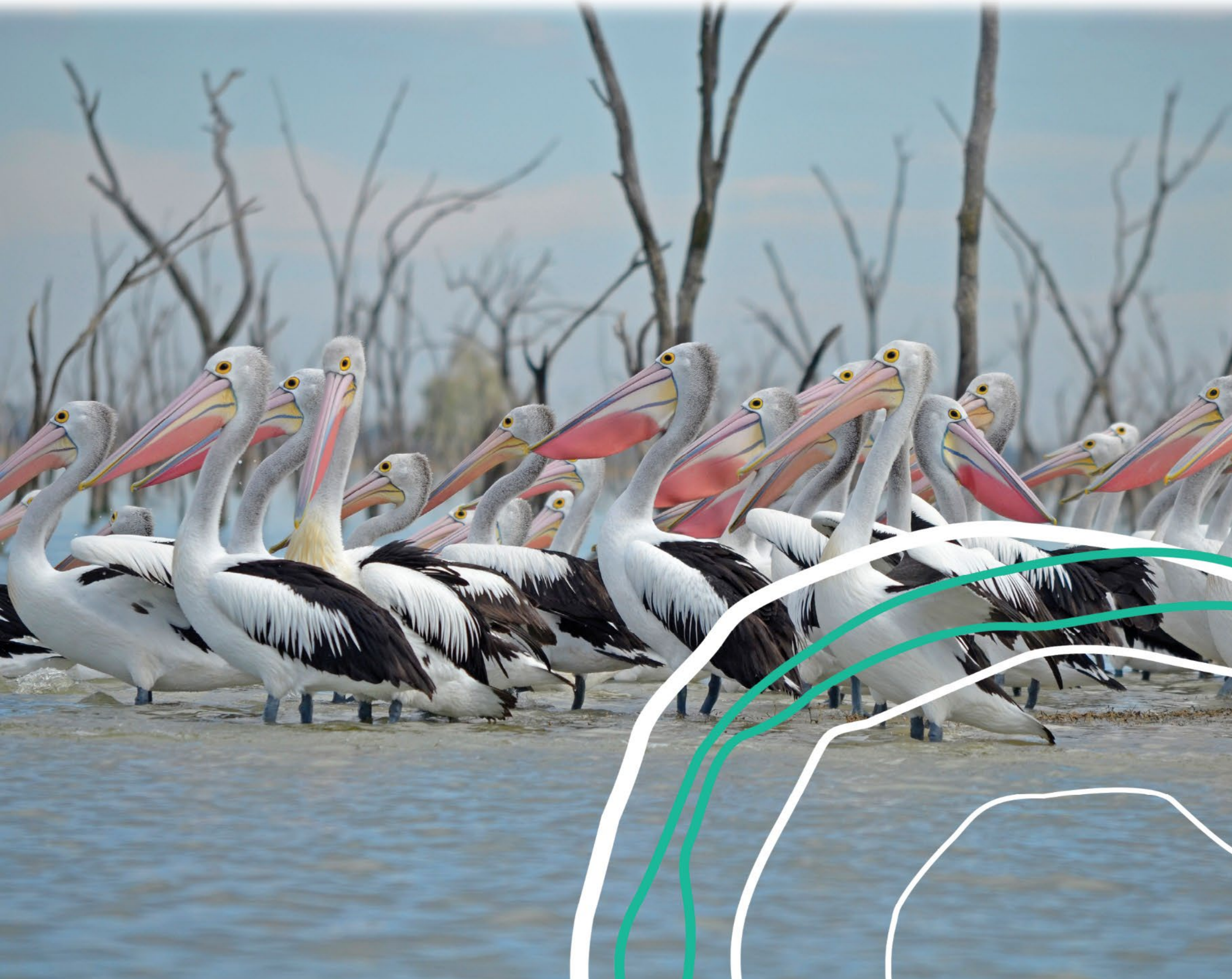
Australian Government
Commonwealth Environmental Water Holder

Water Management Plan 2023-24

Chapter 9 – Lachlan Valley Water Plan



Cataloguing data

This publication (and any material sourced from it) should be attributed as: Commonwealth of Australia 2023, *Commonwealth Environmental Water Holder Water Management Plan 2023–24: Lachlan Valley Water Plan*, Canberra. CC BY 4.0.

ISBN 978-1-76003-434-4

This publication is available at dcceew.gov.au/water/cewo/publications/water-management-plan-2023–24.

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Acknowledgement of Country

Our department recognises the First Peoples of this nation and their ongoing connection to culture and country. We acknowledge Aboriginal and Torres Strait Islander People as the Traditional Owners, Custodians and Lore Keepers of the world's oldest living culture and pay respects to their Elders past, and present.

Acknowledgement of First Nations people

The Commonwealth Environmental Water Holder (CEWH) and their staff acknowledge the First Nations communities of the Murray–Darling Basin and pay respect to their Elders past and present.

We acknowledge First Nations people as the Traditional Owners and custodians of the land, water and sky country across the Basin. We recognise the intrinsic connection of First Nations people to Country, and we value their enduring cultural, social, environmental, spiritual, and economic connection to the rivers, wetlands, and floodplains of the Basin.

Over millennia, First Nations people have shaped, managed, and cared for the land and waterways that sustain them. The CEWH values the relationships we currently have with First Nations people and is continuously building relationships to understand how we can empower and support First Nations people to care for Country. The CEWH will continue to work with First Nations people to identify ways to support cultural values alongside environmental outcomes with Commonwealth environmental water.

We value the ongoing contribution that First Nations peoples make to the planning and delivery of environmental water. We acknowledge this contribution is made largely through frameworks and processes that have not been determined, or endorsed, by First Nations people. More can be done to increase First Nations people's involvement and enable progress towards self-determination within and beyond the environmental watering program. We will continue to support and enable this where we can.

There are more than 40 First Nations in the Basin with many distinct cultures and practices.

The Lachlan River flows through Country of the Nari Nari, Ngiyampaa, Wiradjuri and Yita Yita Nations. The CEWH respectfully acknowledges these people, their Elders past, present and future, as the Traditional Owners of the land on which this chapter is focussed.

We embrace the spirit of reconciliation, working towards equity and equality for First Nations people.

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An overview of the Lachlan Valley including the Traditional Owners, key environmental values and sites, environmental objectives and environmental water delivery partners is provided on the CEWH website.

1.1 Recent conditions and seasonal outlook

1.1.1 Recent conditions and environmental water use

In the period 2017 to 2020, the Lachlan valley experienced lower than average rainfall which resulted in a drying catchment. During the second half of 2020 to 2021 wet conditions returned to the catchment and continued throughout 2021 to late 2022.

During 2022 to 2023, watering actions sought to support waterbird breeding events when required. However, continued unregulated flows met much of the environmental demands in the catchment for 2022–23. Environmental water was provided via pumping to wetlands on Merrimajeel Creek and provided a flood recession to the lower Lachlan wetlands including the core reed beds of the Great Cumbung Swamp. A summer fresh was also provided from Wyangala Dam to address water quality issues post-flood.

Large numbers of waterbirds nested in the Lachlan over the past two years. This included:

- 16,335 pelican nests at Lake Brewster and 171,137 straw-necked ibis nests and 2,218 Australian white ibis nests in the Booligal wetlands in 2022-23.
- a rookery boundary of 183 hectares at the Booligal wetlands and the largest aggregation ever recorded at that site.
- 15,000 Pelican pairs at Lake Brewster, 25,000 ibis pairs at Lakes Cowal and 25,000 ibis pairs at Booligal Swamp in 2021-22.

Approximately 16 gigalitres (GL) of Commonwealth environmental water was delivered in 2022–23 with natural high flows meeting many environmental watering requirements throughout the system.

Delivery of Commonwealth and NSW environmental water successfully supported:

- Mitigating water quality issues post-flood, including high-salinity, low dissolved oxygen and blue green algae outbreaks.
- Maintaining water levels and water quality in Lake Brewster to ensure pelicans could complete their breeding cycle.
- Post-flood flows to manage the flood recession in the lower Lachlan.

1.1.2 Seasonal outlook

The Bureau of Meteorology Climate Outlook (BOM 2023) is forecasting below median rainfall during July to September for much of mainland Australia, particularly in south-east Australia. Across almost all of Australia, maximum and minimum temperatures for July to September are very likely to be warmer than median. The chance of a positive Indian Ocean Dipole and shift to El Niño are likely to be influencing this outlook.

Approximate storage levels as of July 2023, (WaterNSW, 2023) were:

- Wyangala Dam is 97.5% full

- Lake Cargelligo is 50.8% full
- Lake Brewster is 77.9% full.

1.1.3 Water availability

Allocations against Commonwealth water entitlements in the Lachlan River valley are determined by state governments and will vary depending on inflows. As at 1st of July 2023, allocations to general security entitlements are 118 per cent and full allocation against conveyance entitlements as per water sharing plan rules. The volume of carryover from 2022–23 is 103 GL.

Based on the available volume of water held by the Commonwealth and other water holders, as well as recent and forecast catchment conditions, it is expected that the overall resource availability will be high in 2023–24.

1.1.4 First Nations environmental watering objectives

The Commonwealth Environmental Water Holder recognises the critical importance of strengthening involvement of First Nations people in environmental watering, and the importance of building transparent, respectful relationships with Traditional Custodians across the Basin. As such, the CEWH has worked with NSW government agencies to engage with First Nations peoples and representative groups to understand watering priorities for Country and community; summarised below. The CEWH will continue to investigate where it can use environmental flows to contribute to the following:

- Objectives of the Ngiyampaa Nation Plan, prepared by the Ngiyampaa Wangaaypuwan Nation Planning Working Group. This plan notes the objectives and cultural significance of Willandra Creek and Booberoi Creek.
- Lake Ita within Kalyarr National Park based on discussions with NSW National Parks and Wildlife Service and the Mawambul Co-Management Group regarding the potential to deliver environmental water into this site of cultural significance.
- Progressing the involvement of First Nations in the objectives of the Great Cumbung Region Water Management Plan in partnership with NSW Department of Planning and Environment.

The CEWH is committed to continuing to strengthen engagement with all Basin First Nations to support those Nations objectives for water management.

1.1.5 Environmental demands

Environmental water demands in the Lachlan River valley in 2023-24 are moderate to high.

For the environmental water demands for assets in the Lachlan River valley in 2023–24 (Table LR1), the capacity to contribute to these environmental demands is dependent on the status of flows, such as high/translucent flows, in the system. Wet conditions experienced from 2021–2023, and high water availability, will provide a unique opportunity to consolidate the environmental outcomes achieved in 2022–23. For some key assets, environmental water is planned to be used to prolong wet conditions and extend inundation. This is reflected in the high environmental water demands for some sites in the catchment during 2023–24.

Table LR1 Environmental demands, watering priorities and outlook for coming year, Lachlan River valley, 2023–24

Environmental assets and long -term water plan unit (PU) reference number	Target values	Indicative demand (for all sources of water in the system)		Watering history (from all sources of water)	2023–24		Implications for future demand
		Flow/volume	Required frequency (maximum dry interval)		Environmental demand for water (all sources)	Potential Commonwealth environmental water (CEW) contribution	Likely urgency of demand in 2024–25 if watering occurred as planned in 2023–24
Lachlan River (PU 2, 3, 6, 8, 14, 16)	Protect tributary inflows (natural trigger) or deliver upon environmental triggers (e.g. timing or temperature) being reached. Maintain native vegetation condition. Native fish reproduction and native fish health. Maintain in-channel habitats, in-stream productivity, and longitudinal connectivity. Duration and frequency of pulse dependent on outcomes required and potential contribution or linkage to other watering actions.	Greater than 300 megalitres per day (ML/d) in the Lachlan River at Booligal (412005) to also contribute to small scale wetland inundation. If releases are made from Wyangala Dam, will be delivered as part of a small fresh of less than 2,600 ML/day in the Lachlan River at Forbes (412004).	Timing: Sept to Mar (but can occur any time). Usually early spring and/or early Dec (at end of cod nesting). Duration: 30 days, 2 to 8 months of habitat inundation. Frequency: 7 to 8 years in 10 (75% of years). Annual for the maintenance of drought refuge. Max. inter-event period: 2 years.	Flow/volume met every year since 2011–12.	High	A high priority for watering in 2023–24.	High
		Greater than 650 ML/d in the Lachlan River at Booligal (412005) to also contribute to small scale wetland inundation. Will be delivered as part of a small fresh of around 2,600 ML/day in the Lachlan River at Forbes (412004) if releases are made from Wyangala Dam.	Timing: Oct to Apr (but can occur any time). Usually early spring and/or early Dec (at end of cod nesting). Duration: 30 days, 2 to 8 months of habitat inundation. Frequency: 5 to 7 years in 10 (60% of years). Annual for the maintenance of drought refuge. Max. inter-event period: 3 years.	Flow/volume met every year except 2014–15 and 2018–19.	High	A high priority for watering in 2023–24. May also be linked to other watering actions within the system.	High
		Greater than 1,200 ML/d in the Lachlan River at Booligal (412005) to also contribute to large scale wetland inundation. May be delivered to extend duration of translucent flows from Wyangala Dam or Lake Brewster.	Timing: Oct to Apr (but can occur any time). Usually early Spring and/or early Dec (at end of cod nesting). Duration: 60 days, 2 to 3 months of habitat inundation. Frequency: 2 to 3 years in 10 (25% of years) Max. inter-event period: 5 years.	Flow/volume met in 2012–13, 2013–14, 2015–16, 2016–17 (flood year), 2020–21 and 2021-22 and 2022-23 (flood years).	High	A high priority for watering in 2023–24. Will occur if natural trigger is met, or under moderate to high resource availability. May also be linked to other watering actions within the system.	Moderate
Booberoi Creek (PU 7)	Maintain populations of native fish, aquatic plants, and connectivity to the Lachlan River. Assist with recovery in upper reach after desilting in 2019–20. Maintain First Nations cultural values associated with Booberoi Creek.	Greater than 120 ML/d via the Booberoi Creek at Offtake (412189) to contribute to a large fresh. May be delivered as part of a larger Lachlan River watering action (e.g. spring pulse release from Wyangala Dam).	Timing: July to Sept (but can occur any time). Duration: 5 days, 2 to 3 months of habitat inundation. Frequency: 5 to 10 years in 10 (75% of years). Max. inter-event period: 2 years.	Flow/volume met in 2011–12, 2012–13, 2016–17 (flood year), 2018–19, 2020–21 and 2021-22 and 2022-23 (flood years).	High	A high priority for watering in 2023–24 to consolidate outcomes from flows provided in previous years. May also be linked to other watering actions within the system.	High
Mid-Lachlan anabranches (PU 5) Wallamundry Creek and Wallaroi Creek	Provide lateral connectivity to anabranch systems, maintain native vegetation condition and native fish.	Greater than 120 ML/d via Wallaroi Creek upstream Worrongorra Weir (412046) to provide a large fresh.	Timing: July to Sept (but can occur any time). Duration: 5 days. Frequency: 5 to 10 years in 10 (75% of years). Max. inter-event period: 2 years.	Flow/volume met in 2011–12, 2012–13, 2013–14, 2016–17 (flood year), 2019–20, 2020–21 and 2021-22 and 2022-23 (flood years).	Low	A low priority for watering in 2023–24.	Moderate
		Greater than 200 ML/d Wallamundry Creek at Island Creek (412016).		Flow/volume met every year since 2011–12.	Low	A low priority for watering in 2023–24.	Moderate

Environmental assets and long-term water plan unit (PU) reference number	Target values	Indicative demand (for all sources of water in the system)		Watering history (from all sources of water)	2023–24		Implications for future demand
		Flow/volume	Required frequency (maximum dry interval)		Environmental demand for water (all sources)	Potential Commonwealth environmental water (CEW) contribution	Likely urgency of demand in 2024–25 if watering occurred as planned in 2023–24
Willandra Creek (PU 11) Includes Morrison's Lake	Maintain lateral connectivity to major distributary. Maintain riparian vegetation health. Maintain foraging and nesting habitat for waterbirds. Maintain riparian habitat for other species e.g. frogs. Morrison's Lake has significant cultural values.	Greater than 250 ML/d via Willandra at Road Bridge (412012). Small freshes (greater than 70 ML/day) are provided annually by operational flows.	Timing: July to Sept (but can occur any time). Duration: 5 days. Frequency: 5 to 10 years in 10 (75% of years). Max. inter-event period: 2 years.	Flow/volume met in 2011–12, 2012–13, 2013–14, 2015–16, 2016–17 (flood year), 2019–20, 2020–21, and 2021-22 and 2022-23 (flood years).	Low	A lower priority for CEW. Asset receives more water under regulated conditions than would have occurred naturally. However, may be considered for follow-up watering after large scale inundation.	Low
		Morrison's Lake Nature Reserve – 400 to 500 ML to fill but may require up to 3 GL for conveyance and to also target black box.	Can be completed in conjunction with Willandra replenishment flows.	Received water in 2016–17 (flood year) and 2021-22 and 2022-23 (flood year).	Moderate	Secondary priority for CEW. Will occur under moderate to high resource availability. Demand may be met by other means.	Moderate
Lake Cargelligo (PU 9)	Maintain lateral connectivity to major distributary. Native fish reproduction and native fish health. Maintain foraging and nesting habitat for waterbirds.	Greater than 65% full at Lake Cargelligo at Storage (412107).	Timing: Sept to Mar (can occur anytime). Duration: varies depending on objective may include up to 2 to 6 months of habitat inundation. Frequency: 5 to 7 years in 10 (60% of years). Max. inter-event period: 3 years.	Flow/volume met every year since 2011–12.	High	Works at Lake Cargelligo will limit storage level to 50% until approximately September 2023. Actions in future years will seek to provide flows to enable movement of native fish out of Lake Cargelligo and back to the main river channel.	High
Brewster Weir Pool (PU 8)	Help maintain weir pool height to maintain olive perchlet habitat.	Up to 5 GL dependant on the operational level and management requirements of the weir at Lake Brewster Weir (412048). May be delivered as part of pulse flows.	Frequency: 5 to 10 years in 10 (annual for the maintenance of drought refuge).	Flow/volume met every year since 2011–12.	Low	A low priority for watering in 2023–24.	Low
Lake Brewster (PU 10)	Maintain foraging and nesting habitat for waterbirds and pelicans. Maintain aquatic vegetation health.	Flows are managed where possible to avoid inundation of nests if pelican breeding has occurred.	As required.	Watered in 2020–21, 2021-22 and 2022-23 for pelican and aquatic vegetation outcomes.	Moderate	Secondary priority for CEW. Will occur only if natural trigger is met, or under moderate to high resource availability. Demand may be met by other means, including other watering actions within the system.	Moderate
Merrowie Creek (PU 12) While not referenced in LTWP, this system includes Lake Tarwong at end of system (Box Creek)	Maintain lateral connectivity to major distributaries. Maintain riparian vegetation health. Maintain foraging and nesting habitat for waterbirds. Maintain riparian habitat for other species e.g., frogs. Maintain habitat for small-bodied native fish species.	Greater than 150 to 160 ML/d via Merrowie Creek at offtake (412163) to provide small fresh and/or small wetland inundation.	Timing: Sept to Mar (can occur anytime). Duration: 30 days, 2 to 8 months of habitat inundation. Frequency: 7 to 8 years in 10 (75% of years). Max. inter-event period: 2 years.	Flow/volume met annually via stock and domestic replenishment flows each winter/early spring.	Low	A low priority for watering in 2023–24.	Low
		Greater than 150 ML/d via Merrowie Creek at offtake (412163) to provide large wetland inundation.	Timing: Sept to June (can occur anytime). Duration: 60 days, 2 to 3 months of habitat inundation. Frequency: 3 to 5 years in 10 (40% of years). Max. inter-event period: 4 years.	Duration target met in 2011–12, 2012–13, 2016–17 and 2021-22 (flood year). Unlike 2020–21, the 2021-22 translucent flow event and use of e-water did reach Lake Tarwong and progress into the Merrowie–Box Creek system.	High	High priority for CEW to consolidate outcomes from flows provided in 2022-23. May also be linked to other watering actions within the system. Targeting of Lake Tarwong and Box Creek will occur only if natural trigger is met, or under moderate to high resource availability. Infrastructure damage at this site will affect potential deliveries.	Moderate
Merrimajeel Creek (PU 13) Includes Lake Merrimajeel,	Maintain lateral connectivity to major distributaries.	Greater than 300 ML/d in Lachlan River at Booligal (412005) to contribute to small wetland inundation.	Timing: Sept to Mar (can occur anytime). Duration: 30 days. Frequency: 7 to 8 years in 10 (75% of years). Max. inter-event period: 2 years.	Flow/volume met every year since 2011–12. Received translucent flows in 2020–21 and 2021-22 (flood year).	Moderate	Secondary priority for CEW. May also be linked to other watering actions within the system.	Low

Environmental assets and long -term water plan unit (PU) reference number	Target values	Indicative demand (for all sources of water in the system)		Watering history (from all sources of water)	2023–24		Implications for future demand
		Flow/volume	Required frequency (maximum dry interval)		Environmental demand for water (all sources)	Potential Commonwealth environmental water (CEW) contribution	Likely urgency of demand in 2024–25 if watering occurred as planned in 2023–24
Murrumbidgil Swamp and Booligal wetlands (see also waterbird breeding contingency)	Maintain riparian vegetation health. Maintain foraging and nesting habitat for waterbirds. Maintain riparian habitat for other species i.e. frogs.	Greater than 650 ML/d in Lachlan River at Booligal (412005) to contribute to small wetland inundation. Flows at Booligal do not always translate to flows further into Merrimajeel Creek Cobb Hwy (412122), e.g. 2017–18 flows at Booligal did not register at Cobb Highway gauge.	Timing: Oct to Apr (can occur anytime). Duration: 30 days, 2 to 8 months of habitat inundation. Frequency: 5 to 7 years in 10 (60% of years). Max. inter-event period: 3 years.	Flow/volume met every year at Booligal except for 2014–15 and 2018–19. Received translucent flows in 2020–21 and 2021-22 (flood year).	Low	A low priority for watering in 2023–24.	Low
		Greater than 850 ML/d in Lachlan River at Booligal (412005) to contribute to large wetland inundation.	Timing: Aug to Feb (can occur anytime). Duration: 60 days, 2 to 6 months of habitat inundation. Frequency: 3 to 5 years in 10 (40% of years). Max. inter-event period: 4 years.	Flow/volume met in 2011–12, 2012–13, 2013–14, 2015–16, 2016–17 (flood year), 2020–21 (translucent flows), and 2021-22 and 2022-23 (flood years).	Moderate	Secondary priority for CEW. May also be linked to other watering actions within the system. Will occur only if natural trigger is met, or under moderate to high resource availability.	Moderate
		Greater than 1,200 ML/d in Lachlan River at Booligal (412005) to contribute to large wetland inundation.	Timing: Any time. Duration: 60 days, 2 to 3 months of habitat inundation. Frequency: 2 to 3 years in 10 (25% of years). Max. inter-event period: 5 years.	Flow/volume met in 2011–12, 2012–13, 2013–14, 2015–16, 2016–17 (flood year), 2020–21 (translucent flows) and 2021-22 and 2022-23 (flood years).	Moderate	Secondary priority for CEW. May also be linked to other watering actions within the system. Will occur only if natural trigger is met, or under moderate to high resource availability.	Moderate
Muggabah Creek (PU15) (see also waterbird breeding contingency)	Maintain lateral connectivity to major distributaries. Maintain riparian vegetation health. Maintain foraging and nesting habitat for waterbirds. Maintain riparian habitat for other species i.e. frogs.	Greater than 300 ML/d in Lachlan River at Booligal (412005) to contribute to small wetland inundation. Flows at Booligal do not always translate to flows further into Muggabah Creek Cobb Hwy (412124), e.g. 2017–18 flows at Booligal did not register at Cobb Highway gauge. Flows rarely reach or go above 250 ML/day and require flood or translucent flows to be achieved.	As per equivalent Merrimajeel action.	As per equivalent Merrimajeel action.	Low	A low priority for watering in 2023–24.	Low
		Greater than 650 ML/d in Lachlan River at Booligal (412005) to contribute to large wetland inundation.	As per equivalent Merrimajeel action.	As per equivalent Merrimajeel action.	Low	A low priority for watering in 2023–24.	Low
		Greater than 850 ML/d in Lachlan River at Booligal (412005) to contribute to large wetland inundation.	As per equivalent Merrimajeel action.	As per equivalent Merrimajeel action.	Moderate	Secondary priority for CEW. May also be linked to other watering actions within the system. Will occur only if natural trigger is met, or under moderate to high resource availability.	Moderate
		Greater than 1,200 ML/d in Lachlan River at Booligal (412005) to contribute to large wetland inundation.	As per equivalent Merrimajeel action.	As per equivalent Merrimajeel action.	Moderate	Secondary priority for CEW. May also be linked to other watering actions within the system. Will occur only if natural trigger is met, or under moderate to high resource availability.	Moderate
Western Lachlan watercourse (PU 16) Includes Lachlan River channel, Great Cumbung Swamp, Lachlan swamp, Lake Waljeers, Baconian swamp	Lateral and longitudinal connectivity, support movement, spawning and recruitment of aquatic species. Riparian and wetland vegetation health. Nutrient and carbon cycling. Maintain refuge for aquatic biota and fish.	Greater than 650 ML/d in Lachlan River at Booligal (412005) to contribute to small wetland inundation.	Timing: Sept to Mar (can occur anytime). Duration: 30 days, 2 to 8 months of habitat inundation. Frequency: 7 to 8 years in 10 (75% of years). Max. inter-event period: 2 years.	Flow/volume met in 2011–12, 2012–13, 2013–14, 2015–16, 2016–17 (flood year), 2020–21 (translucent flows) and 2021-22 and 2022-23 (flood years).	High (to maintain core reed beds of Great Cumbung Swamp)	A high priority for CEW in 2023–24 to consolidate outcomes from flows provided in 2022-23.	High (to maintain core reed beds of Great Cumbung Swamp)
		Greater than 850 ML/d in Lachlan River at Booligal (412005) to contribute to small wetland inundation.	Timing: Oct to Apr (can occur anytime). Duration: 60 days, 2 to 6 months of habitat inundation. Frequency: 5 to 7 years in 10 (60% of years). Max. inter-event period: 3 years.	Flow/volume met in 2011–12, 2012–13, 2013–14, 2015–16, 2016–17 (flood year), 2020–21 (translucent flows) and 2021-22 and 2022-23 (flood years).	High (to maintain Great Cumbung Swamp)	A high priority for CEW in 2023–24 to consolidate outcomes from flows provided during flood years.	Moderate (to maintain Great Cumbung Swamp)

Environmental assets and long-term water plan unit (PU) reference number	Target values	Indicative demand (for all sources of water in the system)		Watering history (from all sources of water)	2023–24		Implications for future demand
		Flow/volume	**Required frequency (maximum dry interval)**		**Environmental demand for water (all sources)**	**Potential Commonwealth environmental water (CEW) contribution**	**Likely urgency of demand in 2024–25 if watering occurred as planned in 2023–24**
	Maintain foraging and nesting habitat for waterbirds. Maintain riparian habitat for other species i.e. water birds.	Greater than 1,200 ML/d in Lachlan River at Booligal (412005) to contribute to large wetland inundation.	Timing: Aug to Feb (but can occur any time). Duration: 60 days, 2 to 3 months of habitat inundation. Frequency: 3 to 5 years in 10 (40% of years). Max. inter-event period: 4 years.	Flow/volume met in 2011–12, 2012–13, 2013–14, 2015–16, 2016–17 (flood year), 2020–21 (translucent flows) and 2021-22 and 2022-23 (flood years).	High (to maintain Great Cumbung Swamp)	A high priority for CEW in 2023–24 to consolidate outcomes from flows provided in 2022-23. May also be linked to other watering actions within the system. Will occur only if natural trigger is met, or under moderate to high resource availability.	Moderate (to maintain Great Cumbung Swamp)
		Greater than 1,200 ML/d in Lachlan River at Booligal (412005) to contribute to large wetland inundation.	Timing: Any time. Duration: 60 days, 2 to 3 months of habitat inundation. Frequency: 2 to 3 years in 10 (25% of years). Max. inter-event period: 5 years.	Flow/volume met in 2011–12, 2012–13, 2013–14, 2015–16, 2016–17 (flood year), 2020–21 (translucent flows) and 2021-22 and 2022-23 (flood years).	High (to maintain Great Cumbung Swamp)	A high priority for CEW in 2023–24 to consolidate outcomes from flows provided in 2022-23. May also be linked to other watering actions within the system. Will occur only if natural trigger is met, or under moderate to high resource availability.	Moderate (to maintain Great Cumbung Swamp)
Wetlands, lagoons, and billabongs (various PUs). Includes, but not limited to, Yarrabandai Lagoon, Noonamah, Comayjong, Fletchers Lake and Lake Ita.	Maintain off-channel drought refuge habitat for native frogs and waterbirds. Support movement, spawning and recruitment of aquatic species. Maintain floodplain vegetation health.	Site specific. Delivery may involve the use of regulators and/or pumping.	Will vary from site to site and depending on the outcomes being sought. Likely to be annual to maintain wetland vegetation with a period of drying down followed by re-inundation.	Various and site specific. Several sites have received water frequently in recent years (e.g. Noonamah), some have just commenced receiving water (e.g. Comayjong) and planning is underway for other sites, such as Lake Ita, to be able to be watered in the future.	High	A high priority for CEW in 2023–24 to consolidate outcomes from flows provided in previous years.	Moderate
Waterbird breeding contingency	Waterbird breeding sites including (but not limited to) Lake Brewster, the Booligal wetlands (Merrimajeel Creek, Muggabah Creek), Lachlan Swamps and Great Cumbung Swamp.	Variable and seeks to provide at least 0.8 metres of depth below nests until chicks have fledged.	As required, more likely in very wet/flood years.	Water provided during breeding events in 2012, 2015 and 2016 and 2022-23. Pelican rookery supported at Lake Brewster in 2020–21 and 2022-23. Water approved for supporting Booligal wetlands during 2022-23 but not required (water requirements met naturally).	High (contingency: bird breeding)	Depending on timing, option to be considered if breeding event is triggered, however more likely to occur under moderate or high water resource availability.	High (contingency: bird breeding)
Water quality contingency	Mitigate low dissolved oxygen concentration conditions within the River channel.	Variable and may depend on in-channel flow rates (e.g. flood recession).	As required, more likely in very wet/flood years or during very low flow periods and heatwaves in summer.	Use of Lachlan Water Quality Allowance would occur before use of Commonwealth environmental water.	High (fish refuge flows)	Depending on ability to source high quality water and noting potential long travel times from storages to impacted sites in lower Lachlan.	High (fish refuge flows)

Note: reference numbers in table drawn from Lachlan Long Term Water Plan Part B: Lachlan planning units (NSW DPE 2020).

Key

Potential watering in 2023–24

- High priority for Commonwealth environmental watering (likely to receive water even under low water availability)
- Secondary priority for Commonwealth environmental watering (watering to occur only if natural trigger is met, or under moderate – high water resource availability); or water demand likely to be met via other means
- Low priority for Commonwealth environmental watering (under high – very high water resource availability); or unable to provide water because of constraints or insufficient water

Environmental demands (demand is considered at a generalised scale; there may be specific requirements that are more or less urgent within the flow regime)

- High to critical demand for water (needed in that particular year or urgent in that particular year to manage risk of irretrievable loss or damage or to maintain wet conditions for a prolonged duration)
- Moderate demand for water (water needed in that particular year, the next year, or both)
- Low demand for water (water generally not needed in that particular year)

1.2 Water delivery in 2023–24

Based on the environmental demand for water, water availability (supply), and catchment conditions, the overall purpose for managing Commonwealth environmental water in the Lachlan valley in 2023–24 is to maintain and improve the health and resilience of aquatic ecosystems and wetland areas.

The planning of watering actions is undertaken in partnership with NSW agencies, and in consultation with a range of stakeholders including scientists, non-government organisations, land holders and First Nations. A range of scenarios, from very dry to very wet conditions, are planned for so that environmental water managers can respond quickly to changing catchment conditions during the year. The high water availability will provide a unique opportunity in 2023–24 for water managers to consolidate the environmental outcomes achieved since 2021–22 by prolonging wetland inundation.

Subject to river flows returning to regulated levels, several potential watering actions that had to be put on hold in 2021–22 and 2022-23 due to high flows in the system, will be a priority in 2023–24. The inclusion of a spring pulse from Wyangala Dam has demonstrated its value in enabling several watering actions to be efficiently and effectively delivered as part of a larger flow event. A spring pulse potentially includes all the main river channel while also enabling watering actions into Yarrabandai Lagoon, Booberoi Creek, Brewster Weir pool, Noonamah, Comayjong, Fletchers Lake and the Great Cumbung Swamp. This action aims to maintain native vegetation condition; support native fish reproduction and native fish health; and maintain in-channel habitats, in-stream productivity, and longitudinal connectivity. The volume of environmental water required will be dependent on the size of any natural flow event which, ideally, is used as a trigger for delivery (the larger the natural event, the less environmental water required). Depending on the inflow scenario, distributaries such as Willandra, Merrowie, Merrimajeel and Muggabah Creeks would be considered for watering in conjunction with stock and domestic replenishment flows where applicable. Wherever possible, Commonwealth environmental water is proposed to be used in conjunction with water provided by NSW.

As drier conditions are expected moving into 2023–24, environmental watering actions will seek to complement other flows in the system to maintain connectivity with the floodplain, maintain the health of floodplain vegetation, maintain water quality where feasible to do so and/or support naturally triggered waterbird breeding events. Watering actions that contribute to maintaining waterbird foraging habitats within the Lachlan valley, and potentially link to waterbird habitat in other parts of the Basin (for example the Macquarie, Murrumbidgee, and Mid-Murray catchments) will also be prioritised.

1.3 Monitoring and lessons learned

1.3.1 Monitoring

The CEWH Monitoring, Evaluation and Research (MER) Program (2019–20 to 2023–24) integrates and replaces monitoring and research activities under the Long-Term Intervention Monitoring (LTIM) and Environmental Water Knowledge and Research (EWKR) projects.

The University of Canberra is the lead agency, contracted by the CEWH, to undertake the Lachlan LTIM (Dyer et al 2015, 2016, 2017, 2018, 2019) and MER projects (Dyer et al 2020, 2022). The

University of Canberra has developed a detailed MER Plan for the Lachlan River valley which sets out the schedule of monitoring activities.

Additional monitoring is also undertaken by NSW agencies. Landholders and community members play a critical role in providing real-time, on ground advice and observations of conditions in the catchment, including the progress and outcomes from the use of environmental water.

1.3.2 Lessons learned

Outcomes from monitoring and lessons learned in previous years are a critical component for the effective and efficient use of Commonwealth environmental water. These learnings are incorporated into the way environmental water is planned and delivered (through decision making processes including advisory groups, water use plans and water use minutes). This includes influencing the targeted areas and species for environmental water, and the timing, magnitude and duration of environmental flows.

Key findings from monitoring in the Lachlan River catchment are summarised in Table LR2.

Table LR2 Key lessons learned in the Lachlan River Catchment

Theme	Lessons learned
Native fish	• Dyer et al. (2022) notes that for the first time since LTIM/MER monitoring began: – Golden perch were collected during larval sampling in 2020. Two age classes of golden perch larvae indicates that there were likely two separate spawning events, one early November (2nd/3rd) and one approximately 9 days later (11th) when river temperatures were around 21 and 23 °C, respectively. – Golden perch recruits were captured in 2021, with DNA testing confirming these recruits were wild bred and not stocked fish. These spawning and recruitment events were during periods of translucent flow and highlight the potential importance of translucent/very high flows at a warmer time of year in providing the conditions golden perch required for spawning and recruitment in the lower Lachlan River. • Dyer et al. (2019) notes evidence that a remnant adult population of Murray cod persists in the lower Lachlan below Lake Brewster after the 2016 hypoxic water event. Monitoring has shown this population to be spawning and will be the most likely recovery pathway for this species. It will be important for future water delivery to continue to provide breeding opportunities, by facilitating the movement of pre-spawning fish and maintaining spawning habitat during nesting periods to prevent rapid water level drops and nest abandonment or desiccation. Dyer et al. (2020) suggests that increased variability during the Murray cod nesting season may improve spawning and recruitment outcomes for Murray cod. • The provision of minimum flow targets during the spawning season for nesting fish species may also be river reach specific. The decision in 2018–19 to not include a minimum flow target at Hillston (lower Lachlan) appears to have had no impact on cod larvae response in that year. This would suggest that nesting fish species are (a) nesting at sites lower than existing low flow levels, and/or (b) that flows delivered to the upper Lachlan continued to provide benefit to the lower Lachlan in addition to operational base flows. These flows would be better informed/targeted if incorporated with habitat mapping undertaken by NSW and fish movement monitoring (yet to be undertaken in the Lachlan) (Dyer et al. 2019). • Watts et al. (2019) note the learning from the 2015–16 watering action that targeted, but failed to detect, golden perch spawning in the Lachlan River (Dyer et al. 2016). Future watering actions targeting golden perch spawning as an objective, will need to be undertaken in a year of high water availability to be able to provide increasing flows over several days combined with increasing water temperatures (above 23°C). Under such catchment conditions consideration will also have to be given to the likelihood that golden perch may have spawned on earlier high flows (translucent releases or flood flows). This has been shown to be the case in 2020–21 with golden perch spawning detected for the first time in 7 years of monitoring (Dyer, 2021) and linked to 2020–21 translucent flow events.

Theme	Lessons learned
	• The integration of eDNA metabarcoding in the 2018–19 monitoring efforts resulted in more robust species richness data for the lower Lachlan River through the detection of freshwater catfish and silver perch. • Monitoring coordinated by NSW continues to show the importance of off-channel habitat, such as Booberoi Creek, to a range of native fish including freshwater catfish. Monitoring has also shown that olive perchlet are continuing to persist in Brewster Weir pool (McGrath 2020) and recent reports have found the species has expanded post-flood into lower Lachlan distributaries. • Linked to the theme of stream metabolism below, CEWO (2017) notes the difficulty in the timely provision of water for native fish refuge flows during hypoxic water quality events. Long travel times for the delivery of flows can mean that it is not possible to provide refuge flows in time to prevent or minimise the impacts of fish kills, especially in the lower Lachlan. The recent installation of dissolved oxygen loggers on NSW gauges in the system will help with earlier detection of hypoxic water conditions.
Vegetation	• Dyer et al. (2022) notes that: – Environmental water use, especially when used in conjunction with translucent flows, is continuing to make an important contribution in maintaining the richness and cover of plant species in the lower Lachlan River. Sites which received environmental water in the 2020–21 watering year had a more diverse and abundant assemblage of native amphibious species compared to sites which did not receive environmental water. – Research into the use of drone-based vegetation monitoring methods are showing high accuracy and precision in recognising key wetland features (especially *Phragmites australis* reeds), demonstrates the applicability of this technique to estimate a change or response in cover or distribution of *Phragmites australis* reeds in response to management actions or changes in flow regime. • Dyer et al. (2020) notes the MER research project that focusses on the reed beds of the Cumbung Swamp has shown that environmental water is maintaining the condition of the central reed beds of the Great Cumbung Swamp, promoting growth, cover, and reproduction. Higgisson et al. (2022a), via the MER research project, have used drones (unoccupied aerial vehicles and convolutional neural networks) to successfully demonstrate the role environmental water plays in filling the gaps between large flood events and maintaining the condition and resilience of reed beds. • There is a challenge for environmental water managers in maintaining the health of floodplain vegetation, especially at sites that are easier to provide water to (Higgisson et al. 2020a). These sites may be prone to river redgum encroachment. Planning of events for vegetation outcomes must include and trial not only the timing of flow events but also the duration and depth of flows to match what is required for the vegetation outcomes being targeted at individual sites. • Dyer et al. (2019) found that frequently watered sites, such as Nooran Lake, have the greatest number of native amphibious species present and can frequently replenish soil seedbanks. Maintaining flows to these sites may help reduce the number of terrestrial plant species that would be able to invade these sites in the absence of regular watering. A comparison of approaches and results with watering similar wetland sites for vegetation outcomes in the Murrumbidgee catchment (Wassens 2020) may also help inform such an approach in the Lachlan catchment. • Higgisson et al. (2022b) note the importance of high flow events of significant duration for species such as river cooba, which requires a flood event for a duration of approximately one month to provide appropriate conditions for seed dispersal and germination. Higgisson et al. (2020b) note that the distribution of river cooba along rivers facilitates regular dispersal of seeds via hydrochory (seed dispersal by water) regardless of river level, while the dispersal of seeds of tangled lignum between patches is dependent on flooding events.
Connectivity	• Dyer et al. (2020) found that all 4 of the 2019–20 watering actions provided water to parts of the river system that would otherwise have been dry in 2019–20, thus contributing to the provision of refuge habitat for water dependent species. • Dyer et al. (2019) also notes the increasing influence and importance of these watering actions have as they move downstream. For example, in 2018–19 these flows contributed 4 % of the flow in the mid- Lachlan (at Forbes). In the lower Lachlan (at Booligal) these flows contributed 24 % of the flow, doubled the number of freshes that exceeded 200 ML/day and provided the only fresh to reach 500 ML/day for the watering year.

Theme	Lessons learned
	• Higgisson et al. (2020a) analysed modelled long-term flow data under current and "without development" flow scenarios in relation to floodplain connection thresholds and found that: – The connection regime of the floodplain wetlands of the lower Lachlan River has been substantially modified under current flow conditions. – The number of connection events under current flow conditions has been halved compared with "without development" conditions. – The median connection duration has increased by 28%, and the median duration of the dry spell has almost doubled – No change in the timing of connection has occurred under current flow conditions. • Based on Sentinel monitoring, the combination of multiple pulses delivered at Booligal in May-June may achieve a greater spread into the Great Cumbung Swamp when compared to a spring pulse. Depending on the objectives to be targeted and catchment conditions, the use of water in autumn-winter, delivered to Booligal, may be a more efficient at watering the Great Cumbung region than delivery during spring. Winter-autumn would take advantage of lower temperatures and possible winter rain. However, spring may remain a preferred time in terms of response from the core reed beds and upstream in-channel outcomes. Proposed research under MER will inform these decisions into the future. • Consistently reviewing the planned annual hydrograph can enable water saving to be made during the year (e.g. the dispersal pulse as end of fish nesting period may not be required if operational flows can achieve this).
Waterbirds	• Brandis (2016) concluded that even with the provision of flows, the abandonment of Booligal wetland nesting sites by straw necked ibis during June-October 2015 was in response to a combination of factors relating to hotter temperatures, declines in flows and water levels, reduction in foraging habitat and better habitat being available in other catchments. • Brandis and Lyons (2016) note the response of straw necked ibis during the August to November 2016 breeding event where the rookery exceeded 200,000 nests at its peak. This work also showed the effectiveness of the use of drones to assist with monitoring waterbird outcomes. Dyer et al. (2017) notes that this response highlights the importance of regional weather patterns, and the value of extensive flooding to provide foraging areas and habitat for food resources to thrive in a successful breeding event. The strategy of using flows to support breeding events once they have established (rather than trying to trigger a breeding event) is therefore sound. The management of water levels at the second waterbird rookery site in the Booligal Wetlands in 2016–17 demonstrates the value of this approach.
Stream metabolism	• Dyer et al. (2019, 2022) suggest that pulses at the warmer time of year may improve the ability of flows to provide a boost in productivity to the river system. Planning of flows for spring-early summer will take the following points into consideration: – the other objectives that may also be targeted with the use of water – where those objectives may be met as the water moves down the river channel – how best to use environmental water with other water, such as the Lachlan Water Quality Allowance, also being delivered in the system, identifying and filling gaps in key component of the hydrograph where required – minimising the risk of generating hypoxic events by providing pulses into the river when water temperatures begin to exceed 16°C.
Other aquatic animals	• Frogs: At sites like the Booligal Wetlands and the Great Cumbung, there is a need for standing water to be present in the landscape to enable summer breeding frog species to be able to complete their life cycle Dyer et al. (2016). The provision of flows during warmer months of the year needs to include consideration of the potential to contribute to the breeding of carp in the same areas where frog outcomes may be sought. Carp exclusion and management activities may be required on a site-by-site basis prior to flows being delivered in summer for frog outcomes.
Cultural	• Higgisson et al. (2021) note that environmental flows can be used to maintain culturally important plants such as old man weed as the occurrence and distribution of this species is related to the occurrence and distribution of inundation. • Higgisson, W. (2020) describes the response to flooding and drying of three plants widely used by Aboriginal peoples including a food plant (nardoo), medicinal plant (old man weed) and a plant used for fibre (cumbungi).

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