2022-23 Water for the Environment Annual Plan

For the South Australian River Murray

Government of South Australia

Department for Environment and Water

Acknowledgement of the Traditional Owners

The Department for Environment and Water acknowledges Traditional Owners of Country throughout Australia and recognises the continuing connection to lands, waters and communities. We pay our respect to Aboriginal and Torres Strait Islander cultures and to Elders both past and present.

The First Nations of South Australia, the Aboriginal Traditional Owners, have occupied, enjoyed and managed their customary lands and waters since time immemorial and continue their deep cultural, social, environmental, spiritual and economic connection today. The Government of South Australia acknowledges and pays respect to the Traditional Owners and their Nations. The South Australian government also acknowledges and respects the rights, interests and obligations of Traditional Owners to speak and care for their Country – lands and waters – in accordance with their laws, customs, beliefs and traditions. In acknowledging this history and connection we also recognise the deep and irreversible damage and dislocation that Aboriginal and Torres Strait Islander people have experienced and continue to experience through European colonisation, settlement and displacement. Aboriginal Nations have advocated strongly for a healthier Murray–Darling Basin and just settlement of their land and water rights. This commitment led to a stronger Basin Plan for South Australians and asks us as a State Government to better recognise Traditional Owner interests in our water resource management. The Department for Environment and Water seeks to enable partnerships with Aboriginal Nations built upon mutual respect and trust. We recognise the differences between Nations and their preferred approaches for engagement with Government and will work through these arrangements to support Traditional Owners to meet their customary rights and obligations in natural resource planning and implementation.

Foreword

The *2022-23 Annual Water for the Environment Plan for the South Australian River Murray* (the Annual Plan) is an important element of South Australia's river management framework. It builds on actions undertaken and outcomes achieved in previous years and is guided by the current ecological conditions in the River Murray and the ecological objectives and targets in the *Long Term Environmental Watering Plan for the South Australian River Murray* (2020).

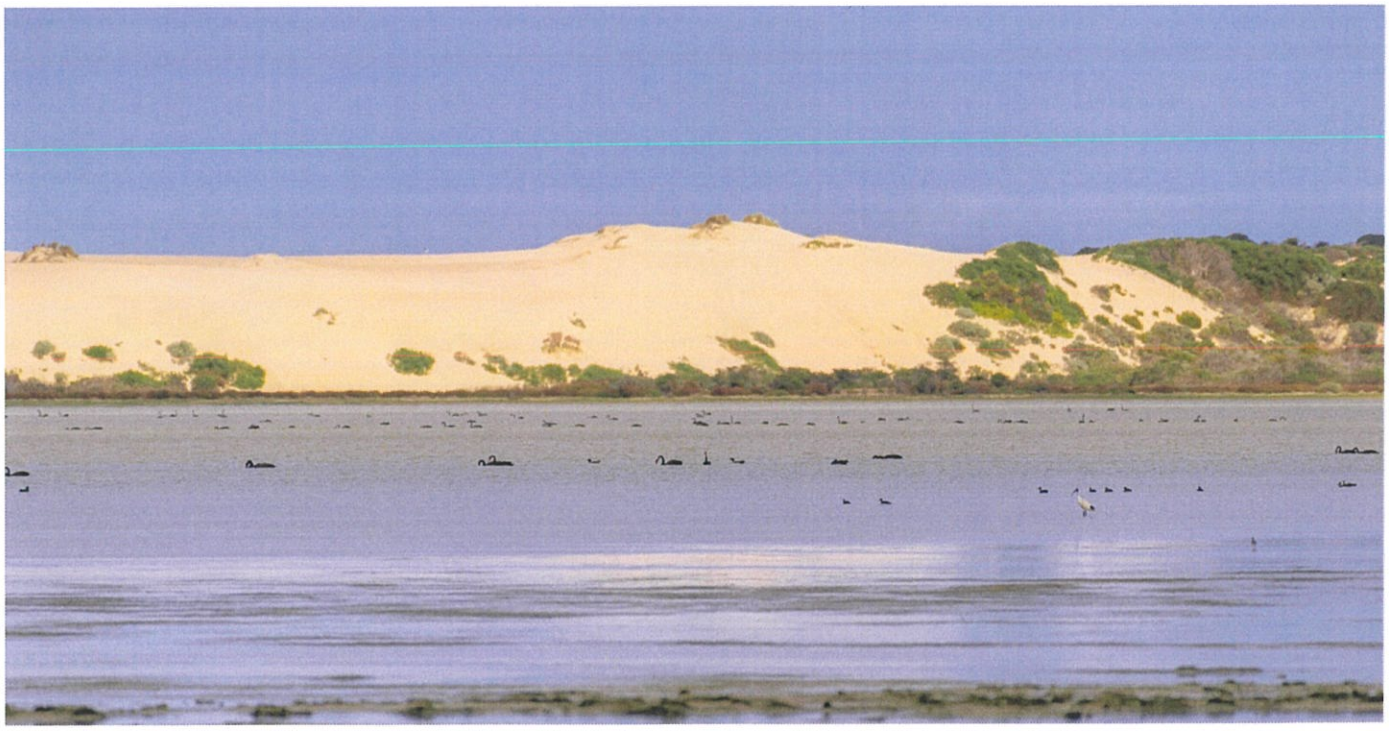
The Annual Plan is prepared as part of the Basin Plan environmental water management framework and it is used to inform how available environmental water will be used in South Australia and throughout the Murray-Darling Basin. A wide range of stakeholders have been engaged in its development, supporting a transparent process to determine environmental watering priorities.

Each year the water resource outlook is different, volumes of available water for the environment change and environmental watering priorities vary. This presents a challenge to water holders and managers to maximise outcomes from the available resources. It is well understood that conditions can change rapidly; therefore the plan presents the priority needs under a wide range of scenarios.

I would like to thank all those who have been involved in the planning, management and delivery of water for the environment and look forward to another successful watering year in 2022-23.

Ben Bruce
South Australia's Basin Officials Committee Member
Executive Director, Water and River Murray
Department for Environment and Water
May, 2022

Cover image: Hogwash Bend



Foraging birds on the Coorong. Credit: John Kruger

Acknowledgements

In addition to DEW staff, input from representatives and employees of the following organisations has been gratefully received:

- Banrock Station, Accolade Wines
- Chowilla Community Reference Committee
- Commonwealth Environmental Water Office
- Coorong, Lower Lakes and Murray Mouth Community Advisory Panel
- First Peoples of the River Murray and Mallee Region
- Katarapko Community Advisory Panel
- Local Action Planning groups and Landcare groups
- Murray-Darling Basin Authority
- Murraylands and Riverland Landscape Board
- Nature Foundation
- Ngarrindjeri Aboriginal Corporation
- Mannum Aboriginal Community Association Incorporated
- Pike Community Reference Group
- Renmark Irrigation Trust
- SA River Murray Channel and Floodplain Scientific Advisory Group
- SA Water
- Lower Lakes, Coorong and Murray Mouth Scientific Advisory Group
- South Australian Research and Development Institute
- The University of Adelaide
- Flinders University
- Other South Australian government departments through interagency reference groups

Water for the environment at Chowilla Floodplain

Glossary

Selected Terms and Acronyms

Name of unit	Symbol
ADF	Additional Dilution Flow – 3,000 ML/day when storage triggers are met in the Menindee Lakes and Hume and Dartmouth Reservoirs
AHD	Australian Height Datum
AOO	Annual operating outlook
Barrage	structures located between Lake Alexandrina and the Coorong, constructed to manage water levels and improve water quality in the lower Murray and Lower Lakes system
CEWH	Commonwealth Environmental Water Holder
CEWO	Commonwealth Environmental Water Office
DEW	Department for Environment and Water
Diadromous	fish that migrate between salt water and freshwater
Entitlement flow	South Australia has an annual Entitlement flow of 1,850 gigalitres under the Murray-Darling Basin Agreement, 1992. This volume can be reduced if water availability is limited when conditions are dry.
EWRs	Environmental water requirements
Fishway	a generic term describing all structures designed to allow the passage of fish along a waterway
FPRMMR	First Peoples of the River Murray and Mallee Region
HEW	Held environmental water
IOS	Integrated Operations Strategy
LLCMM	Lower Lakes, Coorong and Murray Mouth
Lower Lakes	Lakes Alexandrina and Albert
LTWP	Long Term Environmental Watering Plan for the South Australian River Murray Water Resource Plan Area (Department for Environment and Water, 2020)
MDBA	Murray-Darling Basin Authority
NAC	Ngarrindjeri Aboriginal Corporation
PEW	Planned environmental water
Pool-connected wetland	a wetland that is connected to the River when South Australia is receiving Entitlement flows and the weir pool is being maintained at normal pool level
QSA	river flow to South Australia, as calculated at the State border
Return flow	environmental water used upstream which is returned to the river and is available for reuse downstream
RMMAC	River Murray and Mallee Aboriginal Corporation
SA	South Australia
SA Multi-site	a planning output that optimises and coordinates proposed site-specific watering actions for system-scale benefits
SCBEWC	Southern-connected Basin Environmental Watering Committee
Temporary wetland	a wetland that is not connected to the River when South Australia is receiving Entitlement flows and the weir pool is being held at normal pool level
TLM	The Living Murray program – a river restoration program funded by New South Wales, Victoria, South Australia, Australian Capital Territory and the Commonwealth government, coordinated by MDBA
Unregulated flow	water that cannot be captured and regulated through Murray-Darling Basin Authority storages. The Murray-Darling Basin Authority declares an unregulated flow event at the South Australian border for a specific period
WAP	Water Allocation Plan
Water year	the period between 1 July in any given calendar year and 30 June the following calendar year
WRP	Water Resource Plan

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Summary

This document presents South Australia's priorities for delivery of water for the environment along the South Australian (SA) River Murray for the 2022-23 water year. It describes the water delivery requirements to best achieve a range of environmental outcomes along the SA stretch of the River channel, its floodplains and wetlands, through to the Coorong and Murray Mouth, consistent with the requirements under the Murray-Darling Basin Plan. In doing so, it identifies opportunities to maximise outcomes from watering in SA by using return flows from upstream watering actions. It also promotes delivery of water for the environment to the Lower Lakes, Coorong and Murray Mouth, while providing benefits to upstream environmental assets and functions en-route.

The *Annual Environmental Watering Plan* (the Annual Plan) is presented as follows:

- **Section 1: Introduction** provides background information relevant to environmental watering, including recent hydrological conditions in the region.
- **Section 2: Annual Planning Process** summarises how environmental managers identified objectives for environmental watering in SA, engaged with stakeholders and Traditional Owners and identified and assessed any potential risks.
- **Section 3: Annual Priorities** presents the annual environmental watering priorities for the SA River Murray Water Resource Plan (WRP) area, which are submitted to the Murray-Darling Basin Authority (MDBA) in accordance with Basin Plan requirements. It describes a range of site-based watering actions, as well as the preferred combination of all, or the SA River Murray multi-site (SA multi-site) watering action, for the use of water for the environment within the SA River Murray region.
- **Section 4: Annual Plan Implementation** outlines the next steps in undertaking delivery of water for the environment.

Southern bell frog (Litoria raniformis) at Pike Floodplain

1. Introduction

1.1 Purpose of this Plan

The Annual Plan guides the delivery of water for the environment in the SA River Murray and has been developed in consultation with key stakeholders. The Annual Plan presents the priorities for delivery and use of water for the environment under a range of water availability scenarios. This information is submitted to the MDBA and the Commonwealth Environmental Water Holder (CEWH) to inform whole of basin water delivery planning and fulfils SA's Basin Plan requirements to develop annual watering priorities.

The Annual Plan is a part of SA's environmental water management framework which includes the development of the Annual Plan, the annual SA River Murray water for the environment report, the *Long Term Environmental Watering Plan for the South Australian River Murray Water Resource Plan Area* (*SA River Murray LTWP*) (Department for Environment and Water, 2020) and active management of water for the environment delivered to SA. The Annual Plan integrates all of the proposed watering activities for the water year ahead and has been developed based on the best available data and science. However, it is recognised that water availability and delivery is subject to change depending on actual river and climatic conditions, which will necessitate real-time and adaptive water use.

The Annual Plan presents the water demands for the three priority environmental assets: the Lower Lakes, Coorong and Murray Mouth (LLCMM), the River Murray Channel and the River Murray Floodplain as described in the *SA River Murray LTWP*. The Annual Plan identifies the preferred volume and timing of flow to SA, as well as the optimal use of infrastructure such as regulators, weirs and pumps to facilitate water delivery.

The 2022-23 environmental watering priorities identified in the Annual Plan are consistent with the environmental watering requirements (EWRs) described in the *SA River Murray LTWP* and with the *Basin-Wide Environmental Watering Strategy* (Murray-Darling Basin Authority, 2019).

What is Environmental Watering?

Environmental watering is the delivery or use of water to achieve environmental outcomes, providing ecological benefits that contribute to a healthy, functioning river. Water for the environment ensures that important values of the SA River Murray, its wetlands, floodplains and estuary are maintained and that environmental objectives are achieved.

Water for the environment delivered along the River Murray in SA is coordinated by the Department for Environment and Water, with significant input and on-ground action from other government agencies, non-government organisations, scientific bodies and community stakeholders.

Werta Wert wetland at Chowilla

1.2 The 2021-22 Water Year

More than 9 months of unregulated flows [1]

Operation of **Chowilla**, **Pike** and **Katarapko** floodplain regulators

Highest barrage releases since 2016-17

Managed inundation of **over 105** temporary wetlands

1 lake level cycling event of the Lower Lakes

Manipulation of the **6 weirs** on the main-channel [2]

A brief summary of the 2021-22 water year to date (as of 30 April 2022) is outlined below, providing context for the conditions leading up to the 2022-23 water year. Further information on the outcomes of the environmental watering actions in 2021-22 will be presented in the annual environmental watering report which will be produced once the water year concludes.

In the first two weeks of the 2021-22 water year, flow to SA consisted of Entitlement flow plus a small volume of water for the environment. Then, on 15 July 2021, an unregulated flow event at the SA border was declared by the MDBA and the event was still continuing at 30 April 2022. This unique, prolonged unregulated flow event saw flow at the SA border (QSA) remain above 20,000 megalitres per day (ML/day) for the majority of the time, and above 30,000 ML/day for 67 (non-consecutive) days. Flow to SA peaked at just over 37,000 ML/d in late December 2021 (Figure 1). Water for the environment continued to be delivered throughout the 2021-22 water year and contributed to the elevated flows.

From 30 August 2021, SA also received Additional Dilution Flow (ADF) of 3,000 ML/day as required under the MDB Agreement when storage triggers are met in the Menindee Lakes and Hume and Dartmouth Reservoirs. Unregulated flows and ADF are considered planned environmental water (PEW) in South Australia.

The elevated flow conditions, saw the highest volume of water since the 2016-17 water year arriving at the Lower Lakes, with almost 5,000,000 megalitres (or 5,000 gigalitres) released from the barrages in the 2021-22 water year (at 30 April 2022).

Water for the environment delivered to SA, along with the unregulated flows, was used to support numerous watering actions throughout the year, including:

- operating Chowilla, Pike and Katarapko floodplain regulators in conjunction with the raising of Weir 6, Weir 5 and Weir 4, respectively, in spring and early summer
- delivering water to over 105 temporary wetland and floodplain sites (including sites managed by DEW, Murraylands and Riverland Landscape Board, Australian Landscape Trust, Accolade Wines, Renmark Irrigation Trust and Nature Foundation) via pumping or irrigation
- coordinating the delivery of water for the environment in conjunction with unregulated flows to prevent short or rapid decreases in flow to SA
- adaptively managing 52 pool-connected wetlands, including rapidly responding to changing flow conditions
- managing the LLCMM throughout the water year, including lake level cycling, Salt Creek releases, and maintaining barrage and fishway releases to the Coorong to support fish movement, reduce salinity in the Coorong and support the Coorong food web including ruppia, estuarine fish and invertebrates.

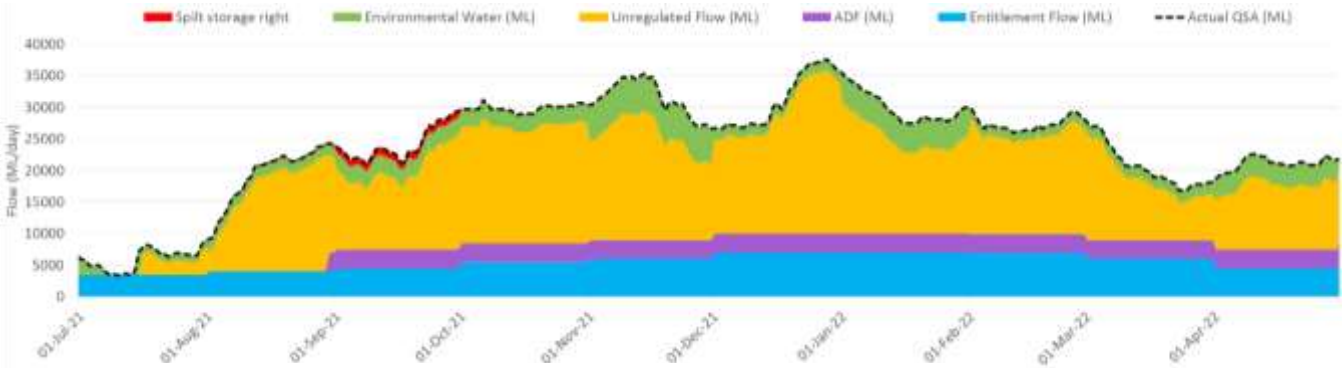

Figure 1. River Murray flows at the South Australian border 1st July 2021 to 30th April 2022.

[1] As of 30 April 2022, the MDBA-declared unregulated flow event was continuing at the SA border

[2] Raisings were undertaken at 4 weirs and lowerings within normal operating range were undertaken at 6 weirs

River Murray channel, at Hogwash Bend.

2. Annual Planning Process

South Australia commences annual planning each February, using a scenario-based approach based on modelled hydrographs provided by the MDBA and projected availability of water for the environment allocations. The SA planning process includes the development of site-based annual environmental watering proposals using a template provided by the Southern-Connected Basin Environmental Watering Committee (SCBEWC) for a range of sites and types of watering actions (Table 1). In addition to these site-based proposals, a SA multi-site proposal is also developed that describes the preferences for coordinated delivery of water for the environment for all sites.

Once complete, the watering proposals are provided to SCBEWC as part of the annual planning process. SCBEWC is coordinated by the MDBA and brings together agencies from the Commonwealth, New South Wales, Victorian and South Australian governments to coordinate and manage water for the environment across the southern-connected Basin within the Murray-Darling Basin. SCBEWC ensures environmental water management is consistent with the Environmental Watering Plan (Chapter 8 of the Basin Plan), including the *Basin-wide Environmental Watering Strategy* (Murray-Darling Basin Authority, 2019) and facilitates collective water for the environment planning for the major water holders. This approach supports effective coordination while allowing different environmental water holders to make independent decisions on watering actions.

The watering proposals are consolidated into this overarching Annual Plan document and represent the state's annual environmental watering priorities for the SA River Murray region. DEW leads the annual planning process with input from site and water managers, environmental water holders, River operators, scientists, Traditional Owners, and stakeholder and community groups. The Murraylands and Riverland Landscape Board and several private organisations including Nature Foundation, Renmark Irrigation Trust, Accolade Wines and the Australian Landscape Trust, play a critical role in planning for watering actions at a large number of wetlands throughout the region including the managed wetting and drying of pool-connected wetlands.

Table 1. Environmental watering proposals submitted to the Murray Darling Basin Authority and/or the Commonwealth Environmental Water Office for 2022-23.

Watering Proposal	Site Manager
Lower Lakes, Coorong and Murray Mouth	SA Department for Environment and Water
SA River Murray Channel and Floodplain	SA Department for Environment and Water
Chowilla Floodplain (incl. Lock 6)	SA Department for Environment and Water
Pike Floodplain (incl. Lock 5)	SA Department for Environment and Water
Katarapko Floodplain (incl. Lock 4)	SA Department for Environment and Water
Weir Pool Raising and Lowering (Locks 6 to 1)	SA Department for Environment and Water
Various wetlands along the River Murray and Lower Lakes	Murraylands and Riverland Landscape Board
Wetlands in the Renmark area	Renmark Irrigation Trust[1]
Banrock Station wetlands	Accolade Wines[1]
Calperum Station lakes and wetlands	Australian Landscape Trust[1]
Various wetlands along the River Murray and Lower Lakes	Nature Foundation[1]

[1] Non-government organisations do not complete a SCBEWC watering proposal

2.1 Planning Inputs

2.1.1 Planning Scenarios

Planning for the 2022-23 water year was undertaken for six water resource availability scenarios: 95 per cent (very dry), 90 per cent (dry), 75 per cent (moderate), 50 per cent (near average), 25 per cent (wet) and 10 per cent (very wet) (Figure 2). These water resource availability scenarios correspond to scenarios used by the MDBA for the Annual Operating Outlook (AOO) and hence are referred to as AOOs in this Annual Plan. In March 2022, the MDBA provided a modelled hydrograph of average flows for a given month for each AOO scenario to assist with developing environmental watering proposals. These were based on the 2012-13 AOO planning, which was considered suitable as that water year had similar starting storage levels to those expected in 2022-23.

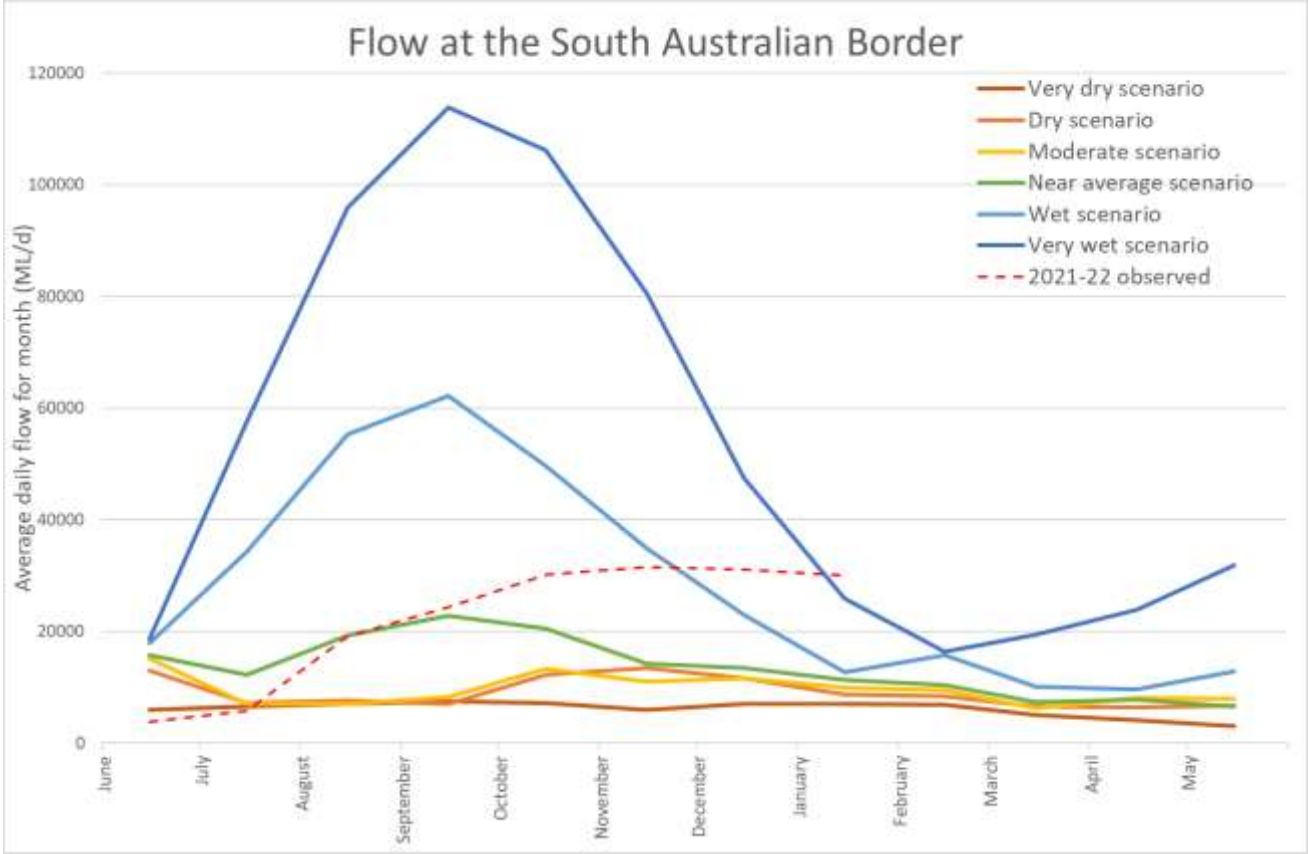

Figure 2. Annual operating outlook (AOO) scenarios provided by the Murray-Darling Basin Authority in March 2022.

2.1.2 Water for the Environment Availability

Held Environmental Water

Potential held environmental water (HEW) availability is taken into account during planning so that the proposed actions and watering objectives consider the feasibility of delivery. As the annual planning process commenced prior to water allocation announcements being made, HEW availability under each water resource availability scenario was estimated by the environmental water holders in March 2022 based on allocation outlooks and carry-over estimates.

The total estimated volume available by the end of the 2022-23 water year ranged from 1,282 gigalitres in a very dry scenario to 1,765 gigalitres in a wet scenario (Table 2). No estimate was provided for the very wet scenario. These volumes represent HEW in Victoria and New South Wales that is held by TLM or CEWH only. Based on previous years, it is assumed that approximately 60 – 70 percent of the total HEW available upstream will reach SA. HEW on licence in SA forms part of the state's Entitlement which is already built into the AOO planning hydrographs and therefore is not included in the estimates of HEW availability during planning. More information regarding HEW within SA can be found in the *South Australian River Murray WRP Held Environmental Water Register* which is published on the DEW website.

Table 2. Estimate of held environmental water available upstream of SA in 2022-23 under each water resource availability scenario.

Scenario	Estimate of held environmental water availability (GL)		
	Total upstream of SA border	60% of total	70% of total
Very dry (95%)	1,282	769	897
Dry (90%)	1,388	833	972
Moderate (75%)	1,547	928	1,083
Near average (50%)	1,756	1,054	1,229
Wet (25%)	1,765	1,059	1,236

Planned Environmental Water Availability

Planned environmental water (PEW) is defined in the *Water Act 2007* as any water that is committed or preserved for achieving environmental purposes or outcomes and that cannot be used for any other purpose unless required in emergency. PEW within SA is identified in the *Water Allocation Plan for the River Murray Prescribed Watercourse* (*WAP*) (Murraylands and Riverland Landscape Board, 2021) and includes the unallocated portion of annual SA's Entitlement flow, the dilution and loss component of SA's Entitlement flow, unregulated flows to SA and Additional Dilution Flow (ADF). PEW availability is already factored into the AOO planning hydrographs. Should a MDBA-declared unregulated flow event occur during 2022-23, then environmental water managers may seek to use unregulated flows to support their watering actions, in accordance with the *Landscape South Australia Act 2019* and subject to sufficient volumes being available.

Shelduck chicks (Tadorna tadornoides) on Pike floodplain

2.2 SA River Murray Environmental Water Planning

2.2.1 Site-based Planning

A suite of environmental watering activities occur at a range of sites within the SA River Murray, including small scale individual wetlands, large scale floodplains, lock reaches and the River Murray channel scale.

The types of watering events that can occur at these sites include:

- the operation of regulators within floodplain anabranches, e.g. Chowilla, Pike and Katarapko floodplains
- weir pool manipulations, including raising and some lowering
- river channel and floodplain watering via augmentation of unregulated flows or creation of in-channel flow events (e.g. spring pulses)
- pumping and water delivery via infrastructure into temporary wetlands
- flushing and freshening disposal basins
- wetting and drying of managed pool connected wetlands
- LLCMM management, including lake level variations, lake cycling, fishway operations and barrage releases.

The development of site-based watering proposals has been undertaken by the respective site water managers. The SCBEWC watering proposal template was used for each site to outline the preferred watering options (including management actions and ecological objectives) for each of the AOO scenarios. The information used to develop the watering proposals includes site condition data, past watering history and outcomes, site operating or management plans, consideration of risk assessments and capacity to monitor and mitigate risks, modelling outputs and input from Traditional Owners, scientists and the community. The outcomes and evaluation of previous years' monitoring projects and the lessons learnt, from past water delivery and operations are also incorporated into the development of site watering proposals.

Water held within the Wetlands Consumptive Pool (Class 9), as described in the *WAP* (Murraylands and Riverland Landscape Board, 2021), is allocated across managed pool connected wetlands within the SA River Murray WRP area. The wetting and drying regime for these wetlands is planned by site managers, including the Murraylands and Riverland Landscape Board, Accolade Wines, Australian Landscape Trust and Nature Foundation.

2.2.2 SA River Murray Multi-site Planning

DEW has developed a SA multi-site watering proposal for 2022-23, outlining the optimal delivery of water for the environment within the SA River Murray system. The SA multi-site proposal seeks to align the site-specific watering actions that have been identified in this document to maximise the effectiveness of environmental water delivery and enhance ecological outcomes throughout the system. The SA multi-site approach is supported by SA policy which prevents return flows from environmental watering actions, such as the operation of the floodplain regulators and weir raisings, from being re-allocated for consumptive use, ensuring this water remains within the River Murray channel for delivery to other downstream environmental watering sites or the LLCMM for ecological benefit.

The SA multi-site proposal identifies:

- objectives for the SA multi-site watering action
- assumptions used in developing the SA multi-site
- environmental watering actions for each scenario and the additional benefits associated with the SA multi-site
- proposed environmental water volume and optimal delivery pattern for the SA multi-site under different scenarios

Consultation with individual site managers, external scientific experts and other key stakeholders was undertaken in the development of the SA multi-site. The development of the SA multi-site was also supported by integrated operations modelling and risk assessments.

2.2.3 Integrated Operations

Integrated Operations is a term used to describe the coordination of water delivery to SA and large scale environmental watering involving infrastructure operation, in a way that manages the potential risks of adverse impacts and, where possible, achieve cumulative benefits across the SA River Murray. A number of tools have been developed to assist with this coordination, including the *Integrated Operations Strategy* (*IOS*; DEW, 2021a) and the *South Australian River Murray Environmental Water Source Model* (the *Source Model*).

The *IOS* has been developed to support the decision-making complexity associated with an increasing number of large scale watering opportunities. It documents ecological and hydrological thresholds, in particular levels of concern for flow and water quality parameters, that may arise through the combination of multiple watering events and river flows (integrated operations) occurring during the year. The *Source Model* is a hydrological modelling platform that forecasts the impact on hydrodynamic and water quality parameters resulting from environmental watering actions.

During annual planning, Source modelling of site based watering proposals and river flows for each of the AOO scenarios was undertaken to forecast the response of surface water parameters to the combined suite of proposed actions. The modelling results were then assessed to identify the potential risks of the combined operations exceeding water quality and flow thresholds as outlined in the *IOS*.

The integrated operations modelling outputs indicated that the salinity, river discharge, dissolved oxygen and dissolved organic carbon levels associated with the preferred suite of watering actions, remained within the low concern levels in the main River channel, and hence posed low risks. Outputs indicated a potential impact on channel velocities at certain times of the year as a result of some combinations of operations. Operations and environmental water delivery will be managed adaptively where possible to limit any potential impacts. The modelling and integrated operations assessments were used to support the final suite of site proposals within the multi-site proposal.

Environmental water at Snake Creek on Pike Floodplain, following operation of Pike floodplain regulator

2.3 Community Engagement

A wide range of stakeholders including a number of community groups are consulted regarding the environmental watering actions proposed for 2022-23. Consultation is undertaken by site managers through long-standing and on-going arrangements with groups such as:

- Coorong, Lower Lakes and Murray Mouth Community Advisory Panel which is comprised of representatives including commercial fishers, irrigators, Landcare organisations, local government, boating organisations, shack owners association and individual landholders.
- Coorong, Lower Lakes and Murray Mouth Scientific Advisory Group which is comprised of members from Flinders University, the University of Adelaide, South Australian Research and Development Institute, Commonwealth Scientific and Industrial Research Organisation, Environment Protection Agency, and independent consultants.
- The Yarluwar-Ruwe Project Coordinator is also a member across both LLCMM advisory groups to represent the interests of the Ngarrindjeri Aboriginal Corporation (NAC) and Ngarrindjeri community.
- South Australian River Murray Channel and Floodplain Scientific Advisory Group, which consists of representatives from the University of Adelaide, South Australian Research and Development Institute, Commonwealth Scientific and Industrial Research Organisation, and independent consultants.
- The Chowilla Community Reference Committee and Katarapko Community Advisory Panel which include representatives from irrigation trusts, Local Action Planning associations, Landcare organisations, and local government
- Pike Land Management Group and other Pike floodplain landholders
- Water Advisory Committee, a committee of the Murraylands and Riverland Landscape Board

Private landholders, industry groups and the general public are kept informed during the planning and implementation of environmental watering actions across the SA River Murray system via media and the DEW River Murray Flow Report.

Proposed watering actions and associated modelling results are presented and discussed at stakeholder meetings, with site tours undertaken where possible. Engagement also occurs between DEW and non-government organisations that are involved in managing water for the environment to help coordinate delivery of water for the environment to various wetlands throughout the SA River Murray system. These non-government organisations include the Australian Landscape Board, Nature Foundation, Renmark Irrigation Trust and Accolade Wines.

Members of the Coorong, Lower Lakes and Murray Mouth Community Advisory Panel on a tour of the Kurrangk (Coorong) led by Ngarrindjeri

2.4 First Nations Engagement

First Nation engagement is undertaken by environmental water managers throughout the year, including during the development of SCBEWC watering proposals and preparation of the Annual Plan. Engagement with the NAC helps to define the ecological and cultural watering objectives and actions proposed for the LLCMM. The First Peoples of the River Murray and Mallee Region (FPRMMR) are also engaged in the process of developing objectives and actions proposed for the Chowilla, Pike and Katarapko Floodplains, the River Murray Channel and floodplain, wetland pumping and weir pool manipulation watering actions.

Funding from The Living Murray program supports two dedicated First Nations staff to assist with engagement between DEW, FPRMMR and NAC. Where possible, engagement with First Nations groups is undertaken in collaboration with the Commonwealth Environmental Water Office and MDBA staff to ensure both site-based and system-scale planning and priorities are discussed.

The NAC is engaged in the management of water for the environment in the LLCMM on an on-going basis throughout the water year. DEW staff on behalf of The Living Murray program, work with the NAC Yarluwar-Ruwe Project Coordinator, to engage with NAC staff, the NAC Board and more broadly the Ngarrindjeri community. This engagement includes face to face/online meetings, on-country tours and workshops to discuss barrage operations, lake level management, planning and delivery of water for the environment, and participation in ecological monitoring. Engagement further extends to reviewing and providing cultural input to many documents including the SCBEWC watering proposals for the LLCMM and River Murray Channel.

In 2020-21, a dedicated 'Yarning Circles' project was delivered by NAC and DEW which aimed to understand and document Ngarrindjeri cultural values regarding water and to assist in decision-making for the planning and delivery of water for the environment to Ngarrindjeri Ruwe (Country). Ngarrindjeri cultural values identified through this process will be incorporated into the 2022-23 water for the environment planning, along with additional information which has also been obtained through subsequent meetings, presentations and workshops with NAC staff, the NAC Board and the Ngarrindjeri community during March and April 2022.

Celebrating the Yarning Circles project with a tour across the Murray barrages

The FPRMMR is engaged throughout the year on the planning and delivery of water for the environment at a number of locations. This engagement includes discussions and presentations at FPRMMR Working Group meetings, sharing of information and time spent on Country. In May 2022, a dedicated meeting on Country at Martins Bend Wetland was held with members of the FPRMMR Working Group to understand cultural values associated with watering actions at Chowilla, Pike and Katarapko Floodplains, delivery of water to the environment through the main River channel, weir pool manipulation and pumping to wetlands throughout the region.

Aboriginal Waterways Assessments are a tool used by Traditional Owners to assess the cultural values of wetlands and other important sites to support water for the environment and wetland management planning. The FPRMMR has undertaken Aboriginal Waterways Assessments at a number of floodplain and wetland sites, including revisiting some sites to see the outcomes from delivering water for the environment. Aboriginal Waterways Assessments enable the sharing of knowledge between First Peoples and environmental water managers about environmental watering actions and the management of sites to meet cultural and environmental outcomes. Members of the FPRMMR and First Peoples Working Group have also been engaged through workshops with the environmental water managers which aim to further develop understanding of river management and help develop materials which can be used to share knowledge. Through these workshops the FPRMMR is working with DEW to compile existing knowledge and understanding of the River Murray which will be shared among community and inform improved ecological outcomes based upon Traditional knowledge.

Annual planning gathering with FPRMMR working group members at Martins Bend

Werta Wert wetland, Chowilla

3. Annual Priorities for 2022-23

South Australia has developed site-specific watering proposals for a number of locations throughout the SA River Murray system in the 2022-23 water year using a scenario-based approach, with the scenarios represented by the AOO planning hydrographs (see section 2.1.1 Planning Scenarios). A summary of site-based actions are presented below. Appendix A provides detailed lists of all proposed actions under each water resource availability scenario, including associated volumes and ecological objectives.

3.1 Site-based Watering Actions

3.1.1 Lower Lakes, Coorong and Murray Mouth Icon Site

Lakes Alexandrina and Albert

In a very dry scenario, water for the environment is needed to maintain water levels in the Lower Lakes above 0.4 m Australian Height Datum (AHD). For all other water availability scenarios, there is sufficient water available to manage water levels in the Lower Lakes within preferred envelopes without the use of water for the environment, therefore all water delivered can be prioritised for barrage releases.

Water levels in the Lower Lakes will undergo slow, seasonal fluctuations, with minimum levels in autumn ranging from 0.5 m AHD in a very dry scenario to 0.65 m AHD in a very wet scenario. Maximum lake levels in December will range from 0.77 m AHD in a very dry scenario to 0.85 m AHD in a wet or very wet scenario. Seasonal water level fluctuation aims to enhance emergent and submergent vegetation in fringing wetlands of the Lower Lakes, which provides habitat for small-bodied threatened fish such as southern pygmy perch (*Nannoperca australis*) and Murray hardyhead (*Craterocephalus fluviatilis*). Raising and maintaining water levels during spring and early summer also aligns with the timing of colonial waterbird nesting in the Lower Lakes.

If sufficient water is available, and if salinity in Lake Albert remains high, a rapid lake level cycle (lowering and raising water levels by up to 0.25 metres) may be considered in winter or early spring, with the objective of drawing salty water out of Lake Albert, replacing that volume of water with fresher water from Lake Alexandrina, and reducing salinity. If this action is implemented, a short-term maximum lake level of 0.9 m AHD may be considered to provide a greater amount of water exchange between the lakes.

Ngarrindjeri Aboriginal Corporation assisting the University of Adelaide with threatened fish monitoring in the Lower Lakes. Credit: Rick Hartman

Barrage Operations, Murray Mouth estuary and the Coorong

For all water availability scenarios, all barrage fishways will remain open for 365 days, even during reverse flow events. When sufficient water is available, barrage bays will be preferentially opened adjacent to fishways to provide attractant flow for fish passage.

During winter, flows will be more evenly split across the barrages, with a greater percentage of flow released from Goolwa and Mundoo barrages. Flows directed to the estuary, Murray Mouth and Southern Ocean during winter are important for attracting migrating fish such as pouched and short-headed lamprey (*Geotria australis* and *Mordacia mordax*) from the ocean to the River Murray. Winter flows also facilitate downstream migration for adult congolli (*Pseudaphritis urvillii*) and common galaxias (*Galaxias maculatus*). During spring and summer, flows will be prioritised to the Coorong, with up to 85% of flows to be targeted from Tauwitchere and Ewe Island barrages. This is the time of the year that the largest volume of water for the environment is required for the LLCMM.

For very dry, dry and moderate scenarios, the likely outcomes from spring/summer water delivery will be *Ruppia tuberosa* (and other associated macrophyte) growth and distribution expansion; benthic invertebrate and estuarine fish habitat expansion in the North Lagoon; and salinity reductions in the North and South Lagoons of the Coorong. Moderate volumes of spring/summer barrage flows should provide feeding habitat (diverse and abundant benthic invertebrates) for migratory waders in the North Lagoon. Black bream (*Acanthopagrus butcheri*) recruitment is also possible in the dry and moderate scenarios, and flows can be managed at Goolwa barrage to create salinity stratification to support egg and larvae drift.

For the near average, wet and very wet scenarios, the likely outcomes from spring/summer water delivery will be an extended period of high water levels in the North and South Lagoons; *Ruppia tuberosa* (and other associated macrophytes) growth, distribution, flowering, seed set and turion production; an increase in the abundance of herbivorous and piscivorous waterfowl (i.e. black swan, ducks, pelicans, cormorants, terns); recruitment of small-bodied fish such as smallmouth hardyhead (*Atherinosoma microstoma*) and sandy sprat (*Hyperlophus vittatus*); expansion of the range of estuarine fish into the South Lagoon; an increase in range of some benthic invertebrate species into the northern part of the South Lagoon and widespread salinity reductions.

In late March and early April, flows will again be prioritised from Tauwitchere and Ewe Island barrages during the very dry to near average scenarios, to ensure fresh water from the North Lagoon will replenish the South Lagoon upon reconnection of the lagoons. For the wetter scenarios, it is unlikely that the lagoons will disconnect over summer and autumn.

Australian Shelduck (Tadorna tadornoides) at Hindmarsh Island. Credit: John Kruger.

Morella Basin and Salt Creek

Flows from Morella Basin and Salt Creek will be managed to provide salinity benefits to the South Lagoon of the Coorong. Providing fish passage at critical times of the year between Salt Creek and the Coorong, and drawing down water levels in Morella Basin over summer to produce mudflat habitat for migratory waders are also considerations for water management. The volume of water available to the Coorong from the South East is highly dependent on localised rainfall.

3.1.2 SA River Murray Channel and Floodplain

In 2022-23, water for the environment is needed for delivery along the entire length of the SA River Murray channel, where possible flowing overbank onto the floodplain, to subsequently arrive in the LLCMM. The proposed water for the environment delivery patterns aim to enhance flow conditions to meet the environmental water requirements (EWRs) identified in the *SA River Murray LTWP* (Department for Environment and Water, 2020).

Overland Corner

Under the very dry scenario, the planning hydrograph indicates that SA will receive Entitlement flow only and releases of water for the environment from upstream will be sought to generate a flow pulse of 15,000 to 17,000 ML/day. Flow pulses have been successfully created in recent years from Entitlement flow conditions but only remained above 15,000 ML/day for fairly short durations. In 2022-23, an extended duration of at least 25 to 60 days is proposed. The preferred timing of the pulse is in late spring/early summer when water temperatures increase. Outcomes from a spring pulse include improved hydraulic conditions, and increased food resources, habitat availability and breeding success for native fish populations. In the areas immediately below the weirs, where water level variability in response to changing flow conditions is the greatest, native vegetation growth and survival through improved soil water availability and groundwater freshening is expected.

In the dry, moderate and near average scenarios, water for the environment is proposed to be used to enhance a small unregulated flow event, targeting 20,000 - 25,000 ML/day at the SA border. Expected outcomes are similar to those associated with the very dry scenarios but with greater confidence of success. Of particular importance, is the significant improvement in hydraulic conditions under these flow conditions, with fast flowing water throughout all of the lock reaches. This fast flowing water helps to keep seeds, eggs and non-mobile biota suspended in the water column, aiding in their transport and dispersal through the River system.

In the wet scenario, water for the environment is proposed to be used to increase the height and slow the recession of a large unregulated flow event. This overbank flow event will reach significant areas of the floodplain and wetlands that have not been inundated since 2016, improving the condition of long-lived vegetation such as lignum, river red gum and black box, and supporting widespread frog and waterbird breeding.

Weir Pool Manipulation

In a very dry scenario, where spring flows are expected to be less than 10,000 ML/d flow at the South Australian Border (QSA), it is preferred that weir pool lowering occur in winters, followed by weir pool raisings in spring. This would occur across all weir pools except weir pool 3. Raisings and lowerings are expected to be of low magnitudes to remain within the available water for the environment volumes and water quality thresholds (Table 3).

In dry, moderate and near average water resource scenarios, where spring flows are expected to be between approximately 13,000 and 23,000 ML/d QSA, it is planned that weir pool raisings will occur in winter, followed by weir pool drawn down or lowering in spring. The spring lowering of weir pools 4, 5 and 6 in the dry, moderate and near average scenarios will only occur if the proposed Katarapko floodplain operations (which incorporate weir pool 4 raising), Pike floodplain operations (which incorporate weir pool 5 raising) and Chowilla floodplain operations (which incorporate weir pool 6 raising) cannot occur. The raising and lowering of weir pool 3 will only occur if there is sufficient flow to manage water quality risks associated with Lake Bonney salinity. Raisings and lowerings are expected to be of maximum possible magnitudes, but will be adaptively managed to stay within available water for the environment volumes and water quality thresholds (Table 3).

Weir pool manipulations are designed to support and enhance spring channel pulses and freshes. Weir pool raisings will increase the lateral inundation extent of flows; freshen groundwater and prevent/reduce vegetation drought stress during weir pool lowerings; provide water to rapidly growing vegetation; promote the germination and establishment of aquatic and flood-dependent plant species; stimulate carbon and nutrient cycling; improve the condition of long-lived, woody vegetation; increase the complexity of riparian, littoral, wetland and floodplain habitats, and thus increase the diversity and resilience of the river bank foodwebs. Weir pool lowering will drain pool-connected wetlands, increase carbon and nutrient transport to the channel; promote the germination and establishment of plant species on the exposed banks; and provide marginal improvements to flow conditions.

Small-scale weir pool lowerings in 2022-23 will support the fast-flowing conditions along the channel that are created through delivery of spring pulses (see above; >0.2 m/s); transport carbon and nutrients from connected water bodies to stimulate a primary productivity pulse in the River; support propagule transport (including fish eggs and larvae); and support the germination of river red gums and black box on exposed, moist soils. Overall, these weir pool manipulations will promote the creation of a wider and more diverse littoral, riparian, wetland and floodplain vegetation community which includes a wide range of aquatic and flood-dependent plant species that germinate in winter on the higher elevations and in spring on the lower elevations.

No weir pool manipulation actions are planned for the wet and very wet scenarios as the high flows will likely mean the weirs are removed.

The durations of the proposed weir pool raising and lowering actions range from approximately 90-150 days (including the filling and drawdown phase) depending on the scenario and weir pool and are proposed to take place between July and December 2022.

Table 3. Proposed manipulations for each weir pool in 2022-23 under the different AOO scenarios.

Annual operating outlook	Proposed manipulation for each weir pool in metres above (+) or below (-) normal pool level											
	Lock 1		Lock 2		Lock 3		Lock 4		Lock 5		Lock 6	
	Winter	Spring	Winter	Spring	Winter	Spring	Winter	Spring	Winter	Spring	Winter	Spring
Very Dry	-0.10	+0.20	-0.08	+0.30	0	0	-0.40	+0.30	-0.08	+0.30	-0.18	+0.30
Dry	+0.20	-0.10	+0.55	-0.08	0	0	+0.30	-0.04	+0.05	-0.08	+0.42	-0.18
Moderate	+0.20	-0.10	+0.55	-0.08	0	0	+0.30	-0.04	+0.05	-0.08	+0.42	-0.18
Near Average	+0.20	-0.10	+0.55	-0.08	+0.21	-0.30	+0.30	-0.04	+0.05	-0.08	+0.42	-0.18

3.1.3 Managed Floodplains

Chowilla Floodplain

In 2022-23, the proposed Chowilla Floodplain environmental watering actions include operation of the Chowilla Creek regulator and Weir 6 under the dry, moderate, near average and wet water availability scenarios. Under the very dry water availability scenario, pumped delivery of water to a number of priority wetlands and floodplain areas will take place. These wetlands are prioritised based on need, informed by monitoring data, the availability of environmental water and funding. Inflows via Pipeclay Creek and Slaney Creek weirs will be managed to optimise outcomes for native fish species through the anabranch throughout the water year.

Black-fronted dotterel (Elseyornis melanops) at Chowilla. Credit: Helga Kieskamp

Under the dry, moderate, near average and wet water availability scenarios, a mid to high level regulator operation will potentially be undertaken along with an associated raising of Weir 6, depending on the level of River Murray flows received. This will enable inundation across approximately 4000 to 8000 ha of floodplain and wetlands.

The regulator operations will provide improved soil moisture conditions within creek banks and across areas of wetlands and floodplains, supporting long-lived, woody vegetation condition and regeneration of floodplain understorey vegetation. The watering will also provide feeding and breeding habitat for birds and amphibians, and allow the mobilisation of carbon and nutrients from the floodplain to the River.

The inundation extent from a high level operation of the Chowilla regulator would extend into areas of black box trees in the high-elevation areas of the floodplain that haven't been watered since natural flooding in 2016.

A managed inundation following environmental regulator operations at Chowilla Floodplain

Pike Floodplain

The Pike and Tanyaca regulators are proposed to be operated under all water availability scenarios. Under a very dry water scenario, small adjustments to the heights of the Pike and Tanyaca regulators, and the volumes of water entering through the inlets may be undertaken to optimise flow velocities and fish habitat in the two main flow paths of Pike Floodplain, and to help manage water quality.

A managed inundation of Tanyaca Creek on Pike Floodplain

Under a dry water availability scenario, the regulators would be operated to generate a small-scale watering event, which would not require Weir 5 to be raised. Under this scenario, an in-channel rise in water level would occur in Pike River and Mundic Creek. This will provide water to long-lived vegetation and promote improved diversity of native amphibious and aquatic understorey plants along the riparian zone, as well as providing cues for frog breeding. High level floodplain regulator operations, inundating up to 1,200 ha of floodplain and temporary wetlands will be undertaken under moderate, near average and wet water availability scenarios. These actions seek to improve soil moisture to promote growth and recovery of floodplain trees, lignum and understorey vegetation that has suffered from lack of overbank flooding and salt accumulation in the soils. Inundation of the floodplain will create additional temporary habitat for waterbirds, small-bodied fish, frogs and turtles, and help transfer nutrients and carbon from the floodplain to support the River channel food web. This floodplain watering would be enabled by raising Weir 5 to increase flows through the floodplain to maintain optimal water quality throughout the operation.

Katarapko Floodplain

The Splash regulator at Katarapko floodplain will potentially be operated under dry, moderate or near average water availability scenarios. A low level watering event is planned under a dry water availability scenario. This would see water levels rise throughout the anabranch, remaining largely in-channel and spreading just overbank in some localised areas, to provide additional moisture to riparian vegetation leading into summer, and provide cues for frog breeding. It would not be necessary to raise Weir 4 to support delivery of this small-scale watering event.

A high level inundation is possible under the moderate and near average water availability scenarios to improve soil moisture for long-lived vegetation and understorey plants. Weir 4 would be raised in conjunction with the regulator operation to increase the flow of water through the floodplain, assisting to maintain optimal water quality during the watering event. Widespread watering of the floodplain is expected to provide suitable foraging and breeding habitat for waterbirds, turtles, frogs and small-bodied native fish. It is estimated that between 800 and 900 hectares of floodplain and temporary wetlands would be watered under these water availability scenarios.

River red gums and black box at mid to high elevation on the Katarapko floodplain have responded well to delivery of environmental water in 2020 and 2021. Nevertheless, monitoring has identified that there continue to be some stressed trees that would benefit from further watering, and that some of the trees that have recently improved in condition would benefit from additional watering to build their resilience.

The Splash regulator at Katarapko floodplain during 2021-22 operations

3.1.4 Wetlands

Various temporary wetlands along the SA River Murray are identified as priorities for receiving water for the environment in 2022-23 (Appendix B. Sites are primarily located in the Riverland region of the River Murray in South Australia and along the length of the River, but also include wetlands fringing the Lower Lakes. Temporary wetland watering, predominantly via pumping, is proposed under all water resource availability scenarios, with the number of wetlands to be watered decreasing as conditions become wetter and increases in flow see them become connected to the River. In 2022-23, under the moderate to wet scenarios, some wetlands may be partially or fully watered as a result of weir pool raising and/or floodplain regulator operations and therefore will require no (or less) pumped delivery. Under the wet to very wet scenarios, many temporary wetlands will be naturally inundated, with a few high elevation temporary wetlands and Lower Lakes wetlands potentially still requiring pumping. Flushing of wetlands impacted by disposal of irrigation drainage water may also be undertaken during scenarios where SA is receiving unregulated flows.

The provision of water for the environment at these sites will contribute to the recovery of threatened species such as the regent parrot, Murray hardyhead and southern bell frog, each listed under the Environment Protection and Biodiversity Conservation Act, 1999 (Commonwealth). Water delivered to these sites also enables the survival of long-lived vegetation such as black box, river red gum and lignum as well as providing conditions for the growth of aquatic and amphibious plant species and the regeneration of understorey plants, thereby creating areas of diverse habitat for a range of wildlife including waterbirds and amphibians.

Wetland watering will be undertaken by the Murraylands and Riverland Landscape Board and DEW, along with a number of non-government organisations (NGO's) including the Australian Landscape Trust, Renmark Irrigation Trust, Nature Foundation and Accolade Wines. The work of these groups is vital in delivering benefits across numerous sites along the SA River Murray, providing valuable refuge habitat and complementing the outcomes achieved through larger scale watering actions such as floodplain operations and weir manipulation by extending watering to areas that would not otherwise receive water.

In addition to the delivery of water to temporary wetlands, approximately 52 pool-connected wetlands will be managed across all water resource availability scenarios, noting that in the wetter scenarios, management of most sites is not possible. Wetland infrastructure will be operated to implement variable water level management, including drying where appropriate, to improve wetland condition and support water-dependent flora and fauna communities that have been impacted by river regulation. Wetland management provides the opportunity to reduce the impact of common carp, improve water quality and increase foraging and breeding areas for wildlife including threatened species.

Wetland watering priorities are reviewed throughout the year based on changing conditions and emerging information. Additional sites and watering actions may be considered when further need for water for the environment is demonstrated as a priority and opportunities to address ecological needs arise.

Pumped water for the environment at Nikalapko. Credit: Murraylands and Riverland Landscape Board

3.2 Cultural Values Associated with Watering Actions

NAC and the River Murray and Mallee Aboriginal Corporation (RMMAC) provided significant input to the development of environmental water priorities in 2022-23. Both organisations were engaged in the development of this Plan, incorporating their interests, visions, and aspirational goals. These include maintaining connectivity through the Basin, providing First Nations' water entitlements for cultural, spiritual and economic use, and encouraging the protection of culturally significant places and Ngartjis (totems). NAC and RMMAC provided the following information for inclusion in this Plan.

3.2.1 Ngarrindjeri Vision for Country

Ngarrindjeri regard all living creatures as equal and don't necessarily want to prioritise one species over another. The focus should be on the overall ecosystem health – a healthy Ruwe (Country) relates to healthy plants and animals and healthy Ngarrindjeri people. As all things are connected, Ngarrindjeri prioritise all species of plants, fish and animals, as impacts on individual plants, fish and animals have a flow on effect within Ruwe. However, Ngarrindjeri recognise the importance of ensuring that Ngartji's (totems) are cared for and have the opportunity to breed within their environment.

The Ngarrindjeri Nation in Southern South Australia use the term Ngarrindjeri Ruwe (Land) or Yarluwar-Ruwe (Sea Country) to encapsulate the inter-connection between country, body, spirit, and all living things. This inter-connection is fundamental to well-being, and it is for this reason that healthy lands and waters are critical to healthy Ngarrindjeri people and culture. Ngarrindjeri have the cultural responsibility to manage the health of Ngarrindjeri lands and waters. Exercising this responsibility ensures that Ngarrindjeri people benefit from all aspects of a healthy Ruwe.

Ngarrindjeri people have an on-going connection to Ruwe and continue to utilise Ruwe for cultural practice, such as camping, hunting and ceremonies.

The Ngarrindjeri Aboriginal Corporation aspire to have Ngarrindjeri people back on Country, practicing culture at the water's edge, with Ngartjis flourishing. The delivery of water for the environment to the Lower Lakes, Coorong and Murray Mouth is instrumental in helping to achieve this goal.

3.2.2 First Peoples of the River Murray and Mallee Region

To capture the FPRMMR interests and objectives in relation to water, the RMMAC (the FPRMMR Native Title prescribed body corporate) have put together an Aboriginal Water Interests Logic Program (Figure 3) with two high-level aspirational goals 'To see our lands and waters healthy to maintain our cultural connections to the lands, water and all living things' and 'To achieve the social and economic outcomes and wellbeing desired by the First People of the River Murray and Mallee Region'.

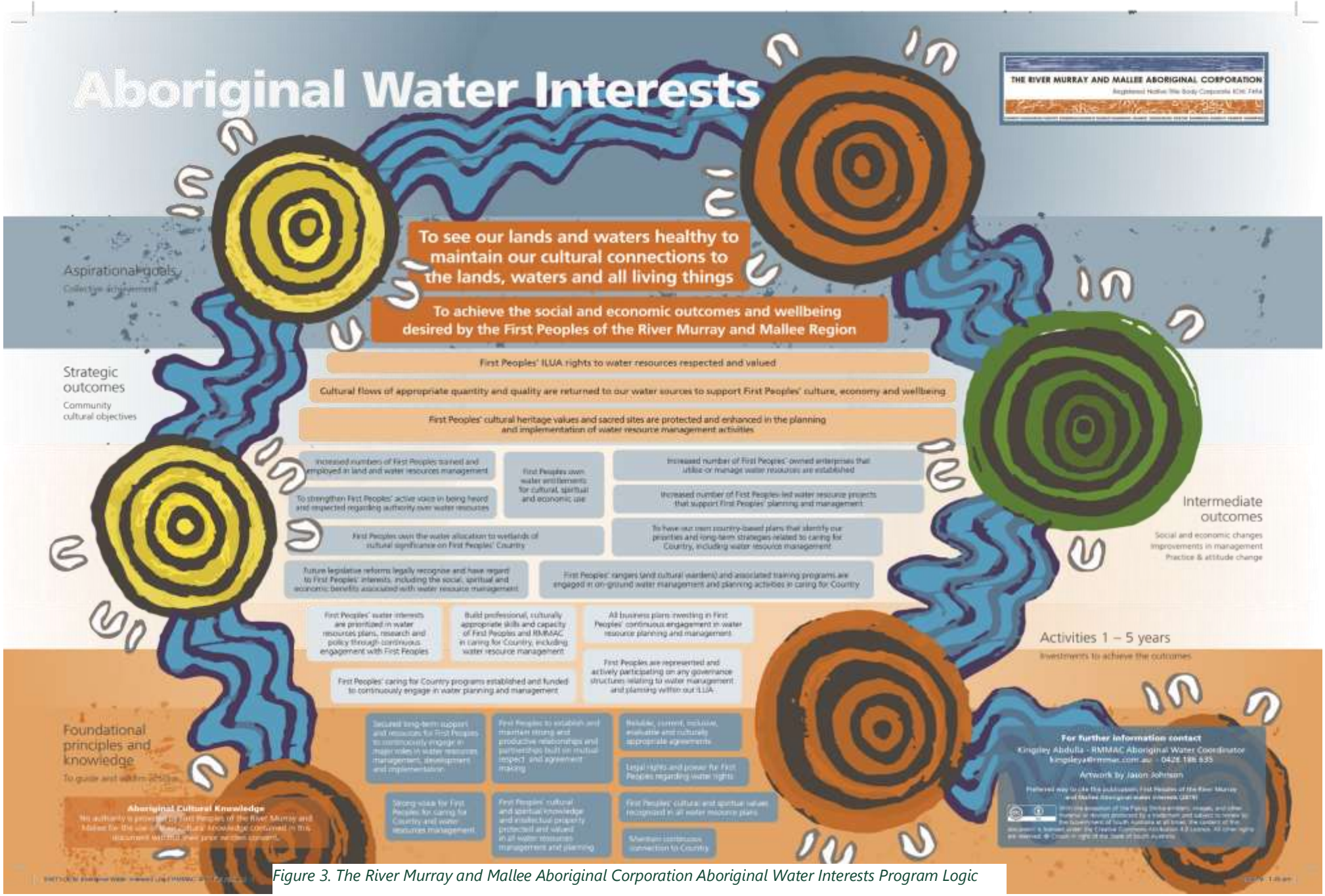

Figure 3. The River Murray and Mallee Aboriginal Corporation Aboriginal Water Interests Program Logic

3.3 System-scale Watering Actions

3.3.1 SA River Murray Multi-site

The 2022-23 SA River Murray multi-site watering proposal aims to meet watering objectives at individual sites, as well as provide additional landscape-scale outcomes. The SA multi-site proposal is underpinned by the objectives, targets and EWRs in the *SA River Murray LTWP* (Department for Environment and Water, 2020) and the expected outcomes in the *Basin-wide Environmental Watering Strategy* (Murray-Darling Basin Authority, 2019).

The SA multi-site watering action for 2022-23 has the following aims:

- coordinate the delivery of environmental water to SA to maximise the potential outcomes throughout the SA River Murray system
- provide pathways for the dispersal, migration and movement of native water-dependent biota
- provide pathways for the dispersal and movement of organic and inorganic sediment to maximise the delivery of resources to downstream reaches and to the ocean
- deliver environmental water to the LLCMM, while providing benefits to upstream environmental assets en-route
- maximise environmental outcomes through the operation of infrastructure where appropriate
- increase the effectiveness of environmental watering and the extent of benefits by aligning the timing, magnitude and duration of discrete actions
- deliver environmental water consistent with the EWRs of the LTWP and contribute to the ecological objectives for priority environmental assets and priority ecosystem functions described in the LTWP.

These SA multi-site objectives are an extension of the environmental watering objectives for site-based actions, which are summarised in Appendix A. The graphs provided in Appendix A indicate the relative timing of the multi-site water demands, the LLCMM water demands and the operation of regulator and lock and weir infrastructure.

In the development of the 2022-23 SA multi-site proposal, the following alignment between site proposals were considered:

- weir pool raisings undertaken as part of floodplain operations will fulfil a number of the objectives of the individual weir pool raising proposals
- where possible, consider minimising the effects of infrastructure operations on flow hydraulics and velocity within the main river channel in critical periods.

The estimated volume of water for the environment required to deliver the 2022-23 SA multi-site proposal ranges from approximately 1,110 GL in the wet scenario to 1,445 GL in the near average scenario (Table 4). The SA multi-site volumes represent the volume of environmental water required to be delivered to the South Australian border to support all proposed watering actions in the SA River Murray for that scenario. These volumes are in addition to water for the environment on SA licences (approximately 250 GL), which is delivered as part of SA's Entitlement and therefore included in the base flow represented in the AOO scenarios. The SA multi-site volumes factor in return flows from site-based watering actions (e.g. Chowilla regulator operation and weir pool lowering) and their contribution to meeting other downstream demands. The volumes also factor in the contribution that the river channel water demand makes to the LLCMM water demands.

This SA multi-site proposal will continue to be used and revised during real-time management planning and was provided to environmental water holders via SCBEWC to support delivery planning for the 2022-23 water year.

Table 4. Indicative volume of environmental water required per month to deliver the SA multi-site action. Options under each scenario represent alternative demand profiles and are not cumulative.

Annual operating outlook	Indicative volume (GL) of environmental water required per month													Total est. volume Jun-22 to Jun-23 (GL)	Total est. volume 2022-23 water year only (GL)
	Jun	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**		
Dry	15	74	75	151	257	287	209	62	35	63	31	31	59	**1,350**	**1,335**
Moderate	28	74	86	170	218	320	206	55	28	63	31	31	62	**1,373**	**1,345**
Near Average	28	94	119	94	285	271	269	77	28	63	51	31	62	**1,473**	**1,445**
Wet	12	17	56	68	149	150	217	225	56	52	30	0	90	**1,122**	**1,110**

3.3.2 Cooperative Arrangements between Water Resource Plan Areas

There is no active management of water for the environment in the Eastern Mount Lofty Ranges WRP area or the SA Murray Region WRP area. Opportunities to coordinate environmental watering between these areas and the SA River Murray are limited. The catchments of the Eastern Mount Lofty Ranges WRP area flow to the lower River Murray and Lake Alexandrina, with the outflow from these catchments contributing approximately 0.5 per cent of the total annual runoff to the Murray-Darling Basin (CSIRO 2007). The timing and volume of environmental watering in the Eastern Mount Lofty Ranges WRP area occurs in response to flow events as they occur, rather than being able to be managed or manipulated to achieve coordinated outcomes with environmental watering in the SA River Murray WRP area. Any flow reaching Lake Alexandrina cannot be allocated and is considered PEW within the SA River Murray WRP area.

The SA Murray Region WRP area includes the Coorong and Murray Mouth, however in recognition of the intrinsic connection between the Coorong and the Lower Lakes, South Australia seeks to manage the site as a whole as described in *the SA River Murray LTWP* (Department for Environment and Water, 2020).

Water holders and managers of water for the environment in SA, New South Wales, Victoria, the MDBA and CEWO have worked together for several years to trial, plan and coordinate annual southern-connected Basin (SCB) multi-site environmental watering events. This planning aims to maximise the use of unregulated flows, water for the environment and return flows at multiple sites as water moves through the SCB.

The SCBEWC and Water Liaison Working Group (both coordinated by the MDBA) contribute to the development of the SCB multi-site events each year. Over the last three years this has included the planning and implementation of a coordinated River Murray channel spring pulse aimed at optimising benefits along the River Murray channel, as well as achieving alignment with upstream tributary inflows and watering actions at wetland and floodplain sites and the LLCMM.

Red-necked avocets (Recurvirostra novaehollandiae) at Coombool Swamp, Chowilla. Credit: Helga Kieskamp.

Pipeclay Billabong, Chowilla

4. Annual Plan Implementation

The *SA River Murray LTWP* and the *SA Environmental Watering Framework* (DEW, 2021b) provide additional information regarding the SA River Murray ecological assets and water for the environment planning, policies and management.

Following annual planning, environmental water is provided, principally by the CEWH and TLM, to support priority watering actions. After water has been agreed for delivery for a particular site/outcome, operational event plans that set out the specifics of infrastructure operations and water delivery are finalised and implemented.

Delivery of water for the environment is undertaken throughout the water year. There is also a need for 'real time' water delivery planning, approvals processes, water delivery, infrastructure operations, monitoring and consultation to adapt to current conditions. The collection of data through monitoring activities is undertaken regularly during planning and water delivery. Importantly, the monitoring results and outcomes provide feedback for decision-making processes and planning in the current and subsequent years (under an adaptive management framework).

The water for the environment water management process (Figure 4) involves:

- Annual planning – development of environmental watering priorities and plans, consultation
- Environmental water provision – approvals, trades
- Water delivery and 'real time' management - infrastructure operations, monitoring
- Reporting and evaluation – water accounting and data analysis

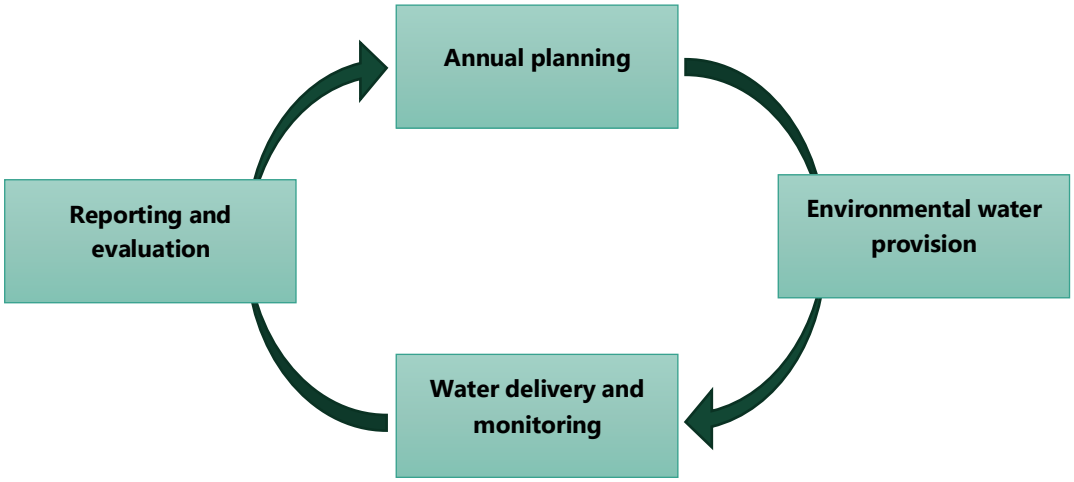

Figure 4: Overview of the annual environmental water management process.

4.1 Environmental Water Provision

Decisions to supply environmental water to meet identified demands in the watering proposals are made by environmental water holders. This includes the CEWH (in relation to Commonwealth environmental watering holdings), SCBEWC (in relation to 'Joint Water', that is TLM, River Murray Increased Flow (RMIF) and River Murray Unregulated Flow (RMUF)) and DEW (on behalf of the SA Minister for Climate, Environment and Water who makes decisions on the use of water on the Minister's water licences).

4.2 Environmental Water Delivery

Delivery and monitoring of water for the environment is undertaken throughout the year. This includes the delivery of water to the SA border and the subsequent management of the water, at the sites identified within this annual plan.

Environmental water delivery incorporates the following activities:

- development of water delivery/operational plans
- approvals
- continuous 'real time' planning
- hydrological modelling
- water delivery in conjunction with infrastructure operation
- monitoring
- ongoing consultation as required
- evaluation, water accounting and reporting.

4.2.1 Real Time Planning and Operations

'Real time' planning is the short-term planning and decision making that occurs on an ongoing basis throughout the year, particularly leading up to and during the delivery of environmental water. The timeframes are shorter than annual planning and the associated water resource forecasts are more accurate than the AOO scenarios used for annual planning.

Real time planning is necessary where the River conditions and flows at the SA border (QSA) differ from the AOO scenarios used in annual planning, resulting in the need to adapt watering actions. This can occur for many reasons, including:

- environmental water requirements identified within the individual watering proposals or SA multi-site are not available, or are unable to be delivered at the required time
- relatively rapid changes in River conditions e.g. flow to SA increases or decreases at rates greater than anticipated
- actual River flow conditions switch between AOO scenarios, e.g. from dry to near average, or do not align with any of the planning scenarios
- there are significant changes in water quality.

Environmental water managers are provided with information on the short-term forecasts of river conditions and the availability of water for the environment. This information is used by the water managers to determine which watering event (or scale of event) may be feasible to undertake.

Where real time planning has led to changes to a watering action, it may be necessary to undertake further modelling and apply the *IOS* to ensure adverse impacts within the River channel are avoided.

Operational Advisory Groups (OAGs) hold regular teleconferences to ensure coordination and communication during watering events and rapid responses to any issues that may arise. Membership of these groups includes environmental water holders, managers of environmental assets and river operators. SA has representatives on cross-jurisdictional committees and OAGs and actively participates in the planning and coordination of large scale environmental watering events for 2022-23.

Spoonbills foraging on Pike Floodplain. Credit: DEW.

4.3 Monitoring, Evaluation and Reporting

Monitoring, evaluation and reporting is critical for improving knowledge of floodplains, wetlands, LLCMM and the River Murray system. It is vital to understanding the physical and biological components of the river system and how these have responded over time to changing water and flow conditions.

Ongoing monitoring programs are essential in being able to assess the outcomes of the delivery of water for the environment. In addition to this, the evaluation and interpretation of monitoring results are fed back into the planning process and are used to support future watering decisions in an adaptive management cycle. This continuous improvement in knowledge and learning increases the effectiveness of environmental water planning and delivery and helps to achieve management and ecological outcomes.

Site specific monitoring is undertaken at all key watering sites, with the methods used, data management and analysis based on the site monitoring plans developed by the water managers, in conjunction with advice from scientific and community stakeholders. As well as supporting site specific watering decisions, the data collected assists with the assessment of environmental water delivery outcomes along the river and supports the evaluation of the *Murray-Darling Basin Plan*.

Each year, DEW compiles an *Annual South Australian River Murray Water for the Environment* Report. The report provides a record of all environmental watering activities undertaken throughout the region during the water year, including evaluation against proposed actions and priorities set out in the relevant Annual Plan. The annual report also presents a summary of key environmental outcome, including case studies, as well as a list of technical reports that provide more detailed information about monitoring and ecological outcomes. All site and water managers across the SA River Murray are encouraged to participate in this reporting process, which also benefits from the input of Traditional Owner groups, scientific experts and community groups. Annual reports are published on the DEW website.

Monitoring at North Purnong wetland. Credit: Murraylands and Riverland Landscape Board

Beldora wetland. Credit: Murraylands and Riverland Landscape Board

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Appendices

Appendix A.

Summary of water for the environment actions proposed for 2021-22 under water resource availability scenarios

Very dry (95%) scenario

Table 5: Very dry (95%) AOO: Proposed operations and objectives for each site

Site	Management action(s) / objectives	Timing	Volume	Ecological Outcomes/Objectives
River Murray Channel	Spring pulse: • 17,000 ML/d for 25 days from mid Oct to early Nov • 15,000 ML/d for 60 days from mid Oct to mid Dec	Oct to Dec	694.0 GL	• Provide diverse hydraulic conditions so that habitat and processes for dispersal of organic and inorganic material between reaches are maintained • Throughout the length of the Channel asset (i.e. SA border to Wellington), establish and maintain a diverse native flood-dependent plant community in areas inundated by flows of 10,000-40,000 ML/d QSA • Restore resilient populations of large bodied native fish
Weir Pools	Weir pool 6: 19.55 m AHD raise; 19.07 m AHD lower Weir pool 5: 16.6 m AHD raise; 16.22 m AHD lower Weir pool 4: 13.5 m AHD raise; 13.16 m AHD lower Weir pool 2: 6.4 m AHD raise; 6.02 m AHD lower Weir pool 1: 3.4 m AHD raise; 3.1 m AHD lower	Jun/Jul to Dec/Jan	42.0 GL (total)	• Dynamic wetting front, benefitting many taxa • Enhanced lateral connectivity • Increased width and diversity of flood-dependent and amphibious plant communities • Enhanced recruitment of long-lived vegetation communities • Carbon and nutrients mobilised into the aquatic foodweb *NOTE: if there is no spring pulse, weir pool lowering will occur in winter and weir pool raising will occur in spring/summer. If a spring pulse is planned, then operations 'switch' with weir pool raising in winter and weir pool lowering in spring/summer.* No proposed action in weir pool 3 as unlikely that flows will provide significant dilution to manage salt loads
Chowilla	Pumping to 5 priority wetlands. No regulator operation Manage inflows via Pipeclay Creek and Slaney Creek weirs		2.0-8.5 GL	• Germination of flood-dependent vegetation • Support cohorts of saplings that established in 2010-11 and 2016-17 high flows and previous delivery of water for the environment • Provide refugia for flora and fauna, including frogs and water birds • Optimise outcomes for native fish through the anabranch
Pike	In-channel rise of 14.9 m AHD, no weir pool 5 operation	Aug to Oct	0.2 GL	In-channel raise to trial flow splits between Pike and Tanyaca regulators to support optimum outcomes
Katarapko	No regulator operation		n/a	Maintain base-flow conditions through anabranch targeting optimal flow conditions for native fish

Site	Management action(s) / objectives	Timing	Volume	Ecological Outcomes/Objectives
Wetlands	Pumping to 47 priority wetlands (26 wetland complexes) along the River Murray	Jul to Jun	12.9 GL	• Support known populations of Murray hardyhead • Support populations of regent parrots • Providing breeding opportunities and refugia for southern bell frogs • Prevent loss of long lived vegetation communities • Provide refuge habitats for waterbirds
LLCMM	**Action A**: Raise and maintain Lower Lakes water levels in spring; deliver 6,000 – 8,000 ML/d of flow to Coorong in spring / early summer **Action B**: Minimise the rate of draw-down in Lower Lakes water levels, and maintain fishway and attractant flows (1,000 – 2,000 ML/d) to the Coorong for 4 months **Action C**: Raise water levels in Lower Lakes by 5-10 cm and support barrage releases (1,500 – 2,000 ML/d)	Jul to Jun	934.0 GL 202.9 GL 106.8 GL **Total**: 1,243.7 GL	• Support North Lagoon food web (fish, invertebrates, birds) • Promote conditions to support lamprey and congolli winter migration • Ensure recruitment success of threatened fishes in the Lower Lakes and Coorong • Maintain or improve aquatic and littoral vegetation in the Lower Lakes • Maximise fish passage connectivity between the Lower Lakes and Coorong • Maintain or improve mudflat invertebrate communities that are of high condition relative to the southern Australian estuarine mudflat ecosystems • Maintain or improve waterbird populations in the Lower Lakes, Coorong and Murray Mouth

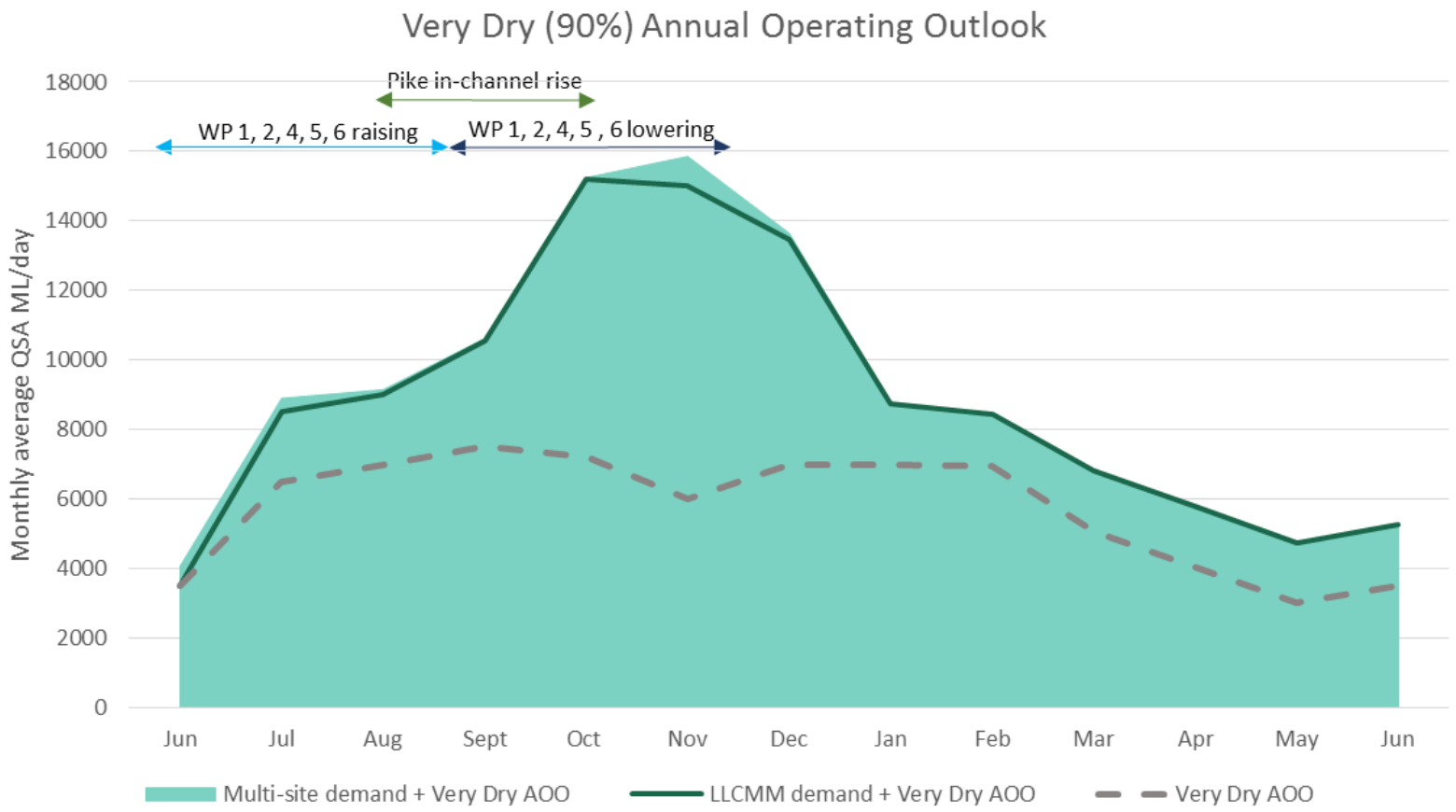

Figure 5. Preferred delivery pattern of South Australian multi-site environmental water under a very dry (95%) Annual Operating Outlook (AOO) scenario. Arrows indicate timing of proposed site-based environmental watering actions; AOO and Lower Lakes, Coorong and Murray Mouth (LLCMM) demand is presented as a reference point.

Dry (90%) scenario

Table 6: Dry (90%) AOO: Proposed operations and objectives for each site

Site	Management action(s) / objectives	Timing	Volume	Ecological Outcomes/Objectives
River Murray Channel	Spring pulse: • 23,000 ML/d for 25 days in Nov • 20,000 ML/d for 60 days from mid Oct to mid Dec	Oct to Dec	651.5 GL	• This action will deliver the SA River Murray Channel environmental water requirement 'EWR-IC1', 'EWR-IC2' and partially meet 'EWR-IC3' as described in the SA River Murray LTWP • Maintain a diurnally-mixed water column to ensure diverse phytoplankton and avoid negative water quality outcomes. • Provide diverse hydraulic conditions over the range of velocity classes in the lower third of weir pools so that habitat and processes for dispersal of organic and inorganic material between reaches are maintained • Throughout the length of the Channel asset (i.e. SA border to Wellington), establish and maintain a diverse, flood-dependent plant community • Restore resilient populations of large bodied native fish
Weir Pools	Weir pool 6: 19.67 m AHD raise, then 19.07 m AHD lower* Weir pool 5: 16.8 m AHD raise, then 16.22 m AHD lower Weir pool 4: 13.5 m AHD raise, then 13.16 m AHD lower Weir pool 2: 6.65 m AHD raise, then 6.02 m AHD lower Weir pool 1: 3.4 m AHD raise, then 3.1 m AHD lower	Jun/Jul to Dec/Jan	42.0 GL (total) *35.0 GL (excl. WP6)*	Same outcomes/objectives as described for weir pools for the very dry AOO ** Actions at weir pool 6 are dependent on planned Chowilla actions and priorities for watering. If floodplain actions do not occur then weirs will be raised and lowered independently as described here. If floodplain actions occur then weirs will be raised in conjunction with floodplain regulators.*
Chowilla	Operate Chowilla regulator to 19.3 m AHD (medium managed inundation) Raise weir pool 6 to 19.65 m AHD	Aug to Dec	55.1 GL	• Provide a rise in surface water levels at the Chowilla regulator equivalent to that generated at QSA of approximately 75,000 ML/d • Restore and maintain long-lived, amphibious, and other flood-dependent plant communities • Increase in extent and diversity of the habitat mosaic within the anabranch system, with mid-elevation floodplain and many key wetlands connected • Improved soil moisture content for vegetation in the inundated and adjacent floodplain • Provide small-scale breeding opportunities for waterbirds and amphibians • Carbon and nutrients mobilised from the floodplain into the aquatic foodweb
	Pumping of up to 5 wetlands	Jun to Apr	2.0-8.5 GL	Same outcomes/objectives as described for Chowilla wetlands for the very dry AOO
Pike	Operate Pike regulator to 15.2 m AHD (low managed inundation) Lock 5 remains at normal pool level	Aug to Nov	4.9 GL	• Provides a rise in surface water levels at the Pike regulator equivalent to that generated at QSA of approximately 50 - 55,000 ML/d • Maintain viable river red gum, black box, river cooba and lignum populations

Site	Management action(s) / objectives	Timing	Volume	Ecological Outcomes/Objectives
				• Establish and maintain a diverse plant community comprised of flood dependent and/or amphibious species • Create habitat for native reptiles, mammals, woodland birds, riparian frogs and small scale bird breeding • Provide diverse hydraulic conditions and complex habitat for flow dependent biota and processes • Carbon and nutrient mobilised from the floodplain into the aquatic foodweb
Katarapko	Operate Katarapko regulator to 11.3 m AHD (low managed inundation) Lock 4 remains at normal pool level	Sept to Dec	0.6 GL	• Provides a rise in surface water levels at the Splash regulator equivalent to that generated at QSA of approximately 25,000 – 30,000 ML/d • Same outcomes/objectives as described for the Pike floodplain for the dry AOO • Restore and maintain resilient populations of large bodied native fish
Wetlands	Pumping to 47 priority wetlands (26 wetland complexes) along the River Murray	Jul to Jun	12.9 GL	Same outcomes/objectives as described for wetlands for the very dry AOO
LLCMM	**Action A:** Raise and maintain Lower Lakes water levels in spring; deliver 7,000 – 13,000 ML/d of flow to the Coorong in spring / early summer. **Action B:** Minimise the rate of draw-down in Lower Lakes water levels, and maintain fishway and attractant flows (1,000 – 3,000 ML/d) to the Coorong for 4 months. **Action C:** Raise water levels in Lower Lakes by 5-10 cm and to support barrage releases (2,000 – 3,000 ML/d) in winter for diadromous fishes.	Jul-Dec Jan-Apr May-Jun	930.0 GL 202.9 GL 106.8 GL **Total:** 1,239.7 GL	• Support North Lagoon food web (fish, invertebrates, birds) and estuarine fish recruitment • Promote conditions to support lamprey and congolli winter migration • Ensure recruitment success of threatened fishes in the Lower Lakes to maintain or establish self-sustaining populations • Maintain or improve aquatic and littoral vegetation in the Lower Lakes • Restore resilient populations of black bream and greenback flounder in the Coorong • Maximise fish passage connectivity between the Lower Lakes and Coorong • Maintain or improve mudflat invertebrate communities that are of high condition relative to the southern Australian estuarine mudflat ecosystems • Maintain or improve waterbird populations in the Lower Lakes, Coorong and Murray Mouth

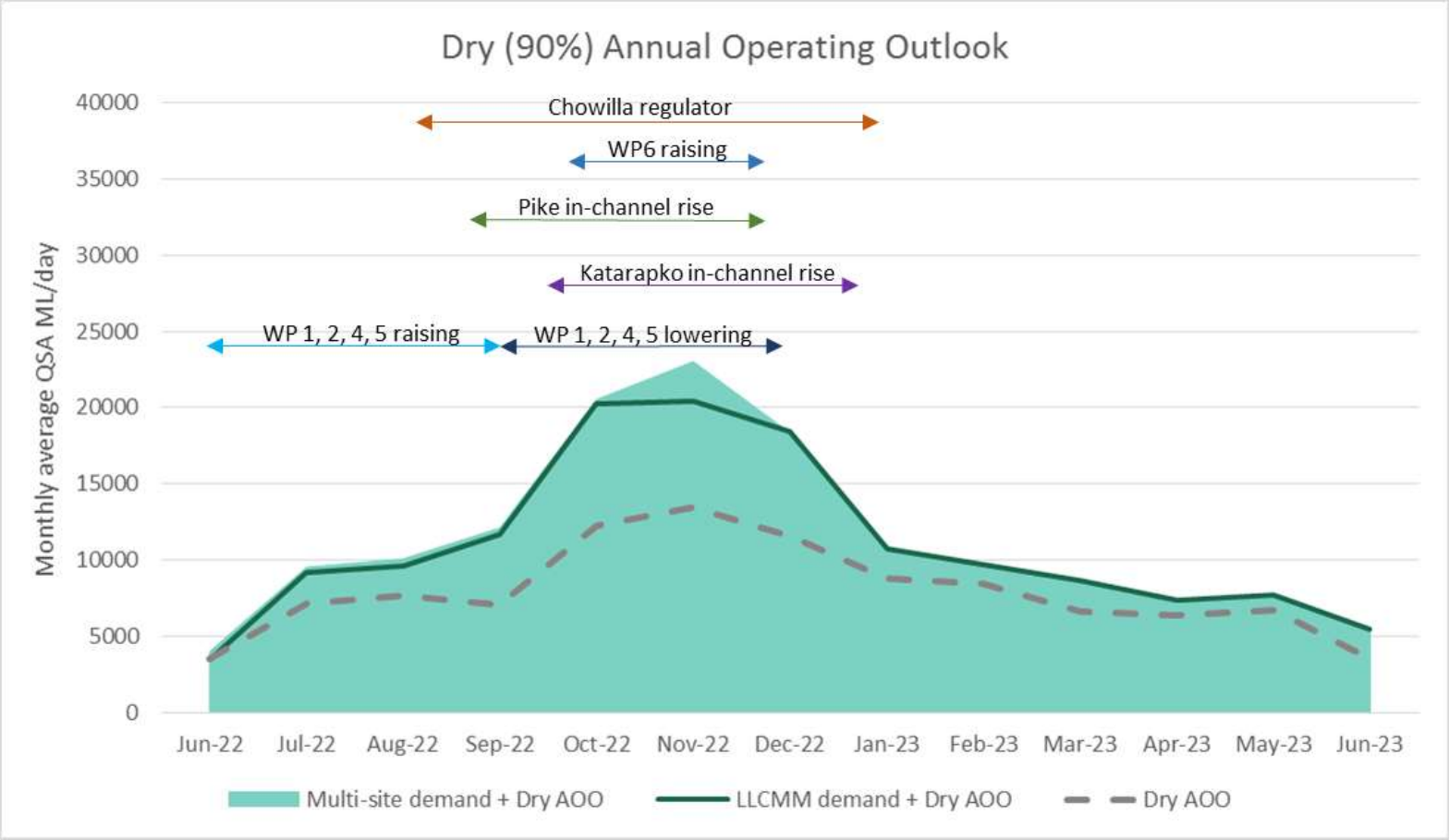

Figure 6. Preferred delivery pattern of South Australian multi-site environmental water under a dry (90%) Annual Operating Outlook (AOO) scenario. Arrows indicate timing of proposed site-based environmental watering actions; AOO and Lower Lakes, Coorong and Murray Mouth (LLCMM) demand is presented as a reference point.

Moderate (75%) scenario

Table 7: Moderate (75%) AOO: Proposed operations and objectives for each site

Site	Management action(s) / objectives	Timing	Volume	Ecological Outcomes/Objectives
River Murray Channel	Spring pulse: • 23,000 ML/d for 25 days from mid Oct to mid Nov • 20,000 ML/d for 60 days from mid Oct to mid Dec	Oct to Dec	686.0 GL	Same outcomes/objectives as described for the River Murray Channel for the dry AOO
Weir Pools	Weir pool 6: 19.67 m AHD raise, then 19.07 m AHD lower* Weir pool 5: 16.8 m AHD raise, then 16.22 m AHD lower* Weir pool 4: 13.5 m AHD raise, then 13.16 m AHD lower* Weir pool 2: 6.65 m AHD raise, then 6.02 m AHD lower Weir pool 1: 3.4 m AHD raise, then 3.1 m AHD lower	Jun/Jul to Dec/ Jan	42.0 GL (Total) *11.8 GL (excl. WP4, WP5, WP6)*	Same outcomes/objectives as described for weir pools for the very dry AOO ** Actions at weir pools 6, 5 and 4 are dependent on planned Chowilla Pike and Katarapko actions and priorities for watering. If floodplain actions do not occur then weirs will be raised and lowered independently as described here. If floodplain actions occur then weirs will be raised in conjunction with floodplain regulators.*
Chowilla	Operate Chowilla regulator to 19.3 m AHD (medium managed inundation) Raise weir pool 6 to 19.65 m AHD	Aug to Dec	55.0 GL	Same outcomes/objectives as described for Chowilla for the dry AOO
	Potential pumping to up to 5 priority wetland sites		2.0-8.5 GL	Same outcomes/objectives as described for Chowilla wetlands for the dry AOO
Pike	Operate Pike regulator to 15.9 m AHD (medium managed inundation) Raise weir pool 5 to 16.8 m AHD	Jun to Dec	30.2 GL	Same outcomes/objectives as described for Pike for the dry AOO
Katarapko	Operate Katarapko regulator to 13.3 m AHD (medium managed inundation) Raise weir pool 4 to 13.5 m AHD	Jun to Dec	15.8 GL	Same outcomes/objectives as described for Katarapko for the dry AOO *NOTE: While tree condition data shows high elevation tree communities in particular would benefit from watering, we are still waiting on ground water data that may indicate successive years of watering is causing sustained elevated ground water levels which may preference a low level operation or in channel rise only.*
Wetlands	Pumping to 47 priority wetlands (26 wetland complexes) along the River Murray	Jul to Jun	12.9 GL	Same outcomes/objectives as described for wetlands for the very dry AOO
LLCMM	Same management actions/objectives as described for LLCMM for the dry AOO	Jul to Jun	**Total**: 1,244.0 GL	Same outcomes/objectives as described for LLCMM for the dry AOO

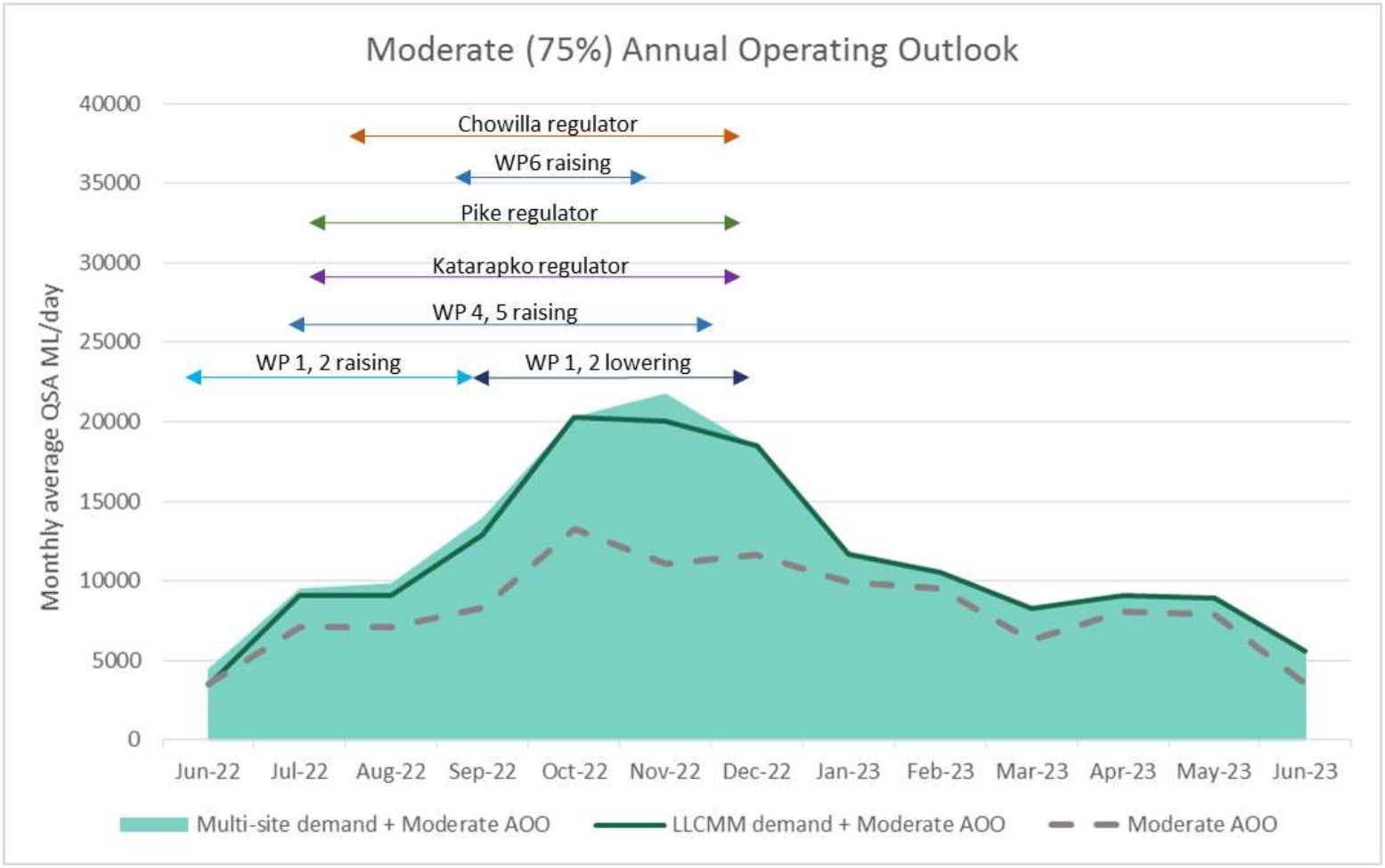

Figure 7. Preferred delivery pattern of South Australian multi-site environmental water under a moderate (75%) Annual Operating Outlook (AOO) scenario. Arrows indicate timing of proposed site-based environmental watering actions; AOO and Lower Lakes, Coorong and Murray Mouth (LLCMM) demand is presented as a reference point.

Near average (50%) scenario

Table 8: Near average (50%) AOO: Proposed operations and objectives for each site

Site	Management action(s) / objectives	Timing	Volume	Ecological Outcomes/Objectives
River Murray Channel	Augment unregulated flows to achieve: • 30,000 ML/d for 25 days in Oct • 24,000 ML/d for 60 days from mid Sept to mid Nov • Extend flows of 15,000 ML/d for 30 days in Dec	Sept to Dec	622.0 GL	Same outcomes/objectives as described for the River Murray Channel for the dry AOO
Weir Pools	Weir pool 6: 19.67 m AHD raise, then 19.07 m AHD lower* Weir pool 5: 16.8 m AHD raise, then 16.22 m AHD lower* Weir pool 4: 13.50 m AHD raise, then 13.16 m AHD lower* Weir pool 3: 10.01 m AHD raise, then 9.77 m AHD lower Weir pool 2: 6.65 m AHD raise, then 6.02 m AHD lower Weir pool 1: 3.40 m AHD raise, then 3.10 m AHD lower	Jun/Jul to Dec/Jan	59.8 GL (Total) *29.6 GL (excl. WP4, WP5, WP6)*	Same outcomes/objectives as described for weir pools for the very dry AOO ** Actions at weir pools 6, 5 and 4 are dependent on planned Chowilla Pike and Katarapko actions and priorities for watering. If floodplain actions do not occur then weirs will be raised and lowered independently as described here. If floodplain actions occur then weirs will be raised in conjunction with floodplain regulators.*
Chowilla	Operate Chowilla regulator to 19.5 m AHD (medium-high managed inundation) Raise weir pool 6 to 19.85 m AHD [2]	Jul to Nov	35.2 GL	• As per outcomes/objectives identified in Chowilla moderate AOO, but there will be increased extent of inundation resulting in greater achievement of outcomes/objectives, including benefits to larger areas of the black box community • Provides a rise in surface water levels at the Chowilla regulator equivalent to that generated at QSA at approximately 85,000 ML/d • Support ongoing growth of cohorts of saplings that established in the 2010-11 and 2016-17 high flows.
Pike	Same management actions/objectives as described for Pike for the moderate AOO	Jun to Dec	30.2 GL	Same outcomes/objectives as described for Pike for the dry AOO
Katarapko	Same management actions/objectives as described for Katarapko for the moderate AOO	Jun to Dec	15.6 GL	Same outcomes/objectives as described for Pike for the dry AOO
Wetlands	Pumping to 42 priority wetlands (20 wetland complexes) along the River Murray	Jul to Jun	10.7 GL	Same outcomes/objectives as described for wetlands for the very dry AOO (but less wetlands needing to be pumped as they are inundated via flows forecast in the AOO)
LLCMM	**Action A:** Extend moderate barrage flows into summer (12,000 – 23,000 ML/d) **Action B:** summer/autumn baseflows to minimise the rate of draw-down in Lower Lakes water levels, and to	Jul to Dec Jan to Apr	965.5 GL 217.0 GL	• Same outcomes/objectives as identified for the LLCMM for the dry AOO. • Maintain or improve *Ruppia tuberosa* colonisation and reproduction. • Maintain abundant self-sustaining populations of smallmouth hardyhead in the North Lagoon and South Lagoon of the Coorong.

[2] Capacity to raise Lock 6 by more than 0.42 m to be confirmed by MDBA (Cl. 66 Procedure)

Site	Management action(s) / objectives	Timing	Volume	Ecological Outcomes/Objectives
	maintain fishway and attractant flows to the Coorong for 4 months **Action C:** winter flows for diadromous fish migration and recruitment (4,000 – 5,000 ML/d)	May to Jun	93.2 GL **Total:** 1,276.0 GL	• Support aquatic habitat by establishing and maintaining variable salinity regimes in the Murray Mouth Estuary, North Lagoon and South Lagoon.

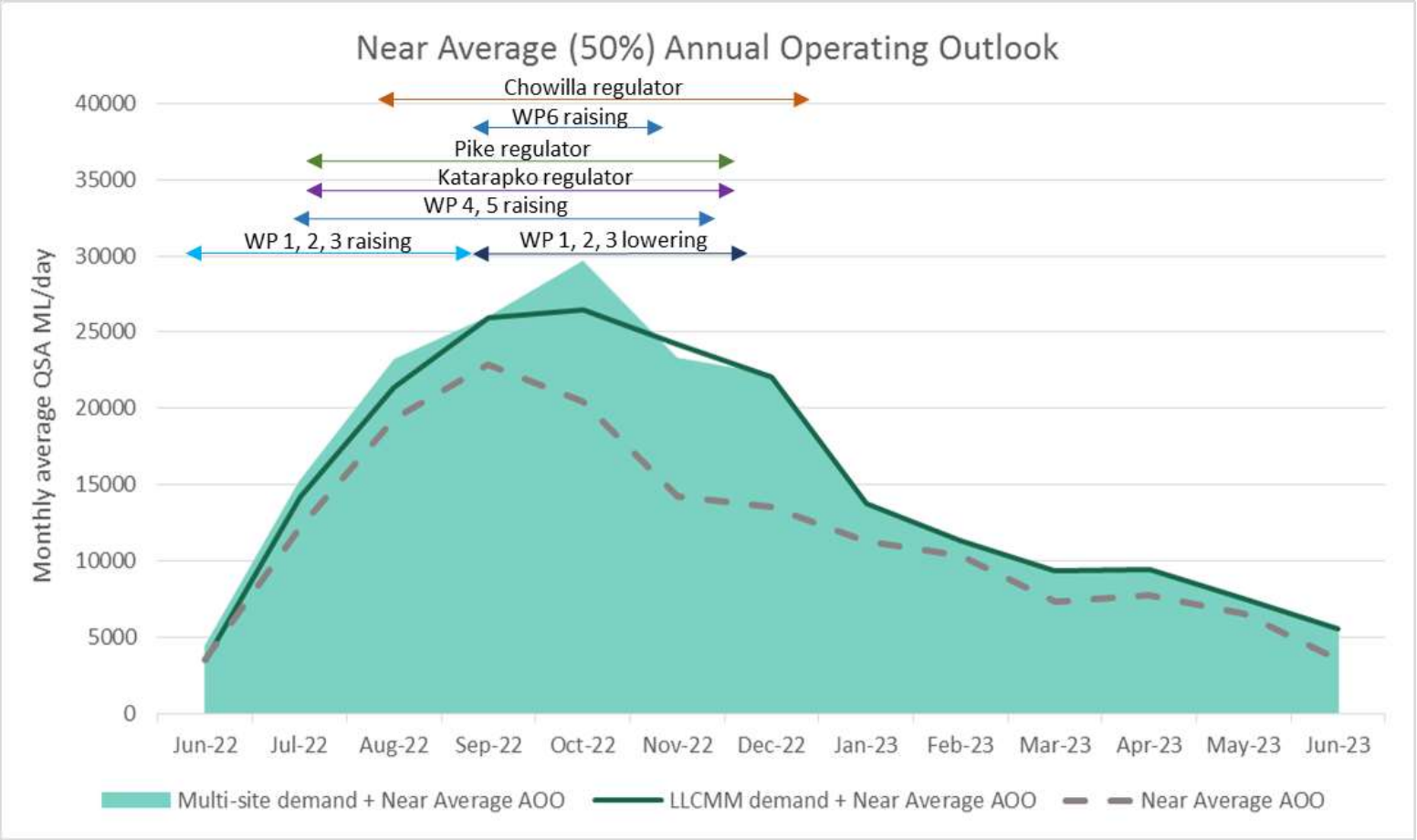

Figure 8. Preferred delivery pattern of South Australian multi-site environmental water under a near average (50%) Annual Operating Outlook (AOO) scenario. Arrows indicate timing of proposed site-based environmental watering actions; AOO and Lower Lakes, Coorong and Murray Mouth (LLCMM) demand is presented as a reference point.

Wet (25%) scenario

Table 9: Wet (25%) AOO: Proposed operations and objectives for each site

Site	Management action(s) / objectives	Timing	Volume	Ecological Outcomes/Objectives
River Murray Channel	Augment unregulated flows to achieve: • 65,000 ML/d for 20 days in Sept • 500 ML/d recession in Oct to Dec • Maintain flows at 15,000 ML/d for 30 days in Jan	Aug to Jan	555.0 GL	• The wet AOO meets all Channel EWRs (EWR-IC1 to EWR-IC4) and two Floodplain EWRs (EWR-FP1 and EWR-FP2). It also enhances flow at SA border to partially meet EWR-FP3 and slow the rate of recession as described in the SA River Murray LTWP. • Same outcomes/objectives as described for the River Murray Channel for the dry AOO. • Mobilisation of carbon, nutrients and propagules from the floodplain to the river • Establish groundwater and soil conditions conducive to maintaining diverse native vegetation across the Floodplain PEA. • Establish and maintain diverse aquatic, flood-dependent and amphibious plant communities across the Floodplain PEA. • Restore resilient populations of large bodied native fish • Provide habitat to support frogs within the Floodplain PEA.
Weir Pools	No operations proposed		n/a	
Chowilla	Operate Chowilla regulator to 19.85 m AHD (maximum managed inundation) Raise weir pool 6 to 19.85 m AHD [3] Volumes are based on the wet AOO and 1 July commencement of operation, which would limit regulator operation to 19.29 m AHD prior to the need to remove structures due to high flow. However, June commencement could enable increased operation height (and thus would require increased environmental water volumes). Extent of operation (and thus volumes required) could increase if wet scenario conditions vary from projected AOO. If the timing of the flow peak varies, and conditions are appropriate, operation of the Chowilla regulator on the falling limb of high flow may also be undertaken to extend inundation if feasible [4]	Jul to Jul (until transition to natural high flows	8.2 GL	As per outcomes/objectives identified in Chowilla near average AOO, but there will be increased extent of inundation resulting in greater achievement of outcomes/objectives, including benefits to larger areas of the black box community

[3] Capacity to raise Lock 6 by more than 0.42 m to be confirmed by MDBA (Cl. 66 Procedure)

[4] Removal of Chowilla regulator and Lock 6 infrastructure ahead of increasing flows occurs as QSA reach near 50,000 ML/d.

Site	Management action(s) / objectives	Timing	Volume	Ecological Outcomes/Objectives
Pike	Operate Pike regulator to 16.1 m AHD (high managed inundation) Raise weir pool 5 to 16.8 m AHD	Jun to Dec	37.0 GL	• Same outcomes/objectives as described for Pike for the dry AOO • Provides a rise in surface water levels at the Pike regulator equivalent to that generated at QSA of approximately 80,000 ML/d
Katarapko	No operations proposed		n/a	
Wetlands	Pumping to 7 priority wetlands (5 wetland complexes) along the River Murray	Jul to Jun	1.0 GL	Same outcomes/objectives as described for wetlands for the very dry AOO (but less wetlands needing to be pumped as they are inundated via flows forecast in the AOO)
LLCMM	**Action A:** Extend high barrage flows into summer (20,000 – 40,000 ML/d); maintain connectivity between the North and South Lagoons into early summer **Action B:** summer/autumn baseflows to ensure adequate attractant flow adjacent to fishways (6,000 – 12,000 ML/d); and continue to maintain connectivity and mixing between North and South Lagoons through to autumn **Action C:** winter flows for diadromous fish migration and recruitment (5,000 ML/d)	Nov to Jan Feb to Apr Jun	592.0 GL 138.0 GL 90.0 GL **Total:** 820.0 GL	Same outcomes/objectives as identified for the LLCMM for the near average AOO

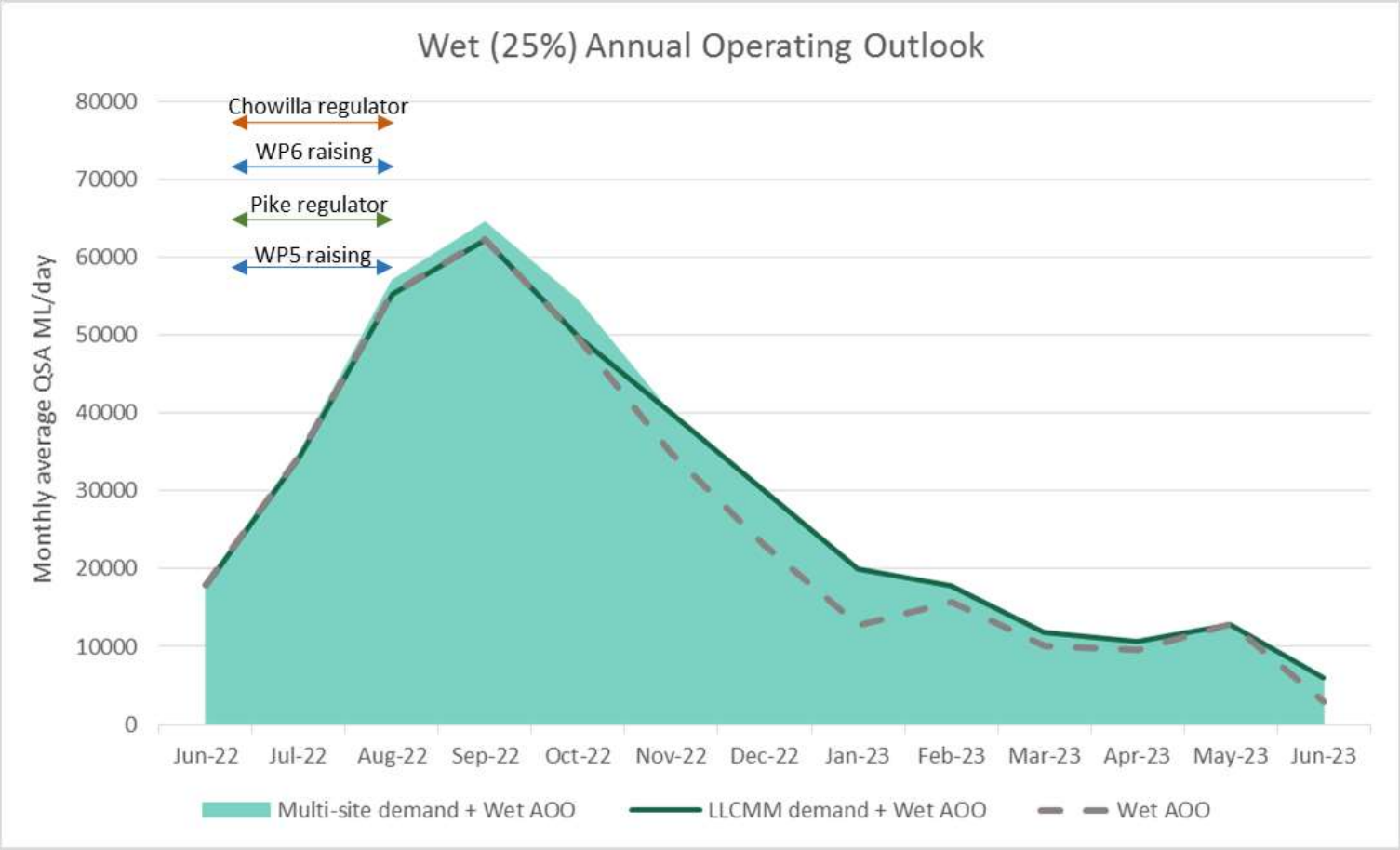

Figure 9. Preferred delivery pattern of South Australian multi-site environmental water under a wet (25%) Annual Operating Outlook (AOO) scenario. Arrows indicate timing of proposed site-based environmental watering actions; AOO and Lower Lakes, Coorong and Murray Mouth (LLCMM) demand is presented as a reference point.

Very wet (10%) scenario

Table 10: Very wet (10%) AOO: Proposed operations and objectives for each site

Site	Management action(s) / objectives	Timing	Volume	Ecological Outcomes/Objectives
River Murray Channel	No operations proposed		n/a	
Weir Pools	No operations proposed		n/a	
Chowilla	No operations proposed		n/a	
Pike	No operations proposed		n/a	
Katarapko	No operations proposed		n/a	
Wetlands	Pumping to 3 priority wetlands within the Lower Lakes	Jul to Jun	0.8 GL	Same outcomes/objectives as described for wetlands for the very dry AOO (but less wetlands needing to be pumped as they are inundated via flows forecast in the AOO)
LLCMM	**Action A:** Extend high barrage flows into summer (30,000 – 60,000 ML/d); maintain connectivity between the North and South Lagoons into early summer; scour the Murray Mouth **Action B:** winter flows for diadromous fish migration and recruitment (10,000 – 15,000 ML/d)	Dec to Feb Jun	150.0 GL	Same outcomes/objectives as identified for the LLCMM for the near average AOO

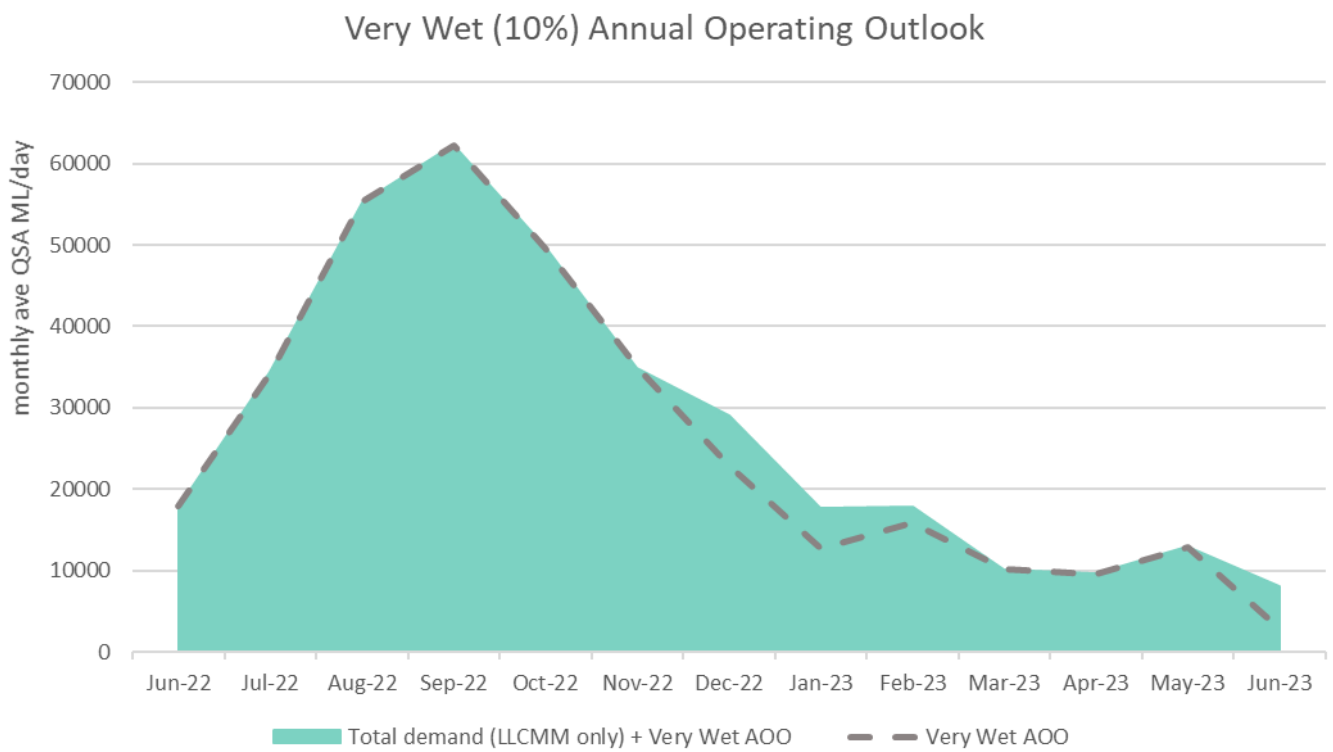

Figure 10. Preferred delivery pattern of South Australian environmental water under a very wet (10%) Annual Operating Outlook (AOO) scenario. No operations are planned for the South Australian River Murray Channel and Floodplain, however Lower Lakes, Coorong and Murray Mouth (LLCMM) demand is presented with the AOO as a reference point.

Appendix B.

Potential temporary wetland watering sites in 2022-23

The following list is indicative only and based on sites identified by the MRL Board only. The temporary wetlands that are identified as priorities to receive water in 2022-23 may change to accommodate emerging priorities and feasibility of delivery.

Wetland Complex	Potential MRL Board wetland watering sites 2022/23
Woolenook	Squiggly Creek
Bookmark Creek	Bookmark Creek
Weila/Murtho	Murtho/Wiela Connector
	Wiela
	Wiela 'Breakaway'
	Wiela Lignum Basin
Berri Evaporation Basin	Berri Evaporation Basin
Disher	Disher Creek
Martins Bend	Martin Bend temporary 1 & 2
	Martin Bend temporary 3
Beldora/Spectacle Lakes	Beldora North Flats
	Beldora South Overflow
Katarapko	Gerard Lignum Basins
	Katarapko Creek Floodrunners - North
	Katarapko Creek Floodrunners - South
	Katarapko Island - Wetland 3
	Katarapko Regent Parrot Floodrunner
Akuna	Akuna
Maize Island	Maize Island 'Floodrunners'
Overland Corner	Overland Corner - Lignum Basins
	Waikerie Pony Club Lignum Basin
Wigley Reach	Wigley Central Channel
	Wigley Reach - Lignum Basin
	Wigley Reach - Western Channel
Hogwash Bend	Hogwash Bend - Central Basin
	Hogwash Bend - North Basin
	Hogwash South Basin
Markaranka	Markaranka - Regent Parrot Strip
	Markaranka Depression
	Markaranka East Basin
	Markaranka Floodrunner 2
	Markaranka Floodrunner 5
	Markaranka Main Basin

Wetland Complex	Potential MRL Board wetland watering sites 2022/23
Molo Flat	Molo Flat Eastern Channel
	Molo Flat Western Basin
	Molo Flat Western Channel
Morgan CP	Morgan CP North
	Morgan CP South
Morgan East	Morgan East
Nilka	Nilkra (Taylor Flat)
Western Flat Lagoon	Weston Flat Lagoon
Moorundie	Sweeney's Lagoon
Currency Creek	Investigator College
Swan Reach Complex	Sugar Shack - Wetland 3
	Sugar Shack - Wetland 6
Clayton Bay	Ibis Road Wetland
Tolderol	Tolderol Game Reserve

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