	U	Partially met through natural flow when reservoir was spilling. West Barwon River@Compensation Weir Spillway gauge was used to confirm this.
	Wet period fresh 330ML/day	X	U	Five freshes were achieved naturally whilst the reservoir was spilling. West Barwon River@Compensation Weir Spillway gauge was used to confirm this.
	Bankfull 2100ML/day	X	X	

	No significant part of the flow component achieved
	Flow component partially achieved
	Flow component has been completely achieved, i.e. complete duration, frequency and volume was achieved
E	Managed environmental water release
O	Consumptive water en route/other managed flow
U	Unregulated (natural)
X	Unknown at this stage

Table 9. Hydrological achievement of flow compliance over time at Ricketts Marsh (Conns Lane, Birregurra): 2009-2023

Flow Component (Lloyd, 2006) for reach 1: Upper Barwon River	Hydrological achievement of flow components over time 2009/10 to 2018/23										Ecological outcomes/observations relating to the achievement of PWA in 2022-23					
	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	Flow component (FLOWS, 2021) for reach 7: Barwon River d/s of Boundary Creek.						2018 -19
Summer low flow										Dry period low flow 50ML/day	UE	UE	UE	UE	UE	
Summer low flow freshes										Dry period fresh 230ML/day	E	U	U	U		
Winter baseflow										Wet period low flow 70ML/day	U	U	U	U	U	Winter low flow recommendations were met 80% of time.
Winter small high flow fresh										Wet period fresh 650ML/day	U	U	U	U	U	Five events (natural), all above recommended volume and two longer than recommended.
Large high flow fresh										Bankfull 3000ML/day		U	U	U	U	On October 14 th , with a flow of 3885 ML/d, and October 15 th with a flow of 6478ML/day, well over the recommended 3,000ML/d and would have achieved ecological outcomes.

	No significant part of the flow component achieved
	Flow component partially achieved
	Flow component has been completely achieved, i.e. complete duration, frequency and volume was achieved

E	Managed environmental water release
O	Consumptive water en route/other managed flow
U	Unregulated (natural)
X	Unknown at this stage

4.4 Key ecological observations

Associated studies where information can be extrapolated to infer possible outcomes associated with environmental water deliveries such as the VEFMAP program are outlined below. Corangamite CMA will continue to seek funding from investment sources for direct and relevant ecological monitoring for environmental water outcomes.

In 2020, Stage 6 of the Victorian Environmental Flows Monitoring and Evaluation Program (VEFMAP) led by the Arthur Rylah Institute (Tonkin et al., 2020), identified some of the patterns associated with fish responses to environmental flows across Victoria. Stage 6 is now complete, and Stage 7 will also look at how changing spring flow pulses and baseflow recommendations may affect fish retention and survival. Stage 7 will also focus on current knowledge gaps that are conceptual in the flow recommendations but untested, such as wetland connectivity, aquatic vegetation interactions and downstream eel migration. Stage 6 of VEFMAP identified some of the emerging patterns from environmental watering in Victoria (Table 10). The VEFMAP program does not comprehensively cover all systems in the state where environmental water is delivered. Representative systems are chosen for monitoring and assessment, with assumptions then made about similar systems such as the Upper Barwon. This information has been included and its relevance to the Upper Barwon River is addressed in Table 10.

Incidental observations are recorded where possible, and the following provides a summary of community observations and reports.

During the 2022-23 water year, Platypus, *Ornithorhynchus anatinus*, were recorded on the east branch (Tom Murphy, Barwon Water, personal communication) and on the west branch (Mariah Sampson, Deakin University, personal communication). Other fauna sightings included a Long-necked turtle, *Chelodina longicollis*, on the west branch and a Growling grass frog, *Litoria raniformis* on the east branch (Mariah Sampson, Deakin University, personal communication).

Further downstream in Birregurra, community sightings of Platypus have been confirmed at the Meadow and at Platypus Point as were native Freshwater crayfish holes on the common. Other observations in Birregurra included an increase in the number of Bush rats and Rabbits observed and there were sightings of multiple Echidnas, Brushtail possums, Microbats and Sugar gliders in the golf course precinct. Further afield, Kangaroos, Koalas, and Wallabies have been spotted in Bambra, Deans Marsh and Birregurra. Snakes, Blue tongue lizards, and Skinks are common this year and lots of Foxes and feral cats have been spotted on the river at night. This water year the bird observations on the river near the Birregurra Golf Course have been White faced herons raising three chicks, Yellow faced honeyeater, Common starling, Eastern yellow robin, Little corella, Galah, Blackbird, Little raven, Grey fantail, Pied currawong, Australian magpie, Grey shrike thrush, Brown thornbill, New holland honeyeater, Red wattlebird, Superb fairywren, Crimson rosella, Sulphur crested cockatoo, Eastern spinebill, Yellow tailed black cockatoo, Gang gang, Silvereye, Red browed finch, Yellow thornbill, Restless flycatcher, Wood ducks and Pardalotes nesting on the Heritage trail. Many Bower birds and Kookaburras, Sacred kingfishers also sighted in the township. (Lachlan Gordon, personal communication).

Table 10. Identified emerging patterns in environmental watering in Victoria and their relation to the Upper Barwon

ARI observations	Upper Barwon consideration
Given that high discharge rates in early spring increase the number of galaxiids in rivers, spring environmental flow releases are not expected to provide detectable benefits at the population scale within rivers when a large natural flow pulse has already occurred during spring. These environmental flow releases are best used in years with relatively low spring discharge (e.g. Werribee River in 2017).	This is not relevant to Upper Barwon system as there is insufficient entitlement to provide spring releases.
To provide conditions for upstream dispersal, instream habitat and survival of galaxiids and Tupong, maintain recent base flow targets that have been shown to provide enough depth for the upstream migration and sustain suitable water quality for galaxiids and Tupong.	Dry season base flow in the east branch is the priority watering action, given fish dispersal is not blocked by the reservoir wall.
Consider prioritising summer or early autumn freshes to provide connectivity for large-bodied species or, during high recruitment years (e.g. years with high spring flows for galaxiids), to enhance the upstream dispersal of juvenile diadromous fishes. However, sufficient base flows are considered a priority.	Summer or early autumn freshes are already prioritised according to the FLOWS study; however, flow constrictions and the limited nature of the entitlement mean that fresh releases will have limited effect on juvenile diadromous fishes in the middle to lower reaches.
Environmental base flows and fresh releases will not benefit upstream dispersal of diadromous fishes in rivers where barriers (natural or artificial) prevent their movement.	See comments above. This is also noted in the FLOWS study. Corangamite CMA has a program of prioritised fish barrier removal throughout the Barwon-Moorabool system and seeks funding to support this program.

4.5 Shared benefit review

This section should be read in conjunction with Section 3 which outlines how stakeholders' values are considered wherever possible in the environmental delivery of water. Table 11 provides more detail where benefits are general in nature and linked to the overall watering activities, and of specific outcomes achieved in 2022-23 water year, where they exist. Corangamite CMA is flexible in its delivery approach and aspires to achieve shared benefit opportunities that arise from the delivery and use of environmental water. Wherever possible, Corangamite CMA times releases to coincide with long weekends and school holidays.

As the environmental entitlement is small, the increased flow down the upper reaches of the Barwon River is small and mainly experienced through private farming property with direct access to the river. However, one community member stated that the river at Birregurra was quite extensively used for swimming in January and February; this is most likely due to high natural flows in the system. Further specific shared benefits were not reported however assumptions can be made that active and passive recreation benefits would occur downstream through the provision of water in the river, such as recreational fishing and walking.

Table 11. Shared benefits review

Beneficiary	Review of benefits / outcomes
Traditional Owners	<p>Traditional Owner wellbeing is closely tied to healthy Country. Environmental flows that support and improve the health of the Upper Barwon River may therefore benefit Traditional Owners. Values include maintaining healthy country, thriving culturally and increased population of significant species.</p> <p>Several of the cultural values and objectives for the Wadawurrung as outlined in Table 4 were supported in the 2022-23 watering year as a result of natural rainfall and the release of environmental flow, however it should be noted that the ability of the current releases to influence values on Wadawurrung Country is limited due to the small volume of the entitlement. These values include maintaining and improving the abundance of culturally significant species such as <i>Wad-dirring/Perridak</i> (Platypus), <i>Bunyia</i> (Eels), <i>Turrput</i> (native trout <i>galaxias spp</i>), <i>Ware-rap</i> (Blackfish), <i>Polango Warngare</i> (water ribbons <i>Triglochin procera</i>), <i>Tark</i> (common reed <i>Phragmites australis</i>), <i>Toolim</i> (Pale Rush <i>Juncus pallidus</i>), <i>Bal-yan</i> (Cumbungi <i>Typha latifolia</i>) and maintaining deep pools and confluences.</p>
Landholders	<p>Low flow releases and freshes delivered throughout the dry period will have contributed to prevent declines in water quality, potentially improving quality of supply for landholders who use the water for stock and domestic purposes. Environmental water may have assisted with maintaining a level of flow that mitigates invasive terrestrial vegetation intruding into the channel, which would cause constrictions and impact negatively on landholders' property as it could potentially cause flooding.</p>
Recreational users/environment groups/local businesses	<p>The dry period low flow released throughout summer and autumn in the west branch would have had a subtle freshening impact which may have improved water quality and connectivity. This may have benefited passive recreation for those participating in swimming, kayaking, bushwalking, camping or fishing.</p>

5. Environmental objectives and scope of environmental watering

The Upper Barwon Surface Water Advisory Group (UBSWAG) was established by Corangamite CMA to provide feedback on surface water management planning in the Upper Barwon River to achieve environmental outcomes. The primary responsibilities of the group are to actively participate in and contribute to discussions about surface water; provide advice on environmental water related research; and be a conduit for community feedback. In 2017, the UBSWAG endorsed the following environmental watering objective:

“To improve the Barwon River’s flow-dependent ecological values and services through the provision of environmental water. The delivery of environmental water will also provide for social and cultural values for future generations.” (UBSWAG endorsed long-term watering objective for the Upper Barwon, 2017).

Consistent with this objective, the purpose of the Upper Barwon Environmental Entitlement is to reduce the adverse impacts caused by the lack of adequate flows downstream of the West Barwon Reservoir storage in reaches 3, 4, 7, 9 and 10 as identified in the Upper Barwon, Yarrowee and Leigh Rivers FLOWS Study Update (Alluvium, 2021).

5.1 Water delivery objectives

The FLOWS study update (Alluvium, 2021) highlights that the volume of water in the environmental entitlement is insufficient to meet all the recommended flow components identified (Figure 12) and sets prioritised targets for water recovery to maintain and improve flow-dependent ecological values into the future.

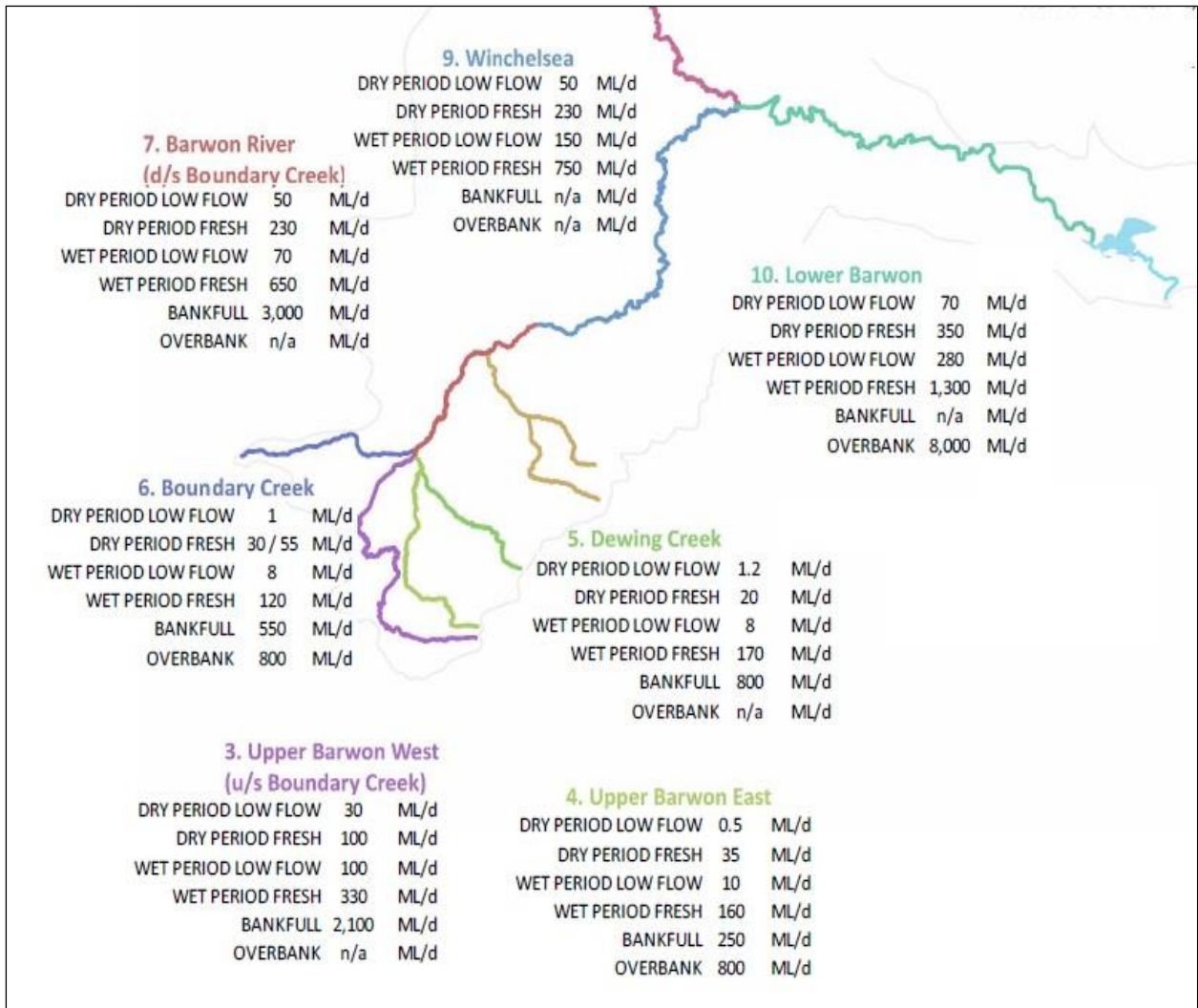


Figure 12. Flow recommendations for the Barwon River

Table 12 presents an overview of the reaches of the Barwon River that can be influenced by the entitlement. The priority of each reach is also presented.

Table 12. Environmental watering priorities and the Upper Barwon entitlement beneficiaries

Reach No.	Reach Name	Priority	Ability of entitlement to influence
3	Upper Barwon west (u/s Boundary Creek)	Moderate (as a means to get more water for reaches 9 and 10).	High
4	Upper Barwon east	High	High
7	Barwon River (d/s Boundary Creek)	Medium (not assigned a priority in the FLOWS study).	Medium
9	Winchelsea	Highest	Minor

The current environmental entitlement falls well short of the volume required to meet recommended flow components for all branches, and the physical location of the entitlement only allows provision of environmental water to the Upper Barwon east and west branches, and to a lesser extent the reaches immediately downstream, with diminishing effect. Water can reach the township of Winchelsea, however the river is prone to drying out, particularly downstream of Winchelsea before the Leigh River enters the system.

With the limited entitlement, Corangamite CMA will deliver the water available down the Upper Barwon east as a priority, then down the Upper Barwon west in order to deliver water through to priority reaches 7 and 9 located downstream. Delivery peaks will be modified to prevent flooding due to channel constricting weed infestations.

Delivery of this water will assist in supporting the environmental objectives defined in the FLOWS study update (Alluvium, 2021) as follows:

- Maintain or improve abundance, breeding and recruitment of migratory fish
- Maintain or improve abundance, breeding and recruitment of resident non-migratory fish
- Maintain or improve abundance, breeding and recruitment of macroinvertebrates as a food source for fish, frog and platypus populations
- Maintain or improve abundance, breeding and recruitment of Growling grass frog
- Improve condition and extent of Growling grass frog
- Maintain or improve, abundance, condition and extent of Platypus
- Maintain or improve condition, extent and diversity of in-stream, emergent, riparian and floodplain vegetation.

Given the current environmental entitlement falls well short of the volume required to meet recommended flow components for all branches and the channel constrictions limit the volume of environmental water that can be released before it causes flooding, it is unlikely that there will be significant improvements in the ecological condition of the river as a result of the watering actions in this proposal. Instead, the watering actions in this proposal aim to maintain the current ecological condition and prevent cease to flow events. There are initiatives in place that will help Corangamite CMA to work towards being able to meet the recommended flow regime and achieve the environmental objectives defined in the FLOWS Study update (Alluvium, 2021). This is captured in *Section: 7 Delivery Constraints* and *Section 8 Confounding Factors*. Because of the limitations to delivery, the environmental objectives listed above have been amended in each of the Priority Watering Actions in the table below (Table 13).

Helping to guide the prioritisation of environmental watering, key cultural objectives identified by the Wadawurrung for the reaches of the Barwon River that flow through Country downstream of Winchelsea can be found in section 3.1 *Aboriginal cultural values and uses of waterways*.

5.2 Flow recommendations and potential watering actions

The FLOWS study update (Alluvium, 2021) recommends a flow regime for the Upper Barwon River, consisting of a number of flow components to be delivered at specific flow rates, frequencies and seasonal timing. These are the basis for the potential watering actions in any given year, which are limited by the size of the environmental entitlement itself.

Potential watering actions produce an ‘expected watering effect’ in the river that will help to achieve an environmental objective. The ‘expected watering effects’ relate to physical, chemical, biological or behavioural responses to specific components of the watering regime. Environmental objectives, such as *‘Maintain or improve abundance, breeding and recruitment of migratory fish’*, are measurable outcomes that are not solely linked to environmental watering and are often achieved through a range of complementary management activities, such as instream and riparian improvements (See Section 8 Confounding Factors).

Flow prioritisation is an important part of flow delivery planning for the Upper Barwon River due to the limited amount of water available within the entitlement and to ensure the water is used for the greatest environmental benefit. The FLOWS study update (Alluvium, 2021) was developed to determine the volume, priority and ecological objectives for flow components in the Barwon River under different climatic scenarios. It prioritises flows in the following order, with flows in the east branch prioritised over the west:

1. provision of dry season low flows
2. provision of dry season freshes
3. provision of wet season freshes
4. provision of wet season low flow.

Whilst the FLOWS study update (Alluvium, 2021) recommends delivering all the Upper Barwon east branch flow recommendations before putting water down the west, these priorities are a trade-off, particularly considering the flow volume limitations of the Upper Barwon east branch preventing delivery of wet period freshes, bankfull and overbank recommendations; the exception being the ability to supplement wet period low flow. On balance, provision of water down both upper branches in the dry period is prioritised as the only practicable option.

The potential watering actions for the coming water year are detailed in Table 13. The table reflects the potential watering actions in order from highest to lowest priority. It is expected that with an average year forecast and the limited entitlement, there will only be enough water for priorities 1 to 4. Priority 4 may occur if the West Barwon Reservoir continues to fill with rainfall. If climate conditions change as the water year progresses, flow planning may be amended to reflect revised water availability. Refer to Appendix 5 for more detail. Flow volumes represent the in reach recommendation and will include any natural or passing flow. Corangamite CMA is currently developing a Risk Management Guidance Note in consultation with the VEWH to document all the factors to be considered when planning a release. These include the other forms of flows referenced above, climate, seasonal conditions, weather forecasts and recent works and observations.

Table 13. Potential watering actions for 2023-24

Potential watering action	Priority 1: Dry period low flow (Dec-May 0.5-5ML/day) – east branch/ reach 4				
Measurement Point	EAST BARWON RIVER @ FLUME (233268)				
Expected watering effects	<ul style="list-style-type: none"> • Provide minimum velocity to maintain mixing in pool • Provide water in pools for habitat and food sources • Provide pool habitat • Maintain adequate depth of permanent water in channel, with natural seasonal drawdown to promote recruitment. • Maintain adequate depth of permanent water in stream channel to limit terrestrial encroachment into aquatic habitats • Maintain a shallow water table with low salinity throughout the year 				
Environmental objectives	<ul style="list-style-type: none"> • Maintain abundance of resident freshwater fish, including galaxias, smelt, big-headed gudgeon and Yarra pygmy perch. • Maintain abundance of Platypus • Maintain or improve condition and extent of instream vegetation to provide structural habitat for macroinvertebrates and various fish species. • Maintain or improve condition, extent, and diversity of emergent macrophyte vegetation to provide structural habitat and channel/lower bank stability to low and moderate flows. • Maintain or improve condition and extent of floodplain vegetation as part of endangered EVCs. • Reduce prolonged stratified conditions in pools and promote adequate levels of water quality to allow fish and macroinvertebrate populations to persist 				
Application of potential watering action in 2023-24		Magnitude (ML)	Duration (days)	Frequency (per year)	Timing (months)
	Dry	0.5 to 5 ML/day	Continuous	Continuous	Dec to May
	Average	0.5 to 5 ML/day	Continuous	Continuous	Dec to May
	Wet	0.5 to 5 ML/day	Continuous	Continuous	Dec to May
Rationale for proposed application in 2023-24	This flow is required for the survival of high value species; to provide essential habitat for aquatic fauna; and to provide moisture to instream and emergent macrophyte vegetation. The water entitlement must be delivered down the Upper Barwon east or Upper Barwon west branches, and the Upper Barwon east branch has been identified as the higher priority. Dry period low flow is the highest flow priority. A flow release range up to 5ML/day has been proposed to achieve the average in-reach recommendation of 0.5ML/day.				

Potential watering action	Priority 2: Dry period freshes (Dec-May modified from 35ML/day to 6-9ML/day for 2 days) – east branch/ reach 4				
Measurement Point	EAST BARWON RIVER @ FLUME (233268)				
Expected watering effects	<ul style="list-style-type: none"> • Provide water over riffles to allow fish to move between pools to breed, feed and find new habitats • Submerge and clean woody debris and hard surfaces to provide breeding substrate • Sustain macroinvertebrate communities during the dry period • Provide longitudinal connectivity between reaches • Provide a mosaic of spatially and temporally differentially wetted areas within stream channel, on benches and on lower banks • Support growth on terraces, channel edge and lower bank • Provide minimum velocity to establish mixing of pools • Mobilise sediment from base of pools 				
Environmental objectives	<ul style="list-style-type: none"> • Maintain abundance of resident freshwater fish, including galaxias, smelt, big-headed gudgeon and Yarra pygmy perch. • Maintain breeding and recruitment of resident freshwater fish including River blackfish. • Maintain abundance of macroinvertebrates as a food source for fish, frog and platypus populations. • Maintain condition and extent of Platypus. • Maintain condition, extent, and diversity of emergent macrophyte vegetation to provide structural habitat and channel/lower bank stability to low and moderate flows. • Maintain condition, extent, and diversity of riparian vegetation as part of endangered Ecological Vegetation Class' (EVC). • Reduce prolonged stratified conditions in pools and promote adequate levels of water quality to allow fish and macroinvertebrate populations to persist. • Maintain abundance and condition of pools, large wood and riffles to provide structural habitat for macroinvertebrates and various fish species. • Maintain channel capacity, shape and form to support flora and fauna values and objectives. 				
Application of potential watering action in 2023-24		Magnitude (ML)	Duration (days)	Frequency (per year)	Timing (months)
	Dry	6 to 9 ML/day	2	2	Dec to May
	Average	6 to 9 ML/day	2	2	Dec to May
	Wet	6 to 9 ML/day	2	3	Dec to May
Rationale for proposed application in 2023-24	<p>These freshes provide flushes that assist in maintaining adequate water quality and the opportunities for migration of fish and other fauna. Without these freshes, there is the potential for regional extinction and many species will not be able to move to new habitats and reproduce. The flows recommendation states peak fresh volume of 35ML/day however flow constrictions in the Upper Barwon east branch will only allow delivery of considerably less than 35ML/day to prevent localised flooding. Peak fresh volumes will be modified based on delivery experience gained from the previous water years and 'real time' local knowledge around constriction impacts and management. In the 2019-20 water year 9ML/day passed down the east branch within the channel, however 15ML/day did not. Watering action will be released at 9ML/day to avoid flooding.</p>				

Potential watering action	Priority 3: Dry period low flow (Dec-May 3-30ML/day, as water availability permits) – west branch/ reach 3				
Measurement Point	West Barwon River @ Boundary Road Forrest (233255)				
Expected watering effects	<ul style="list-style-type: none"> • Provide water in pools for habitat and food sources • Provide pool habitat • Maintain adequate depth of permanent water in channel, with natural seasonal drawdown to promote recruitment. • Maintain adequate depth of permanent water in stream channel to limit terrestrial encroachment into aquatic habitats • Maintain a shallow water table with low salinity groundwater throughout the year • Provide minimum velocity to maintain mixing in pool 				
Environmental objectives	<ul style="list-style-type: none"> • Maintain abundance of migratory fish including Short-finned eels, Australian grayling, and Tupong. • Maintain abundance of resident freshwater fish, including Galaxias, Smelt, Big-headed gudgeon and Yarra pygmy perch. • Maintain abundance of Platypus • Maintain condition and extent of instream vegetation to provide structural habitat for macroinvertebrates and various fish species. • Maintain condition, extent, and diversity of emergent macrophyte vegetation to provide structural habitat and channel/lower bank stability to low and moderate flows. • Maintain condition and extent of floodplain vegetation as part of endangered EVCs. • Reduce prolonged stratified conditions in pools and promote adequate levels of water quality to allow fish and macroinvertebrate populations to persist. 				
Application of potential watering action in 2023-24		Magnitude (ML)	Duration (days)	Frequency (per year)	Timing (months)
	Dry	3 to 30 ML/day	Continuous	Continuous	Dec to May
	Average	3 to 30 ML/day	Continuous	Continuous	Dec to May
	Wet	3 to 30 ML/day	Continuous	Continuous	Dec to May
Rationale for proposed application in 2023-24	<p>Low flows are required for the survival of high value species, to provide essential habitat for aquatic fauna and to provide moisture to instream and emergent macrophyte vegetation. While the next priority in the FLOWS study is wet period freshes, such freshes cannot be delivered down the Upper Barwon east branch due to flow constrictions. It has therefore been decided that delivering dry period low flow down the Upper Barwon west branch should be the next priority. The flows recommendations state 30ML/day however it is likely to be delivered at a much lower rate of up to 30ML/day due to the small entitlement. Combined with the releases down the Upper Barwon east, this priority watering actions will help avoid cease to flow events in the higher priority Winchelsea reach downstream.</p>				

Potential watering action	Priority 4: Wet period low flow (June-Nov modified from 10ML/day to 1-9ML/day, as water availability permits) – east branch/ reach 4				
Measurement Point	East Barwon River @ Flume (233268)				
Expected watering effects	<ul style="list-style-type: none"> • Mobilise sediment from base of pools for sustained duration • Provide water in pools for habitat and food sources • Provide pool habitat • Maintain adequate depth of permanent water in the channel, with natural seasonal draw down to promote recruitment • Maintain adequate depth of permanent water in stream channel to limit terrestrial encroachment into aquatic habitats • Maintain a shallow water table with low salinity groundwater throughout the year • Provide minimum velocity to maintain mixing in pool 				
Environmental objectives	<ul style="list-style-type: none"> • Maintain channel capacity, shape and form to support flora and fauna values and objectives. • Maintain abundance of resident freshwater fish, including Galaxias, Smelt, Big-headed gudgeon and Yarra pygmy perch. • Maintain abundance of Platypus. • Maintain condition and extent of instream vegetation to provide structural habitat for macroinvertebrates and various fish species. • Maintain condition, extent and diversity of emergent macrophyte vegetation to provide structural habitat and channel/lower bank stability to low and moderate flows. • Maintain condition and extent of floodplain vegetation as part of endangered EVCs. • Reduce prolonged stratified conditions in pools and promote adequate levels of water quality to allow fish and macroinvertebrate populations to persist. 				
Application of potential watering action in 2023-24		Magnitude (ML)	Duration (days)	Frequency (per year)	Timing (months)
	Dry	1 to 9 ML/day	Continuous	Continuous	June to Nov
	Average	1 to 9 ML/day	Continuous	Continuous	June to Nov
	Wet	1 to 9 ML/day	Continuous	Continuous	June to Nov
Rationale for proposed application in 2023-24	As mentioned above, low flows are required for the survival of high value species, to provide essential habitat for aquatic fauna and to provide moisture to instream and emergent macrophyte vegetation. The water entitlement must be delivered down the Upper Barwon east or Upper Barwon west branches, and the Upper Barwon east branch has been identified as the higher priority. The flows recommendations state 10ML/day however the watering action will be reduced to 1 to 9ML/day to avoid flooding.				

Potential watering action	Priority 5: Dry period fresh (Dec-May modified from 100ML/day to 20-30ML/day for 6 days x5) – west branch/ reach 3				
Measurement Point	West Barwon River @ Boundary Road Forrest (233255)				
Expected watering effects	<ul style="list-style-type: none"> • Provide water over riffles to allow fish to migrate upstream from estuary • Provide water over riffles to allow fish to move between pools to breed, feed and find new habitats • Submerge and clean woody debris and hard surfaces to provide breeding substrate • Sustain macroinvertebrate communities during the dry period • Provide longitudinal connectivity between reaches • Provide a mosaic of spatially and temporally differentially wetted areas within stream channel, on benches and on lower banks • Support growth on terraces, channel edge and lower bank • Provide minimum velocity to establish mixing of pools • Mobilise sediment from base of pools 				
Environmental objectives	<ul style="list-style-type: none"> • Maintain abundance of migratory fish including short-finned eels, Australian grayling, and Tupong. • Maintain abundance of resident freshwater fish, including Galaxias, Smelt, Big-headed gudgeon and Yarra pygmy perch. • Improve breeding and recruitment of resident freshwater fish including River blackfish. • Maintain abundance of macroinvertebrates as a food source for fish, frog and Platypus populations. • Maintain condition and extent of Platypus. • Maintain condition, extent, and diversity of emergent macrophyte vegetation to provide structural habitat and channel/lower bank stability to low and moderate flows. • Maintain condition, extent, and diversity of riparian vegetation as part of endangered EVCs. • Reduce prolonged stratified conditions in pools and promote adequate levels of water quality to allow fish and macroinvertebrate populations to persist. • Maintain abundance and condition of pools, large wood and riffles to provide structural habitat for macroinvertebrates and various fish species. • Maintain channel capacity, shape and form to support flora and fauna values and objectives. 				
Application of potential watering action in 2023-24		Magnitude (ML)	Duration (days)	Frequency (per year)	Timing (months)
	Dry	20 to 30 ML/day	6	5	Dec to May
	Average	20 to 30 ML/day	6	5	Dec to May
	Wet	20 to 30 ML/day	8	6	Dec to May
Rationale for proposed application in 2023-24	<p>As above, after all the flow components that can be physically delivered down the Upper Barwon east branch have been achieved, the next priority is to target a dry period fresh down the Upper Barwon west branch following a dry period low flow. These freshes provide flushes that assist in maintaining adequate water quality and the opportunities for migration of fish and other fauna. Without these freshes, there is the potential for regional extinction and many species will not be able to move to new habitats and reproduce. The flows recommendations state 100ML/day however the watering action will be reduced to 20-30ML/day due to current restrictions. As weed choke points are removed release volumes will be increased from 20ML/day. Corangamite CMA will monitor flows during the 2023-24 water year to see how the river behaves when natural flows of 30ML/day are achieved. Corangamite CMA will check for flooding of public and private infrastructure to see if environmental flows of up to 30ML/day is possible if water in the entitlement was available.</p>				

Potential watering action	Priority 6: Wet period low flow (June-Nov modified from 100ML/day to 20-30ML/day) – west branch/ reach 3				
Measurement Point	West Barwon River @ Boundary Road Forrest (233255)				
Expected watering effects	<ul style="list-style-type: none"> • Mobilise sediment from base of pools for sustained duration • Provide water in pools for habitat and food sources • Provide pool habitat • Maintain adequate depth of permanent water in the channel, with natural seasonal drawdown to promote recruitment • Maintain adequate depth of permanent water in stream channel to limit terrestrial encroachment into aquatic habitats • Maintain a shallow water table with low salinity groundwater throughout the year • Provide minimum velocity to maintain mixing in pool 				
Environmental objectives	<ul style="list-style-type: none"> • Maintain channel capacity, shape and form to support flora and fauna values and objectives. • Maintain abundance of migratory fish including Short-finned eels, Australian grayling and Tupong. • Maintain abundance of resident freshwater fish, including Galaxias, Smelt, Big-headed gudgeon and Yarra Pygmy perch. • Maintain abundance of Platypus. • Maintain condition and extent of instream vegetation to provide structural habitat for macroinvertebrates and various fish species. • Maintain condition, extent and diversity of emergent macrophyte vegetation to provide structural habitat and channel/lower bank stability to low and moderate flows. • Maintain condition and extent of floodplain vegetation as part of endangered EVCs. • Reduce prolonged stratified conditions in pools and promote adequate levels of water quality to allow fish and macroinvertebrate populations to persist. 				
Application of potential watering action in 2023-24		Magnitude (ML)	Duration (days)	Frequency (per year)	Timing (months)
	Dry	20 to 30 ML/day	Continuous	Continuous	June to Nov
	Average	20 to 30 ML/day	Continuous	Continuous	June to Nov
	Wet	20 to 30 ML/day	Continuous	Continuous	June to Nov
Rationale for proposed application in 2023-24	As mentioned above, these flows play an important role in channel shape and form over long time scales. Failure to provide these flows over long periods of time may result in reduction of available habitat due to deposition of material in pools and other changes in channel form. While the next flow component priority after dry period freshes is wet period freshes, these are undeliverable at anywhere near the recommended volume of 100ML/day, with the current restrictions. Wet period low flow is therefore the next priority and can be achieved in a modified form if the water is available, at approximately 20-30ML/day.				

6. Scenario Planning

6.1 Outlook for 2023-24

The Barwon South West region has a temperate climate, with mild to warm summers and cold winters. Summer average maximum temperatures are around 22-24°C near the coast and in elevated areas, and 25-27°C inland. Winter average maximum temperatures are around 12-14°C. Rainfall occurs mostly in winter and spring and is generally the result of rain-bearing weather systems coming from the west (DELWP, 2015). Regarding long term climate projection (DELWP & CSIRO, 2019), based on a medium (RCP4.5) emissions scenario, annual rainfall totals are likely to decline by 25% by the end of the decade, with the greatest drying to occur in spring. As warming continues, more heat extremes will occur.

Australia's temperature and rainfall variability are influenced by global warming caused by human activities, with the nation's climate warming by around 1.47 °C ± 0.24 since 1910 (BOM, 2022). In 2023, the BOM (2023) predicts March to May and April to June is likely to have below median rainfall in southwest Victoria. Minimum temperatures for March to May and April to June are likely to be warmer than the median in southwest Victoria. The long-range forecast reflects the status and outlook for La Niña declining in the Pacific Ocean and the positive Southern Annular Mode (SAM) returning to neutral.

Given the climate predictions for this year and the relative unpredictability of what this means locally, the FLOWS study update (Alluvium, 2021) recommendations for the Upper Barwon will be in line with an 'average year' and will be prioritised based on the available entitlement. In a year of potential unknowns regarding rainfall, a priority-based regime will attempt to avoid multiple loss of fauna and flora. Regular monitoring of water levels and discharge through DEECA's Water Measurement Information System (WMIS) and field observations will be important to determine the best time to release and in what volume.

In the event of flooding, environmental flows will not be delivered. In the event of low or high flow in the catchment, the flow planning would be reassessed against the recommendations to determine a new priority for flow releases.

6.2 Scenario planning

Planning for this year's environmental watering has been tailored to average rainfall conditions (see Section 4.1) but may be adapted if conditions change. The average year scenario has been highlighted in Table 14, which outlines how achievement of priorities may change under a range of resource availability and climate scenarios. In the driest scenarios, the priority is to avoid critical losses or catastrophic events, while in wetter years the priority is to maximise recruitment, build resilience and maintain geomorphic processes. The ecological objectives of environmental watering under different climates are developed through consideration of impacts from three different seasonal outcomes, ranging through dry, average and wet.

The analysis of hydrological compliance over recent years (Section 4), shows typically a shortage of water availability especially over the dry months. Depending on climatic conditions it is expected that all the available entitlement will be delivered or held in drought reserve (500ML) over this dry

period, which means wet period flows are reliant on rainfall events. There will be an increased capacity to meet a larger number of priority flow components in wetter years as more elements will be met by naturally occurring flows. Because the current entitlement only secures a fraction of the river's water requirements, the achievement of environmental flow components is largely dependent on the prevailing climate during the 2023-24 water year.

Table 14. Planning of environmental watering under different climate scenarios

UPPER BARWON	Dry	Average (predicted)	Wet
Expected availability of environmental water	Assumptions. <ul style="list-style-type: none"> Starting volume 2000ML 500ML of inflows <p>Estimated available environmental water = 2500ML</p>	Assumptions. <ul style="list-style-type: none"> Starting volume 2000ML 1000ML of inflows <p>Estimated available environmental water = 3000ML</p>	Assumptions. <ul style="list-style-type: none"> Starting volume 2000ML 1500ML of inflows <p>Estimated available environmental water = 3500ML</p>
Expected river conditions (including unregulated water, consumptive water, etc.)	Disconnected pools in some parts during first half of the year. Cease to flow events. Disconnected refuge habitat pools Little to no passing flows over summer.	Some passing flows (~50%) over summer, high peaks in winter months. Good connectivity especially in winter and spring.	Full passing flows being released. Good connectivity year-round. Possibility of a spilling reservoir.
Logic for scenario	The logic here is the same as for the drought scenario, but it is assumed that some inflows will be received and that conditions will be slightly less dry, allowing less water to be used to achieve watering actions in the east branch.	Under this scenario, flow compliance in the east branch can be maintained with lower releases again, due to a wetter system and passing flows. It is assumed that passing flows will also contribute to west branch flows.	The logic here is the same as for the average scenario, but <i>greater</i> benefits can be provided to the upper west branch and lower reaches due to greater volume of water available for delivery and the likelihood of east branch flow components being met naturally.
Tier 1a Potential watering actions: expected to be delivered in 2023-2024	<ul style="list-style-type: none"> Priority 1 – East branch dry period low flow 0.5-5 (may need 2.5 ML/day release to achieve 0.5 ML/day in channel) Priority 2– East branch dry period freshes x 2- 6 to 9 ML/day (constraints up to 9 ML/day) for 2 days. Priority 3– West branch dry period low flow up to 8 ML/day (modified volume) 	<ul style="list-style-type: none"> Priority 1 – East branch dry period low flow 0.5-5 (may need 1.5 ML/day release to achieve 0.5 ML/day in channel) Priority 2– East branch dry period freshes x 2 – 6 to 9 ML/day (constraints allow up to 9 ML/day) for 2 days. Priority 3– West branch dry period low flow up to 12 ML/day (modified volume) 	<ul style="list-style-type: none"> Priority 1 – East branch dry period low flow 0.5-5 (release 0 ML/day)- achieved naturally Priority 2– East branch dry period freshes x 3 – 6 to 9 ML/day– achieved naturally. Priority 3– West branch dry period low flow up to 20 ML/day (modified volume). Priority 4– East branch wet period low flow 1 to 9 ML/day (modified volume) (achieved naturally)
Tier 1a environmental water demand	1,947ML	2,513ML	2,986ML

UPPER BARWON	Dry	Average (predicted)	Wet
Tier 1b Potential watering actions: delivery is reliant on additional water/resources becoming available in 2023-2024	<ul style="list-style-type: none"> • Priority 3– West branch dry period low flow topped up to 20 ML/day (modified volume) • Priority 4– East branch wet period low flow 1 - 9 ML/day (modified volume) • Priority 5– West branch dry period fresh (modified volume) 20 ML/day for 6 days x 5 • Priority 6– West branch wet period low flow 20ML/day (modified volume) 	<ul style="list-style-type: none"> • Priority 3– West branch dry period low flow topped up to 20 ML/day (modified volume) • Priority 4– East branch wet period low flow 1 - 9 ML/day (modified volume) • Priority 5– West branch dry period fresh (modified volume) 20 ML/day for 6 days x 5 • Priority 6– West branch wet period low flow 20 ML/day (modified volume) 	<ul style="list-style-type: none"> • Priority 5– West branch dry period fresh (modified volume) 20 ML/day for 8 days x 6 • Priority 6– West branch wet period low flow 20 ML/day (modified volume)
Tier 1b environmental water demand	6,697ML	4,308ML	2,896ML
Potential environmental watering – tier 2	NA (current physical constraints do not allow for tier 2 watering actions)	NA (current physical constraints do not allow for tier 2 watering actions)	NA (current physical constraints do not allow for tier 2 watering actions)
Tier 2 environmental water demand	NA	NA	NA
Priority carry over requirement	500ML	500ML	500ML

7. Delivery constraints

7.1 Temporary constraints

Although there are few potential temporary constraints that inhibit delivery, risks are identified prior to and reviewed throughout the year. Potential risks associated with climate events, such as fire, flood and heatwaves may negatively impact the water quality and availability. There is no indication that this year will be dry, however given the climate unpredictability, temporary constraints may be revealed throughout the 2023-24 year (outlined below in Table 15).

Table 15. Potential temporary constraints to environmental water delivery

Potential temporary constraint	Impact on watering	Action
Weed removal works	Potential impact on low flow and fresh delivery	Corangamite CMA conducts an integrated catchment management program that incorporates willow, glyceria and riparian management with the delivery of environmental water. Barwon Water are a delivery partner so we will work collaboratively to determine if any works are likely to impact environmental water delivery options.
Systematic landscape-scale in-channel weed infestations	Interrupt environmental water passing further downstream and spot works associated	Corangamite CMA conducting works on site to deal with specific weed infestation, potentially results in reduced volumes of environmental water to facilitate works. Water delivery is discontinued if it is considered that there will be detrimental effects, such as private land inundation.
Blue-green algal bloom in storage reservoir	Interruption to environmental watering, may result in delays.	Water delivery process and schedule will assessed and revised if necessary.
Fire in the catchment or adjacent to the river.	Interruption to environmental watering, depending on scale of fire will determine significance.	Water delivery discontinued if it is considered that there will be detrimental effects, such as water quality issues to the river or further downstream.
Flood warnings	Interruption to environmental watering.	In the event of a flood watch or flood warning issued by the Bureau of Meteorology, all environmental releases will be stopped.

7.2 Systemic constraints

7.2.1 Flow constriction and diversion points

The FLOWS study update (Alluvium, 2021) highlights that many complementary actions will be required to realise the full effectiveness of the environmental entitlement, in particular ‘fresh’ events. For example, the dry period fresh flow peak for the east branch has been reduced from 35ML/day to 9ML/day. The need for modification of planned flow releases has been demonstrated in previous watering years in both branches where despite the flow rate being significantly reduced each season, some flooding was still experienced. The flooding appeared to be caused by in-channel flow constrictions such as choking Willows and Glyceria, and to a lesser extent, old channel diversions to

restricting infrastructure points. See section 8.1 and 8.2 for more information. Water delivery is discontinued if it is considered that there will be detrimental effects, such as private land inundation.

The Central and Gippsland Sustainable Water Strategy (DELWP, 2022), is a significant strategy for the Upper Barwon as sustainable water strategies enable long term water resource planning for Victoria's water resources and can be a vehicle for recovering more water for the environment. The strategy addresses the issue of flow constriction in Action 8.4.

Action 8-4: Improving waterway health in the Barwon River (Short term: by 2027)

The Victorian Government will improve waterway health in the Barwon River, increase the effectiveness of environmental water releases and address constraints to their delivery by:

- *investigating options to improve native fish migration at Buckley Falls*
- *restoring channel form and removing willows and reed sweet-grass from the upper Barwon River*
- *investigating risks of releasing higher volumes of water and prioritising works to mitigate them.*

7.2.2 Allocation

The FLOWS study update (Alluvium, 2021) recommends a water recovery target of 28.6GL for the Barwon River to get back to 70% of natural flow and meet ecological requirements. Therefore, the current allocation is significantly insufficient to meet the river's health requirements. The Central Gippsland Region Sustainable Water Strategy (DELWP, 2022) acknowledges that the allocation of 1GL/year delivers only a small portion of the recommended summer flows for the east and west branches of the upper Barwon River and in Policy 8-3 states that by 2032, the Victorian Government will return up to 5GL of water for the environment in the Barwon River to improve waterway health.

The Upper Barwon Environmental Entitlement 2018 allows for a 2,000ML share of the total storage capacity of the West Barwon Reservoir and allows for storage of 3.8% of the flow into the reservoir, up to the 2,000ML. Modelling has shown that this will typically be about 1,000ML of water each year, but theoretically up to 2,000ML or more could be available if a portion of the stored allocation was used and the 2,000ML storage allocation refilled. Corangamite CMA will however aim to always keep approximately 500ML in storage in case of drought.

7.2.3 Barwon Water delivery infrastructure limitations

Although the West Barwon Reservoir is situated on the Upper Barwon west branch, water can be released down the Upper Barwon east branch (through a diversion tunnel) as well as to the Upper Barwon west branch. Due to the manual operation of gates on the inlet to the tunnel and the diversion weir on the west branch there is limited control of flow through the gate system into the tunnel at low flows. For this reason, it is very difficult to accurately deliver low flow environmental transfers to the east branch when the minimum passing flow for the Bulk Entitlement (Upper Barwon System) is "Pass natural flow". This reduces Barwon Water and the Corangamite CMA's ability to deliver environmental water efficiently and manage the risk associated with delivering low flow environmental water releases on top of fluctuating natural flows in the East Barwon River and the potential for minor inundation of private property.

As operators of the West Barwon Reservoir, Barwon Water reports that the maximum release capacity from the reservoir is 320ML/day, with 140ML/day down the Upper Barwon east branch. This is not a

systematic constraint now, due to channel capacity limitations further downstream. Barwon Water and Corangamite CMA are liaising to ensure any modification of the environmental weir takes into consideration opportunities to simplify/improve the management and delivery of environmental releases. A return of up to 5GL of water for the environment in the Barwon River by 2032 (DELWP, 2022) will need to be considered when planning upgrades to Barwon Water delivery infrastructure.

8. Confounding factors

Flow alteration is one of many factors that affect the environmental condition of the Upper Barwon and many environmental watering objectives will not be fully achieved unless other impacts are adequately addressed. In the Upper Barwon system, there are multiple confounding factors that impact negatively on the river's health that cannot be mitigated by the entitlement alone. Confounding factors can be resolved between agencies and other stakeholders.

The Upper Barwon project is a newly established integrated catchment management project under the Barwon Flagship that will work with many stakeholders to address flow restrictions through riparian management as part of a long-term program.

8.1 Flow Constrictions

Following review of the environmental flow requirements for the Upper Barwon, Yarrowee and Leigh Rivers (Alluvium, 2021), release of the first environmental flows caused some inundation of private properties. This flooding was caused by in-channel flow constrictions from invasive species such as Willow and Glyceria and historic channel diversions and infrastructure. These flow constrictions prevent optimal delivery of the entitlement through the east and west branches of the river and have forced Corangamite CMA to reduce the volumes of many flow components in these branches to avoid flooding.

In response to flooding and the temporary closure of Birregurra-Forrest Road in 2021, a modelling exercise was completed to determine what impact targeted removal of instream Glyceria and Willows would have on flow in the west branch of the Upper Barwon River (Alluvium, 2021a). The final report by Alluvium recommended that to help alleviate backwatering, Corangamite CMA remove an infestation of Glyceria upstream and downstream of Birregurra-Forrest Road and two willow blockages in the reach downstream of the road. In Autumn 2022, Corangamite CMA removed Glyceria from a 2.6km stretch of river and removed six willows downstream of the road. In the summer months of 2022-23, Corangamite CMA has completed spray treatment of the site and plan to revegetate in winter/spring 2023. Further removal of Willows is planned on the east and west branch of the Upper Barwon River in 2023-24. (Angus Donaldson, CCMA, personal communication)



Figure 13. Photos taken before (left) and after (right) removal of Glyceria by Corangamite CMA in the west branch of the Upper Barwon River in 2022.

On the east branch, Barwon Water removed 3.5km of willows during the summer of 2021-22 to improve water transfer for the supply system. Barwon Water is delivering additional willow removal and river remediation works on a 500m reach of the east branch, downstream of the Wurdee Boluc offtake and recently completed willow removal. The works will include removing more willows and weeds, grade control, channel excavation and stabilisation works and riparian revegetation. The detailed design plans have been confirmed and the Cultural Heritage Assessment completed. Barwon Water is continuing to engage with landholders and the community and is developing the project delivery and procurement strategy in preparation for on ground works to be completed over the 2023/24 summer period. The Wurdee Boluc channel may be utilised to divert the natural flows and transfer environmental flows around the impacted reach during construction however this will be confirmed during the construction planning (Brigid Creasy, Barwon Water, personal communication).

8.2 Riparian Rehabilitation

Healthy land supports healthy waterways. Water quality, bank stability and habitat can decline due to a lack of adequate riparian vegetation surrounding the river channel. As many parts of the Barwon River run through agricultural properties, there are degraded riparian zones that negatively impact on the river's health. In order to mitigate these impacts, Corangamite CMA works directly with landholders to fence off the riparian zone to keep stock away from the waterway and replant and revitalise native vegetation.

The Corangamite CMA funds waterway protection and restoration works with incentives available for fencing, weed control and revegetation. Riparian restoration is a significant component of the Barwon Flagship project but so far there has been no uptake of incentives available to landholders in the project area. In response, the Corangamite CMA funded Monash University to conduct a series of in-depth interviews with landholders in the upper Barwon River catchment to inform how the Corangamite CMA can work with them to increase the uptake of fencing accompanied by weed management and revegetation works (Monash University, 2021). The study revealed several barriers to participation in the previous Corangamite CMA funding model of river restoration works and has led to a new model being trialled on the Upper Barwon with project requirements being different to the past. One of the major differences is riparian buffer widths have halved from of 20 metres to an average of 10 meters. This new riparian works trial started in 2022 and will run over two years. The trial is targeted toward engaging landowners with sites located on the waterway frontage of the east and west branch of the Upper Barwon River.

8.3 Fish Barriers

In the Upper Barwon system, there are several barriers to fish passage. This includes weirs, dams and obsolete structures that limit fish migration. To mitigate these impacts, removal or modification will be required. Along with other agencies, Corangamite CMA will seek to remediate these barriers where funding and resources are available.

9. Increasing knowledge

Increasing our knowledge and addressing priority knowledge gaps is an important part of managing risks associated with environmental water delivery. Corangamite CMA regularly reviews knowledge needs to enable the organisation to plan for and deliver environmental water in an adaptive and effective manner.

Recent studies undertaken for the Upper Barwon River that have supported environmental water delivery include:

- **The platy-project** (ACF, 2022)
 This is a citizen science project coordinated by the Australian Conservation Foundation. Citizen scientists help researchers fill knowledge gaps by visiting priority areas, looking for platypuses, and uploading their findings to the University of New South Wales' platypus sighting database <https://platy-project.acf.org.au/>. Recent and historic sightings on the Upper Barwon River are visible on the database.
- **Upper Barwon Eel Investigation** (ARI, 2021).
 This study collected baseline data on short-finned eel and various fish populations in the West Barwon Reservoir. Initial results indicate a total of 349 individual fish comprising two native (common Galaxias (*Galaxias maculatus*) and Flat-headed gudgeon (*Philypnodon grandiceps*)) and two exotic fish species were collected. However, preliminary results indicate that there were no short-finned eels present during the three-day survey period. The absence of the short-finned eels may reflect the possibility that the 2021 spring reservoir spilling may have disrupted migration of adult eels from the reservoir to downstream reaches as indicated in recent studies conducted by ARI.
- **Great Australian Platypus Search, Victoria 2021** (Odonata, 2021).
 The Great Australian Platypus Search launched phase one throughout Victoria from August 2021. This project involved a state-wide investigation into platypus populations which will help better our understanding of this threatened species in Victoria. Seeking to unite Victorians in this search, Odonata used an innovative wildlife detection technique known as environmental DNA (eDNA), which will allow scientists to develop a comprehensive map of platypus populations across the state. A total of 67 sites were sampled on the Barwon River as part of the Great Australian Platypus Search.
- **Riparian land management in the Upper Barwon** (Monash University, 2021).
 Part 1 of this project commenced in February 2021 with interviews conducted with landholders in the Upper Barwon exploring opinions, practices and experiences in relation to riparian land management. Part 2 is currently in progress and involves implementation and evaluation of innovative options for riparian management based on recommendations from the landholder interviews.
- **Geelong Values: Analysis of the social and economic values dependent on a flowing Barwon River (through Geelong) and lower Moorabool River** (RMCG, 2021).
 This study was commissioned by the Corangamite CMA to examine the social and economic benefits the Barwon and Moorabool Rivers provide to the community of Geelong, and the importance of river flows for supporting and protecting these values. It is intended the results of this study will be used to guide future water recovery decisions for the Barwon and Moorabool Rivers.

- **West Barwon Flood Response** (Alluvium, 2021a).
Due to the West Barwon Reservoir spilling in 2021, Alluvium was commissioned by the Corangamite CMA to review the conditions at the site, identify constrictions, potential options of improved flow and risks from potential management intervention. The report recommended that removing glyceria infestations and two willow blockages would alleviate flooding risk.
- **Upper Barwon Restoration** (Alluvium, 2020).
This study was commissioned by the Corangamite CMA as a scoping study for the restoration of the Upper Barwon channels (east and west branches). The report highlights that there are approximately 50 sites that have potential to constrict the flow in the Barwon River.
- **Strategic analysis of Waterwatch data** (Alluvium, 2020a)
This work has looked back over Waterwatch data sets available on the Moorabool to see how useful they might be to assess the effectiveness of environmental water delivery before and after a flow event, and over many years of delivery. It also assessed which Waterwatch parameters were most responsive to e-flows and how data collection could be adapted in the future to better inform the achievement of environmental water objectives.
- **Stage 6 of the Victorian Environmental Flows Monitoring and Evaluation Program (VEFMAP)**.
Tonkin et al. (2020) identified some of the patterns associated with fish responses to environmental flows across Victoria. Stage 6 is now complete, and Stage 7 (2020-2024) will also look at how changing spring flow pulses and baseflow recommendations may affect fish retention and survival. See section 4.2 for further information about the findings for stage 6.
- **Determining the distribution of platypuses in the upper Barwon region using environmental DNA** (EnviroDNA, 2019).
The aim of this project was to address the lack of current knowledge by investigating the current distribution of platypuses throughout the upper Barwon region using environmental DNA (eDNA) and identify declines while engaging the local community in conservation issues. The data generated provides a comprehensive baseline for future monitoring and direct management actions to improve the long-term viability of platypus populations.
- **Prioritising barriers to upstream fish passage** (Marsden et al., 2016).
The objective of this project was to assess and identify all potential barriers to fish passage and low flows in the Barwon and Moorabool River basins. Out of the total 97 potential barriers in the Barwon and Moorabool basins, 56% were identified as barriers to fish migration. In the top 25 barriers prioritised, second equal were the three Buckley Falls barriers on the Barwon River in Geelong. The three barriers are estimated to cost approximately \$1 million to remove. Corangamite CMA has prioritised fish barriers which will significantly increase the habitat available to migratory fish.

In addition to this important information, greater monitoring within the system, analysis of existing data and mapping of significant water users may assist in developing more effective strategies to deliver environmental water and in demonstrating outcomes to the community. Most studies listed above are available online in the Corangamite CMA Knowledge Base.

Below are important projects for the entire Barwon River system:

- **The Barwon Flagship prioritising the Upper Barwon project**

The Barwon Flagship Project has just recently commenced. As a Flagship project under Water for Victoria it is a long-term, integrated waterway health project that will focus on different priorities over time. Initially the Upper Barwon is the first priority with the aim of improving waterway health by addressing chokes and riparian management that will enhance environmental water delivery and outcomes. The geographical area of interest for the project is the priority reaches of the Upper Barwon River's east branch and west branch as well as Dewing Creek.

The Flagship includes:

- **'Riparian land management in the Upper Barwon**

An additional benefit of environmental releases includes coinciding releases with riparian and in-stream weed removal works as the likelihood of weed re-establishing is reduced. Larger environmental flow releases will benefit the entire river system.

- **Central and Gippsland Regions Sustainable Water Strategy (SWS)**

Corangamite CMA was also engaged in the DELWP-led project of preparing the new Central and Gippsland Regions Sustainable Water Strategy and sharing the draft SWS with the Upper Barwon Surface Water Advisory Group (UBSWAG). The SWS is an important document for increasing the environmental water entitlement in the Upper Barwon.

- **Analysis of the social and economic values dependent on a flowing Barwon River through Geelong and lower Moorabool River**

Corangamite CMA continues to work to build the case for more water in the Barwon River through projects such as the 'Analysis of the social and economic values dependent on a flowing Barwon River through Geelong and lower Moorabool River', finalised in November 2021.

9.1 Knowledge gaps

Table 16 below outlines knowledge gaps in the Upper Barwon River. The initial projects were prioritised by Corangamite CMA and project status has been provided. Please note the proposed projects have not been committed to by the Corangamite CMA or external funding providers. This list represents potential projects that could improve knowledge for managers and the community. The Corangamite CMA will continue to seek opportunities for investment in these priority projects to enhance the management for waterway health outcomes.

Table 16. Knowledge Gaps, Responsible Authority and Status

<i>Knowledge gaps and project recommendation</i>	<i>Responsible authority</i>	<i>Status</i>
<p>Identifying Traditional Owner values Acquiring greater understanding of tangible and intangible indigenous heritage values in the area is a key priority for the Corangamite CMA. Empowering Traditional Owners to re-establish linkages with the river system will bring about a more precise knowledge base for delivery of environmental water and realise significant shared benefits for Traditional Owners and the wider community.</p> <p>Information and actions found in Water is Life (DELWPa, 2022) that are directly related to environmental water are not currently reflected in this document. Corangamite CMA will continue to work with Traditional Owners and VEWH to incorporate Water is Life information and outcomes into the planning and delivery of environmental water.</p>	CCMA	<i>Proposed</i>
<p>Fish monitoring in the Upper Barwon system There is currently no monitoring on the Upper Barwon River to assess progress towards environmental objectives being targeted by the Upper Barwon Environmental Entitlement deliveries.</p> <p>Proposed Barwon River Flagship monitoring includes fish monitoring as it is a major knowledge gap in the system, despite the Barwon River having 44 species of fish (including native protected species) and the local community being highly interested. Monitoring could be undertaken to track presence and abundance in the context of current environmental releases, following an expected increase in the annual volume of the environmental entitlement and post remediation of choke points throughout the system over the life of the Flagship. This would progress towards the fish objectives outlined in the FLOWS study. Engagement with the Eastern Maar Traditional Owners would be beneficial to ascertain culturally significant species.</p>	CCMA	<i>Proposed</i>
<p>Rivers of the Barwon (Barre Warre Yulluk) Action Plan</p>	DEWLP	<i>Completed</i>

<p>is the Government's response to the Ministerial Advisory Committee (MAC). The Action Plan lays out steps to protect the catchment and ensure its assets can be enjoyed by future generations. It recognises these waterways and their landscapes as unique, interconnected living entities and the Traditional Owners as the 'voice of the living entities'.</p>		
<p>Alluvium Upper Barwon Restoration report A scoping study for the restoration of the Upper Barwon channels (east and west branches), to investigate physical and hydrological condition, identify constraints, develop a potential program of work to address these constraints, identify knowledge and data gaps and outline the next steps to resolve these constraints.</p>	Corangamite CMA	<i>Completed</i>
<p>Downstream migration of adult silver eels This project aims to investigate the effect of river discharge, including environmental flows, on the downstream spawning migrations of adult eels in the Barwon-Moorabool river system. This information is needed to validate and support refinement and implementation of environmental flows to assist the management and conservation of eel populations. In February 2023 field work took place at several locations on the Moorabool River and at Winchelsea on the Barwon River.</p>	Corangamite CMA, Barwon Water, ARI	<i>In progress</i>
<p>Riparian land management in the Upper Barwon Part 1 of this project commenced in February 2021 with interviews conducted with landholders in the Upper Barwon exploring opinions, practices and experiences in relation to riparian land management. Part 2 is currently in progress and involves implementation and evaluation of innovative options for riparian management based on recommendations from the landholder survey.</p>	Corangamite CMA, DELWP	<i>In progress</i>
<p>Great Australian Platypus Search The aim of this citizen science program conducted in Spring 2021 is to identify the eDNA in our waterways from not only platypus but also other vertebrates including fish, turtles and rakali. When available the report findings will build on eDNA data evidence gathered by the Upper Barwon Landcare Network in</p>	Odonata, DELWP	<i>Completed</i>

association with Friends of the Barwon and Geelong Landcare Network in 2018, 2019 and 2020.		
National Waterbug Blitz The aim of this citizen science program is to help evaluate the benefit of e-water regimes on waterbug communities in the Upper Barwon.	Corangamite CMA	<i>In-progress</i>
Deakin University Riparian Buffer Study – Riparian Restoration A PhD project focusing on the effects of the willow removal and the physical characteristics of riparian restoration on water quality, microclimate and morphology.	Barwon Water, Deakin University and WaterRA	<i>In Progress</i>
Deakin University Riparian Buffer Study – Costs and Benefits of Riparian Buffers A Masters project to develop a tool for calculating the costs and benefits of riparian buffers for stakeholders.	Barwon Water, Deakin University	<i>Completed</i>
Deakin University Riparian Buffer Study – Leaf Decomposition An Honours project investigating leaf decomposition rates and processes between streams.	Barwon Water, Deakin University	<i>Completed</i>

Gauging

For the first three years of the Upper Barwon Environmental Entitlement there was insufficient water gauging on the Upper Barwon River to adequately assess how releases from the West Barwon Reservoir move down through the river system. In January 2021, the East Barwon @ U/S River King Creek Junction gauge was installed on the east branch near Forrest, however it could only record low flow events approximately <34ML/day. At the time of writing this proposal the gauge was offline and was in the process of being relocated. Corangamite CMA is now using East Barwon River @ Flume gauge data at the top of the Upper Barwon east reach, to which environmental water can be delivered. The East Barwon River @ Flume gauge can record up to approximately 200ML/day, which allows the Corangamite CMA to analyse flow compliance more broadly. The new West Barwon River @ Boundary Road near Forrest gauge was also installed by Barwon Water on the west branch which became available in February 2021, but can only record low flow events up to approximately 100ML/day. So, there is a knowledge gap on both branches relating to flows above the maximum limit of the new gauges. This gap prevents assessment of flow compliance at higher flow rates. Corangamite CMA worked collaboratively with Barwon Water during the design phase to ensure the new gauges do not create any barriers to fish migration.

Cold water pollution

In 2020, a question was raised by the community about Cold Water Pollution (CWP) risks in relation to environmental water releases from West Barwon Reservoir. The risk of CWP occurring can be influenced by the depth of water from where reservoir releases are taken. There are two offtake points

in the West Barwon Reservoir and depending on the level of water, releases can be taken from up to 12m deep. Corangamite CMA and Barwon Water are aware of the risks to biota because of cold or anoxic releases and for this reason have formalised a requirement that environmental flows will always be released from the offtake closest to the surface of the reservoir.

To assess the influence that releases from West Barwon reservoir may have on temperature changes in the east and west branch of the Upper Barwon River, Barwon Water in consultation with the Corangamite CMA has:

- Implemented an initial temperature monitoring program to collect data which informed the 2022 Temperature Monitoring Analysis.
- Based on the outcomes of the initial temperature monitoring analysis, implemented a permanent temperature monitoring program to continue to collect a long-term dataset for any future analysis requirements

In 2022, environmental consultant Streamology was engaged by Barwon Water to analyse the spatial and temporal change of water temperature across the Upper Barwon system using the data collected as part of the monitoring program. The analysis concluded that there is no evidence from the monitoring to date that indicates a decrease in temperature is occurring in the downstream waterways because of releases from the West Barwon Reservoir (i.e., no cold water pollution is occurring). The data showed that the water released from the reservoir is typically warmer than the reservoir inflow by 2 -3 degrees and the data shows the water temperature increases further downstream or is similar at the downstream sites (Streamology, 2022). The temperature of the water in both waterways varies throughout the day and from season to season. The degree of shading, exposure to sunlight and depth of water are all factors that can influence the temperature of the water.

10. Risk management

A risk assessment has been undertaken for the 2023-24 season, with representatives from Barwon Water, the VEWH, and the Corangamite CMA present.

This assessment identifies the risks associated with delivering water for the priority actions. Mitigation actions to reduce risks have been identified and should be undertaken as part of the release plan.

An overview of the risk assessment and management for the current plan with potential risk mitigation measures and associated residual risk assessment is outlined below in Table 17.

Table 17. Risk assessment for the Upper Barwon River environmental watering 2023-24

Risk ID	Risk category	Risk description	Mitigation actions	Lead organisation	Likelihood	Residual Risk		Risk type Static or Dynamic
						Consequence	Risk Rating	
CEBA2020-22	Legal	Heavy rainfall following environmental deliveries may lead to unintended inundation of private land in the upper Barwon River, resulting in impacts on landowner activities and assets.	<ul style="list-style-type: none"> Undertake detailed monitoring of water levels and adjust delivery plans based on seasonal conditions and forecasts. Ongoing communication of delivery plans to landholders. Limiting maximum delivery rates to reduce risk of flooding Undertake regular communications between CMA and Barwon Water to identify local risks (using operator knowledge) and manage releases accordingly Reassess acceptable flow limits following willow/constraints removal program 	CCMA CCMA CCMA/BW CCMA/BW CCMA	Unlikely	Minor	Low	Static
CEBA2021-23	Cultural Heritage	Inadequate engagement with Eastern Maar during planning may lead to a failure to address T.O. values or damage to heritage/artifacts and may impact on values or heritage Note: There may also be some reputational risks if Eastern Maar can't be engaged in environmental water processes	<ul style="list-style-type: none"> Continue efforts to seek to establish meaningful partnership arrangements with Eastern Maar people, leading to ongoing inclusion of T.O. values into watering proposals Continue to partner and share knowledge with T.O.s to build capacity to actively engage in water related issues 	CCMA	Unlikely	Minor	Low	Static
CEBA2020-24	Reputational	Implementing watering actions for new sites supplied from West Barwon Reservoir may	<ul style="list-style-type: none"> Review and assess potential risk issues for water delivery actions and develop specific mitigation actions. Continue to support community and 	CCMA	Unlikely	Minor	Low	Static

Risk ID	Risk category	Risk description	Mitigation actions	Lead organisation	Likelihood	Residual Risk		
						Consequence	Risk Rating	Risk type Static or Dynamic
		not be successful due to lack of information on flow behaviour and constraints with the result that environmental benefits are not achieved.	<p>stakeholder information and engagement processes.</p> <ul style="list-style-type: none"> • Continue to implement upper Barwon restoration project to restore channel capacity for environmental water delivery • Expand flow monitoring capability where possible to assess outcomes of restriction removal programs, and adjust watering actions accordingly 					
CEBA2020-25	Reputational	Community concerns related to establishment and implementation of Barwon Water groundwater remediation plan may be extended (incorrectly) to Barwon River environmental release plans, leading to a loss of public/political support for activities	<ul style="list-style-type: none"> • Engage with key objectors to address information gaps and concerns. 	CCMA	Unlikely	Minor	Low	Dynamic
CEBA2020-26	Reputational	The availability of environmental entitlements creates a community expectation (which can't be met) that regular "natural" cease to flow events in the mid-Barwon and low flows/BGA issues in the lower Barwon will no longer occur.	<ul style="list-style-type: none"> • Continue to engage with the local community to build understanding of the limitations on the available environmental water entitlements and the processes for identifying and prioritising environmental watering actions. • Engagement in the redevelopment of the SWS to address environmental water needs. • Consider accessing additional water through trade 	CCMA CCMA VEWH	Unlikely	Minor	Low	Dynamic
CEBA2020-27	Environment	Environmental releases do not achieve planned/specified flow targets due to releases	<ul style="list-style-type: none"> • Ensure licensing authority is aware of planned events and alert it to the need to manage compliance by all users. 	CCMA	Possible	Minor	Low	Static

Risk ID	Risk category	Risk description	Mitigation actions	Lead organisation	Likelihood	Residual Risk		
						Consequence	Risk Rating	Risk type Static or Dynamic
		being diverted by other users before reaching delivery site.	<ul style="list-style-type: none"> • Work with SRW to improve diversions compliance management options and shepherding of environmental flows through the system. 					

11. Approval and endorsement

I, John Riddiford, the authorised representative of the agency shown below, approve the Seasonal Watering Proposal for the Upper Barwon River system 2023-24.

SIGNED FOR AND ON BEHALF OF Corangamite Catchment Management Authority



Signature of authorised representative

John Riddiford

Name of authorised representative

Date 14/04/2023

Appendix 1. Abbreviations

ARI	Arthur Rylah Institute
BOM	Bureau of Meteorology
CCMA	Corangamite Catchment Management Authority
DELWP	Department of Environment Land Water and Planning
EMAC	Eastern Maar Aboriginal Corporation
EVC	Ecological Vegetation Class
LAWROC	Land and Water Resources Otway Catchment
GL	Gigalitre
MAC	Ministerial Advisory Committee
ML	Megalitre
PWA	Priority Watering Action
RAP	Registered Aboriginal Party
SWP	Seasonal Watering Proposal
UBSWAG	Upper Barwon Surface Water Advisory Group
VEWH	Victorian Environmental Water Holder
VEFMAP	Victorian Environmental Flows Monitoring and Assessment Program
WaterRA	Water Research Australia
WMIS	Water Measurement Information System
WTOAC	Wadawurrung Traditional Owners Aboriginal Corporation

Appendix 2. References

- Alluvium (2020). *Final Report: Upper Barwon Restoration*. [Report prepared by Alluvium Consulting Australia for Corangamite CMA].
- Alluvium (2020a). *Strategic analysis of Waterwatch data*. [Report prepared by Alluvium Consulting Australia for CCMA].
- Alluvium (2021). *Upper Barwon, Yarrowee and Leigh rivers FLOWS study update*. [Report prepared by Alluvium Consulting Australia for CCMA].
- Alluvium (2021a). *Final Report: West Barwon flood response*. [Report prepared by Alluvium Consulting Australia for Corangamite CMA].
- Australian Conservation Foundation (2022) *The platy-project*. <https://platy-project.acf.org.au/>
- Monash University (2021). *Riparian land management in the Upper Barwon. Exploring the opinions, practices and experiences of landholders*. [Report prepared by BehaviourWorks Australia for Corangamite CMA].
- Barwon Water (2022). *West Barwon Reservoir spills*. <https://www.barwonwater.vic.gov.au/about-us/news-and-events/news/west-barwon-reservoir-spills-august-2022>
- Bureau of Meteorology (2023a) *Annual Climate Statement 2022*. <http://www.bom.gov.au/climate/current/annual/aus/#tabs=Key-points>
- Bureau of Meteorology (2023) *Climate outlooks-weeks, months and seasons*. <http://www.bom.gov.au/climate/outlooks/#/overview/summary/>
- Bureau of Meteorology (2022), *State of the Climate*. <http://www.bom.gov.au/state-of-the-climate/>
- DELWP (2015). *Climate ready Victoria– Barwon South West*. [Factsheet]. https://www.climatechange.vic.gov.au/_data/assets/pdf_file/0020/60743/Barwon-South-West.pdf
- DELWP & CSIRO (2019) *Victorian Climate Projections 2019* <https://www.climatechangeinaustralia.gov.au/en/projects/victorian-climate-projections-2019/vcp19-publications/>
- DELWP (2022). *The Central and Gippsland Region sustainable water strategy*. <https://www.water.vic.gov.au/planning-and-entitlements/long-term-assessments-and-strategies/central-gipps-sws>
- DELWP (2022a). *Water is life: Traditional Owner access to water road map*. <https://www.water.vic.gov.au/aboriginal-values/the-aboriginal-water-program>
- EMAC (2015). *Meerreeengeeye ngakeepoorryeeyt – Our Country*. EMAC Country Plan accessed from <https://easternmaar.com.au/>
- EnviroDNA and Odonata (2021), *Platypus Results Report, The Great Australian Platypus Search, Victoria 2021*. <https://www.thegreataustralianplatypussearch.org/results-2021>
- IAP2 International Federation. (2018). *IAP2 spectrum of public participation* <https://www.iap2.org.au/resources/spectrum/>
- Lloyd et al. (2006). *Environmental flow determination for the Barwon River*. [Final report – flow recommendations prepared Lloyd Environmental, Fluvial Systems and Ecological Associates Pty Ltd for Corangamite CMA, Colac].


Marsden, T., Stuart, I. & O'Connor, J. (2016). *Prioritising barriers to upstream fish passage: Barwon and Moorabool catchments*. [Report prepared by The Fisheries Collective for the Corangamite CMA].

RMCG (2021). *Analysis of the social and economic values dependent on a flowing Barwon River (through Geelong) and lower Moorabool River*. [Report prepared by RMCG for CCMA].

VEWH (2022). *Seasonal watering proposal 2023-24 guidelines*

Wadawurrung Traditional Owners Aboriginal Corporation (2020). *Paleert Tjaara Dja – Wadawurrung Country Plan*. <https://wadawurrung.org.au/resources>

Appendix 3. IAP2 spectrum of public participation

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

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IAP2 spectrum of public participation

Appendix 4. VEHW Risk matrix

Table 2: Risk likelihood rating table¹

Likelihood		Description	% Probability
4	Almost certain	<ul style="list-style-type: none"> The event is expected to occur in most circumstances and/or Risk will occur within the next 6 months/or several times a year and/or Controls associated with the risk are extremely weak and/or non-existent and without control improvement the risk will eventuate. 	75-100
3	Likely	<ul style="list-style-type: none"> The event is likely to occur in most circumstances and/or Risk will occur in the next 12 months/or once or twice a year and/or The majority of the controls associated with the risk are weak and without control improvement it is likely the risk will eventuate. 	50-74
2	Possible	<ul style="list-style-type: none"> The event might occur and/or Risk will occur in the next 24 months/or once in two years and/or Some controls need improvement and if there is no improvement it is possible the risk will eventuate. 	25-49
1	Unlikely	<ul style="list-style-type: none"> The event could occur at some time and/or Risk will occur in the next 60 months/or once in five years and/or Controls environment is strong with few control gaps and requires assurance check to maintain control effectiveness. 	0-24

¹ Source: Adapted from DELWP, 2019, *Risk management guidelines* by the Victorian Managed Insurance Authority (VMIA)

Table 3. Risk consequence table (harm) ²

Rating		Environment	Business Costs	People		Political/ Reputational	Legal and Compliance	Service Delivery	Cultural Heritage ³
				Safety and Well-being	People and Culture				
Minor	1	<ul style="list-style-type: none"> Limited effect on the natural and/or built environment and/or the environment suffers harm for up to 5 years. Environmental recovery on a minor scale up to 5 years. Mostly impacts environmental values at a single location in an individual system. 	<ul style="list-style-type: none"> Cost impact on total budget of up to 5%. 	<ul style="list-style-type: none"> Minor injuries or illness (physical/ mental) requiring first aid or medical attention of staff, visitor, contractor, or member of the public. 	<ul style="list-style-type: none"> Staff complaints, passively upset, and uncooperative. 10-15% staff turnover with minor loss of skills, knowledge, and expertise. 	<ul style="list-style-type: none"> Adverse localised public and political interest. Limited attention on a single issue in local media over a short period. 	<ul style="list-style-type: none"> Non-compliance with legislation or breach of duty of care, identified externally and either: <ul style="list-style-type: none"> resolved internally with no further escalation; or resulting in minor compensation, and/or negative precedent. 	<ul style="list-style-type: none"> Minor short-term impact on business unit's delivery of services/functions. Customers/stakeholders/ communities slightly inconvenienced. Up to 1 day impact on business unit's critical activities. Minor impact (up to 10% delay) on project or program milestones. 	<ul style="list-style-type: none"> Limited potential impact on heritage sites/artefacts Exposure of previously unknown cultural heritage items
Moderate	2	<ul style="list-style-type: none"> Moderate effect on the natural and/or built environment and/or environment suffers harm for 5-10 years. Environmental recovery on a small scale and/or over a period 5-10 years. Impacts environmental values at multiple locations in an individual system. 	<ul style="list-style-type: none"> Cost impact on total budget between 5-10%. 	<ul style="list-style-type: none"> Significant injury or illness (physical/ mental) requiring in-patient hospitalisation of staff member, visitor, contractor, or member of the public. 	<ul style="list-style-type: none"> Low morale, disengagement, increased absenteeism, and workplace conflict. 15-25% staff turnover with loss with resignations of some key staff. 	<ul style="list-style-type: none"> Adverse localised negative public and political attention. Short term negative local media attention. Local community concern on a single issue over a sustained period. 	<ul style="list-style-type: none"> Non-compliance with legislation or breach of duty of care resulting in: <ul style="list-style-type: none"> external investigation or report to responsible authority; and/or prosecution or civil action, with one of moderate level of compensation or moderate level of negative precedent. 	<ul style="list-style-type: none"> Moderate impact on business unit's delivery of services/functions. Customers/stakeholders/ communities inconvenienced. Up to 3 days impact on business unit's critical activities. Significant impact (10-20% delay) on project or program milestones. 	<ul style="list-style-type: none"> Moderate potential impact on heritage sites/artefacts Damage to previously unknown cultural heritage items or values
Major	3	<ul style="list-style-type: none"> Major effect on the natural and/or built environment and/or environment suffers harm for 10-20 years. Environmental recovery on a large scale and/or over a period of 10-20 years. Impacts regional environmental values or affects connected systems. 	<ul style="list-style-type: none"> Cost impact on total budget between 10-20%. 	<ul style="list-style-type: none"> Extensive and/or permanent injury or illness (physical/ mental) of staff member, visitor, contractor, or member of the public. 	<ul style="list-style-type: none"> Major morale issues, high absenteeism. 25-50% staff turnover with resignations of key staff. Staff are not skilled to meet priorities. 	<ul style="list-style-type: none"> Serious adverse public attention at State/National level. Negative State/National media on one or more issues over a prolonged period. Repeated displeasure by the Minister. Medium-term negative public interest (correspondence and phone calls) and political interest (in Parliament). 	<ul style="list-style-type: none"> Non-compliance with legislation or breach of duty of care resulting in: <ul style="list-style-type: none"> external investigation or report to responsible authority; public inquiry (i.e. Royal Commission/ Parliamentary Committee); prosecution or civil action with high level compensation and high-level negative precedent; and/or sanctions imposed by external regulator. 	<ul style="list-style-type: none"> Ongoing difficulties in delivering the business unit's services/functions. Major impact on customers/ stakeholders/ communities Up to 10 days impact on business unit's critical activities Major impact (20-50% delay) on project or program milestones 	<ul style="list-style-type: none"> Major potential impact on heritage sites/artefacts Damage to known cultural heritage items or values
Extreme	4	<ul style="list-style-type: none"> Very serious effect on the natural and/or built environment and/or environment suffers long term harm (20+ years). Environmental recovery on a very large scale and/or over a long period (20+ years). Impacts environmental values statewide. 	<ul style="list-style-type: none"> Cost impact on total budget >20%. 	<ul style="list-style-type: none"> Single or multiple deaths or severe permanent disability or illness (physical/mental) of staff, visitor, contractor, or member of the public. 	<ul style="list-style-type: none"> Organisation wide morale issues and absenteeism. >50% staff turnover. Staff are not skilled to meet core corporate outputs. 	<ul style="list-style-type: none"> Very serious public outcry at State/National level. Negative State/National media over a prolonged period. Breakdown of public confidence in the Government / department / Minister or key project/program. On-going or prolonged negative public interest (correspondence and phone calls) and political interest (in Parliament). 	<ul style="list-style-type: none"> Non-compliance with legislation or breach of duty of care resulting in: <ul style="list-style-type: none"> prosecution or civil action leading to imprisonment of an officer; public inquiry (i.e. Royal Commission/ Parliamentary Committee) uninsured compensation payments negative precedent requiring very serious impact and major reform to the department; and/or severe sanctions imposed by external regulator. 	<ul style="list-style-type: none"> Long term and severe impact on delivery of services/functions Severe impact on customers /stakeholders/communities More than 10 days impact on business unit's critical activities Vital or very serious delays (>50% delay) to program/project delivery or project/program objective is not met 	<ul style="list-style-type: none"> Very serious potential impact on heritage sites/artefacts Destruction of cultural heritage items or values

² Source: Adapted from DELWP, 2019, *Risk management guidelines*.

³ In assessing risks in this category, consideration will need to be given to actions that have been approved through a Cultural Heritage Management Plan (CHMP) and how this fit with the legislation. Impact of actions authorised by Traditional Owners under a CHMP will have a much lower rating compared with unauthorised impacts – which may immediately meet the ‘extreme’ category. This method will require documentation.

Table 4. Risk rating matrix⁴

Likelihood		Consequence			
		Minor	Moderate	Major	Extreme
		1	2	3	4
Almost certain	4	Medium (4)	High (8)	Extreme (12)	Extreme (16)
Likely	3	Low (3)	Medium (6)	High (9)	Extreme (12)
Possible	2	Low (2)	Medium (4)	Medium (6)	High (8)
Unlikely	1	Low (1)	Low (2)	Low (3)	Medium (4)

Table 5. Control Effectiveness Rating

Rating		Description	Response
Effective	1	Control is well designed, addresses the risk and are effective and reliable at all times. There is no need and limited scope to improve the control.	Maintain and monitor control.
Partially effective	2	Some deficiencies in the control have been identified. Control is not fully documented or undertaken by all the partners as required. There are some opportunities to improve the control.	Improve control or prepare alternative treatment.
Ineffective	3	Control does not meet an acceptable standard and there are many deficiencies identified. Control does not provide a reasonable level of assurance that risk is being mitigated.	Prepare treatment.
Unknown/ Uncontrolled	4	Assessment of control not possible due to lack of knowledge or there is no credible control that addresses the risk.	Take steps to understand the risk and implement control as soon as possible.

⁴ Adapted from DELWP, 2019, *Risk management guidelines*..

Appendix 5. Hydraulic criteria for flow objectives in the Upper Barwon, Yarrowee and Leigh Rivers, arranged by value (Alluvium, 2021)

Value	Objective	Reaches	Function	Period	Component	Criteria
ABORIGINAL CULTURAL						
Mammals	Maintain or improve abundance, breeding and recruitment of Wad-dirring/ Perridak (platypus)	1, 2, 9, 10	Provide pool habitat	Dry	Low flow	AM1 See other fauna (PL1)
		1, 2, 9, 10	Provide longitudinal connectivity between reaches	Wet	Fresh	AM2 See other fauna (PL2)
Fish	Maintain or improve abundance of Buniya (eels)	1, 2, 9, 10	Provide water in pools for habitat and food sources	Dry	Low flow	AF1 See fish (MF1)
		1, 2, 9, 10	Provide water over riffles to allow fish to migrate upstream from estuary	Dry	Fresh	AF2 See fish (MF2)
	Maintain or improve abundance of Turrpurt (native trout <i>galaxias</i> spp.)	1, 2, 9, 10	Provide water in pools for habitat and food sources	Dry	Low flow	AF3 See fish (RF1)
		1, 2, 9, 10	Provide water over riffles to allow fish to move between pools to breed, feed and find new habitats	Dry	Fresh	AF4 See fish (RF2)
		1, 2, 9, 10	Provide prolonged seasonal inundation of vegetation beds and instream benches as habitat to stimulate invertebrate hatching and fish breeding	Wet	Fresh	AF5 See fish (RF4)
			Maintain or improve abundance of Ware-rap (blackfish)	1, 2, 9, 10	Submerge and clean woody debris and hard surfaces to provide breeding substrate	Dry
Vegetation	Maintain or improve abundance of Polango/Warngare (water ribbons <i>Triglochin procera</i>)	1, 2, 9, 10	Maintain adequate depth of permanent water in the channel, with natural seasonal drawdown to promote recruitment	Dry	Low flow	AV1 See vegetation (IV1)
		1, 2, 9, 10	Maintain adequate depth of permanent water in stream channel to limit terrestrial encroachment into aquatic habitats	Dry	Low flow	AV2 See vegetation (EV1)
	Maintain or improve condition, extent, and abundance of Tark (common reed <i>Phragmites australis</i>), Toolim (pale rush <i>Juncus pallidus</i>), and Bal-yan (cumbungi <i>Typha latifolia</i>)	1, 2, 9, 10	Provide a mosaic of spatially and temporally differentially wetted areas within stream channel, on benches, and on lower banks	Dry	Fresh	AV3 See vegetation (EV2)
		1, 2, 9, 10	Support growth on terraces, channel edge, and lower bank	Dry	Fresh	AV4 See vegetation (EV3)
		1, 2, 9, 10	Provide a mosaic of spatially and temporally differentially wetted areas within stream channel, on	Wet	Fresh	AV5 See vegetation (EV4)

Value	Objective	Reaches	Function	Period	Component	Criteria
			benches, and on lower banks			
	Maintain or improve abundance of Biyal (river red gum <i>Eucalyptus camaldulensis</i>)	2, 10	Support growth on terraces, channel edge, and lower bank	Dry	Fresh	AV6 See vegetation (RV1)
Support growth on terraces, channel edge, and lower bank			Wet	Fresh	AV7 See vegetation (RV2)	
Support growth in the channel and upper bank, disturb riparian zone and channel to open recruitment niches for riparian plants			Anytime	Bankfull	AV8 See vegetation (RV3)	
	Maintain or improve abundance of Larrap (manna gum <i>Eucalyptus viminalis</i>) and Kokibainang (swamp wallaby grass <i>Amphibromus recurvatus</i>).	2, 9, 10	Inundate floodplain, provide moisture and fill floodplain depressions and billabongs to support the growth of seasonal and emergent wetland vegetation	Anytime	Overbank	AV9 See vegetation (FV3)
Geomorphology	Deep pools	1, 2, 8, 10	Scour sediment from base of pools to maintain pool and to use bed sediments to scour algae from riffles	Dry	Fresh	AG1 See supporting functions (GE1)
			Scour sediment from base of pools to maintain pool and to use bed sediments to scour algae from riffles	Wet	Fresh	AG2 See supporting functions (GE2)
			Mobilise sediment from base of pools	Dry	Fresh	AG3 See supporting functions (GE3)
			Mobilise sediment from base of pools for a sustained duration	Wet	Low flow	AG4 See supporting functions (GE4)
	Confluences of Barwon and Leigh rivers, and Yarrowee River and Cargerie Creek	1, 2, 10	Maintain adequate depth of permanent water in the channel	Dry	Low flow	AG5 Flow between pools
FISH						
Migratory fish	Maintain abundance of migratory fish including short-finned eels, Australian grayling, and tupong	1, 2, 3, 7, 9, 10	Provide water in pools for habitat and food sources	Dry	Low flow	MF1 600 mm water depth in pools
			Provide water over riffles to allow fish to migrate upstream from estuary	Dry	Fresh	MF2 500 mm water depth over riffles
			Provide water over riffles to allow longitudinal connectivity and for fish to move between pools	Wet	Fresh	MF3 500 mm water depth over riffles
	Improve breeding and recruitment of migratory fish including broad-finned galaxias and common Jollytail	All reaches	Provide connectivity to allow fish to migrate downstream to breed	Wet	Fresh	MF4 300 mm water depth over riffles
Resident freshwater fish	Maintain abundance of resident freshwater fish, including galaxias, smelt, big-headed gudgeon, and Yarra pygmy perch	All reaches	Provide water in pools for habitat and food sources	Dry	Low flow	RF1 250 mm water depth in pools
			Provide water over riffles to allow fish to move between pools to breed, feed and find new habitats	Dry	Fresh	RF2 300 mm water depth over riffles

Value	Objective	Reaches	Function	Period	Component	Criteria
	Improve breeding and recruitment of resident freshwater fish including blackfish	1, 2, 3, 4, 6, 7, 9, 10	Submerge and clean woody debris and hard surfaces to provide breeding substrate	Dry	Fresh	RF3 500 mm water depth over some instream benches and vegetation beds or meet criteria GE2
	Improve breeding and recruitment of resident freshwater fish, including galaxias, smelt, big-headed gudgeon, and Yarra pygmy perch	All reaches	Provide prolonged seasonal inundation of vegetation beds and instream benches as habitat to stimulate invertebrate hatching and fish breeding	Wet	Fresh	RF4 500 mm water depth over some instream benches and vegetation beds
OTHER FAUNA						
Macro-invertebrates	Maintain abundance of macroinvertebrates as a food source for fish, frog and platypus populations	All reaches	Sustain macroinvertebrate communities during the dry period	Dry	Fresh	MA1 Inundation of benches
		All reaches	Create and extend aquatic habitats for macroinvertebrates	Wet	Fresh	MA2 Extend wetted area
	Improve breeding and recruitment of macroinvertebrates as a food source for fish, frog and platypus populations	All reaches	Allow growth and reproduction of macroinvertebrate communities	Wet	Fresh	MA3 Scour sediment and disturb biofilm, see objective S2 (GE1 and GE2)
Growling grass frog	Maintain abundance of growling grass frog	1, 2, 6, 9, 10	Provide pool habitat	Dry	Low flow	GF1 Flow between pools
	Improve breeding and recruitment of growling grass frog	1, 2, 6, 9, 10	Allow growth and reproduction of macroinvertebrate communities	Wet	Fresh	GF2 Scour sediment and disturb biofilm, see objective S2 (GE1 and GE2)
	Improve condition and extent of growling grass frog	1, 2, 6, 9, 10	Provide longitudinal connectivity between reaches	Wet	Fresh	GF3 300 mm water depth over riffles
Platypus	Maintain abundance of platypus	1, 2, 3, 4, 7, 8, 9, 10	Provide pool habitat	Dry	Low flow	PL1 Flow between pools
	Improve condition and extent of platypus	1, 2, 3, 4, 7, 8, 9, 10	Provide longitudinal connectivity between reaches	Dry	Fresh	PL2 200 mm water depth over riffles
VEGETATION						
Instream	Maintain or improve condition and extent of instream vegetation to provide structural habitat for macroinvertebrates and various fish species	All reaches	Maintain adequate depth of permanent water in the channel, with natural seasonal drawdown to promote recruitment	Dry	Low flow	IV1 400 mm water depth in pools
Emergent macrophyte	Maintain or improve condition, extent, and diversity of emergent macrophyte vegetation to provide structural habitat and channel/lower bank	All reaches	Maintain adequate depth of permanent water in stream channel to limit terrestrial encroachment into aquatic habitats	Dry	Low flow	EV1 400 mm water depth in pools
		All reaches	Provide a mosaic of spatially and temporally	Dry	Fresh	EV2 Water level rise from low flow

Value	Objective	Reaches	Function	Period	Component	Criteria	
	stability to low and moderate flows.		differentially wetted areas within stream channel, on benches, and on lower banks			level of 100-200 mm	
		All reaches	Support growth on terraces, channel edge, and lower bank	Dry	Fresh	EV3 Inundate channel terraces and lower bank	
		All reaches	Provide a mosaic of spatially and temporally differentially wetted areas within stream channel, on benches, and on lower banks	Wet	Fresh	EV4 Water level rise from low flow level of 100-200 mm	
Riparian	Maintain or improve condition, extent, and diversity of riparian vegetation as part of endangered EVCs	All reaches	Support growth on terraces, channel edge, and lower bank	Dry	Fresh	RV1 Inundate lower bank and channel terraces	
		All reaches	Support growth on terraces, channel edge, and lower bank	Wet	Fresh	RV2 Inundate lower bank and channel terraces	
		1, 3, 4, 5, 6, 7, 8	Support growth in the channel and upper bank, disturb riparian zone and channel to open recruitment niches for riparian plants	Anytime	Bankfull	RV3	Inundate all channel
Floodplain	Maintain or improve condition and extent of floodplain vegetation as part of endangered EVCs	5	Groundwater interactions with floodplain features supports flow-dependent species	Dry	Low flow	FV1 400 mm water depth in pools	
		3, 4, 6, 8	Maintain a shallow water table with low salinity groundwater throughout the year	Dry	Low flow	FV2 400 mm water depth in pools	
		2, 4, 6, 8, 10	Inundate floodplain, provide moisture and fill floodplain depressions and billabongs to support the growth of seasonal and emergent wetland vegetation	Anytime	Overbank	FV3	Water flows to floodplain
SUPPORTING FUNCTIONS							
Water quality	Reduce prolonged stratified conditions in pools and promote adequate levels of water quality to allow fish and macroinvertebrate populations to persist	All reaches	Provide minimum velocity to maintain mixing in pool	Dry	Low flow	WQ1	Minimum velocity in pools of 0.1m/s
		All reaches	Provide minimum velocity to establish mixing and flushing of pools	Dry	Fresh	WQ2	Minimum velocity in pools of 0.3m/s
Geomorphology	Improve and maintain abundance and condition of pools, large wood and riffles to provide structural habitat for macroinvertebrates and various fish species	All reaches	Scour sediment from base of pools to maintain pool and to use bed sediments to scour algae from riffles	Dry	Fresh	GE1	Shear stress in pool exceeds 1N/m ² for sand bed streams and 0.1N/m ² for silt bed streams
		All reaches	Scour sediment from base of pools to maintain pool and to use bed sediments to scour algae from riffles	Wet	Fresh	GE2	Shear stress in pool exceeds 1N/m ² for sand bed streams and 0.1N/m ² for silt bed streams

Value	Objective	Reaches	Function	Period	Component	Criteria
	Maintain channel capacity, shape and form to support flora and fauna values and objectives	All reaches	Mobilise sediment from base of pools	Dry	Fresh	GE3 Shear stress in pool exceeds 1N/m ² for sand bed streams and 0.1N/m ² for silt bed streams
		All reaches	Mobilise sediment from base of pools for a sustained duration	Wet	Low flow	GE4 Shear stress in pool exceeds 1N/m ² for sand bed streams and 0.1N/m ² for silt bed streams
		All reaches	Maintain volume and size of transported sediments	Wet	Fresh	GE5 Inundate high channel benches
		All reaches	Maintain volume and size of transported sediments	Anytime	Bankfull	GE6 'Effective discharge' (around 1.5 yr ARI event)
	Improve and maintain level of floodplain connectivity to support instream and riparian flora and fauna	All reaches	Connect the channel and floodplain to promote sediment deposition, carbon exchange, and organic matter supply	Anytime	Overbank	GE7 Water flows to floodplain

Appendix 6. WTOAC Letter of Support



Office 3, 110 Creswick Road
Ballarat Central, VIC 3350
Australia
P (03) 4308 0420
F (03) 4308 0421

March 2023

Attn: Rose Jackson (via email)

RE: Upper Barwon River Seasonal Watering Proposal

Dear Sharon,

Wadawurrung Traditional Owners Aboriginal Corporation (WTOAC) is a Registered Aboriginal Party (RAP) under the Aboriginal Heritage Act 2006 (Vic) and was established in 1998. WTOAC is governed by a Board of Directors of Wadawurrung Traditional Owners. Each director represents a family group of the Wadawurrung People.

The role of the Corporation is to protect and advance the aspirations of Wadawurrung People by managing their cultural heritage rights and interests while providing a representative voice for Traditional Owners in relation to the management of Wadawurrung Country.

I am pleased to advise that Wadawurrung Traditional Owners Aboriginal Corporation support the Corangamite Catchment Management Authority's Seasonal Watering Proposal for the Upper Barwon River and the potential watering actions for 2023-24.

Yours sincerely,

A handwritten signature in black ink, appearing to read "Paul Davis".

Paul Davis

CEO

Ph: 0417 593 000

E: paul@wadawurrung.org.au