



Australian Government

Commonwealth Environmental Water Office

Commonwealth Environmental Water Office Water Management Plan 2021–22

Chapter 5 Warrego and Moonie Valleys Water Plan

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Acknowledgement of the Traditional Owners of the Murray–Darling Basin

The Commonwealth Environmental Water Office respectfully acknowledges the Traditional Owners, their Elders past and present, their Nations of the Murray–Darling Basin, and their cultural, social, environmental, spiritual and economic connection to their lands and waters.

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5 Warrego and Moonie Valleys Water Plan

5.1 Region overview

5.1.1 River system

The Warrego and Moonie River Valleys are characterised by highly variable rainfall and ephemeral (intermittent) stream flows (Map WMV1) (MDBA 2021a,b). Significant flow events generally result from heavy rainfall in elevated headwater areas (CSIRO 2007,2008; DEHP 2016, MDBA 2021a,b). No flow periods of several months are common, extending to several years during prolonged dry conditions (CSIRO 2007, 2008; DEHP 2016, MDBA 2021a,b).

The flat landscape, low local runoff and intermittent flow conditions in both the Warrego and Moonie Valleys have led to the evolution of distinctive ecology in lowland river reaches (Balcombe et al. 2006). Aquatic and floodplain species are adapted to high flow variability and 'boom and bust' cycles (Balcombe et al. 2006). This is characterised by episodes of intense reproduction and high productivity by opportunistic plants and animals – the boom – associated with periods of flooding, followed by periods of stress and reduced production – the bust (Balcombe et al. 2006).

The Warrego River is largely unregulated, other than the State-owned Allan Tannock Weir at Cunnamulla (MDBA 2021a). Only a small volume of surface water in the Warrego catchment is diverted for irrigation and urban use (MDBA 2021a). Some water is also taken from the river by diversion of flow or overland flows into private off-channel storages (MDBA 2021a).

Similar to the Warrego, the Moonie River is a predominantly unregulated system and has no major water storages. A weir was built over the river at Thallon in 1959 to supply town water (MDBA 2021b). Almost all irrigation in the Moonie depends on surface water. However, these diversions are small compared to overall surface water available (CSIRO 2008).

5.1.2 Traditional Owners

The lands and waters of the Warrego and Moonie Valleys hold significant spiritual and cultural importance for Aboriginal people. Many Aboriginal nations retain a connection with the two regions and their history, culture and livelihoods are closely intertwined with their river systems. The Commonwealth Environmental Water Office (CEWO) respectfully acknowledges these Nations, their Elders past and present, as the Traditional Custodians of the lands on which this chapter is focused.

The Warrego Valley takes in (or closely borders) the traditional lands of the Yuwaalaraay/Euahlayi, Bidjara, Gwamu/Kooma, Gunggari/Kungari, Kunja, Mandandanji, Mardigan, Githabul and Murrawarri nations (MDBA 2021a).

The Moonie catchment includes the traditional lands of the Bigambul, Gomeroi/Kamilaroi and Mandandanji nations (MDBA 2021b).

5.1.3 Important sites and values

There are many environmental assets in the Warrego Valley including species and communities of fish, waterbirds and vegetation and important habitats such as wetlands and drought refuges.

The Warrego Valley supports large areas of wetlands. The nationally significant Cuttaburra Channels and Yantabulla Swamp (a mosaic of channels, floodways and wetlands) consistently support large numbers and a high diversity of waterbirds and provides breeding sites for ducks and colonial waterbirds when flooded (Kingsford et al. 1997,1999, 2013; Bino et al. 2015; NSW DPIE 2020; MDBA 2021a). Waterholes along the Warrego River near Charleville are an important breeding area for native fish including Murray cod and silver perch (MDBA 2021a). Toorale’s Western Floodplain is also an ecologically important floodplain wetland, providing important feeding and breeding habitat for a range of water dependent species in wet conditions (ELA 2019; NSW DPIE 2020; UNE & 2 Rog Consulting 2020a,b, 2021).

These ecological populations and habitats are connected to the Barwon–Darling River, providing a critical drought refuge and movement corridor for fish and waterbirds (NSW DPIE 2020).

Native vegetation in the Warrego Valley includes important riparian and floodplain communities such as lignum, river red gum, river cooba, black box and coolabah (NSW DPIE 2020). There is a high proportion of remnant vegetation in good condition in some areas including the floodplains of the Warrego, such as stands of coolibah, black box and lignum (NSW DPIE 2020). The Western Floodplain also supports ‘tiny teeth’ (*Dentella minutissima*) a plant species listed as threatened under NSW legislation (NSW DPIE 2020).

In between boom periods, channels in the Warrego typically dry to a series of disconnected waterholes, which are drought refuges that are reconnected by the next significant flow event (Marshall & Lobegeiger 2020). Semi-permanent and permanent waterholes in the main river channels and tributary creeks and anabranch systems are critical to ensuring the survival of species between boom periods and their capacity to recolonise the system in subsequent flow periods (Marshall & Lobegeiger 2020). Much of the riverine fauna (e.g. fish, turtles, invertebrates) of the Warrego Valley is dependent upon the persistence of a network of refugial waterholes during frequent and often prolonged no flow periods (NSW DPIE 2020; Marshall & Lobegeiger 2020).

The Warrego and Moonie Valleys support several species listed as endangered or vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999*. These include Murray cod, silver perch, Australian painted snipe, Australasian bittern, and examples of the threatened ecological community of coolibah-blackbox woodland (NSW DPIE 2020).

Over 100 wetlands exceeding one hectare in area have been mapped in the Moonie, many of which are in the lower catchment below Nindigully (CSIRO 2008; DES 2018). Thallon waterholes have been observed to support between 10,000 and 20,000 waterbirds (Kingsford et al. 1997). There is past evidence of black swans, grey teal and little black cormorants breeding at the waterholes (DNR 1999). Banded lapwing and wandering whistling-duck have also occurred in high abundance (Bino et al. 2015; DES 2018).

The Moonie flows through the endangered southern Brigalow belt, which contains remnants of Brigalow forests, poplar box, Wilga and white cypress pine (DES 2018).

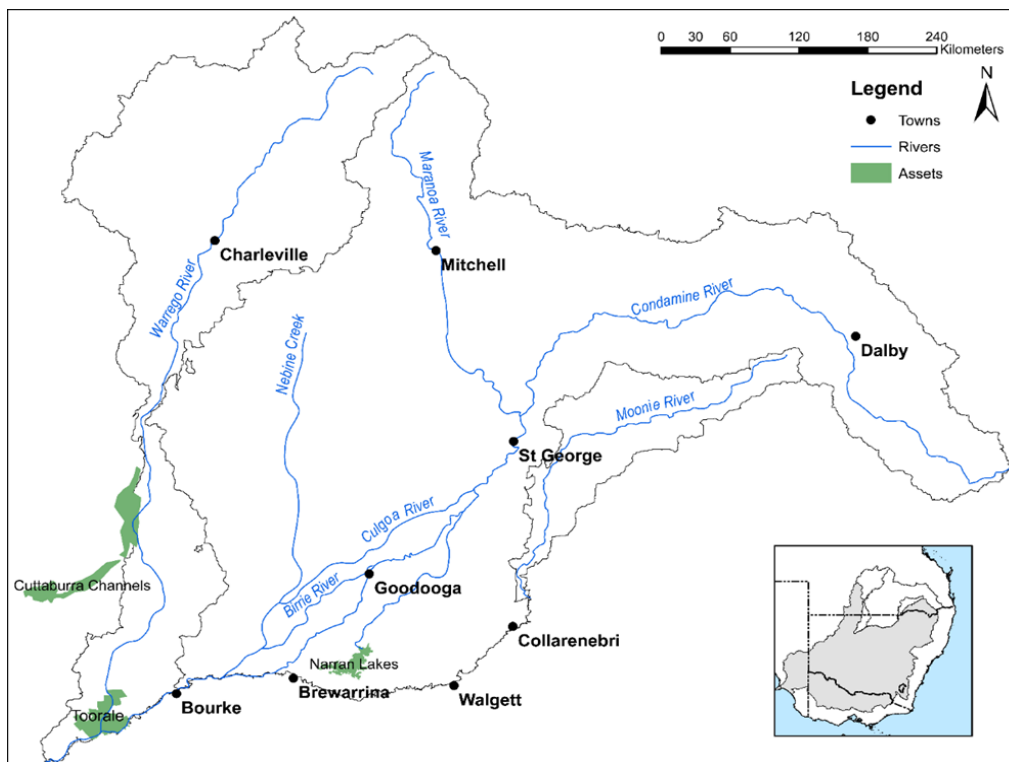
The Moonie has relatively long and deep waterholes that have been shown to be critical refugia for sustaining native fish populations in the often long periods between flows in the system. Waterhole habitat has been identified in three main spatial areas in the Moonie: upstream of Flinton, downstream of the confluence of the Moonie River and Teelba and Bidgel creeks, and within the Nindigully floodplain assessment reach (DES 2018). Species including golden perch, bony bream, eel tailed catfish and smelt moved significant distances (up to 70 kilometres) in response to waterhole reconnecting flows, enabling recolonisation of the system and genetic mixing (Marshall et al. 2016). Native fish species recorded in the Moonie include the threatened silver perch and freshwater catfish as well as the environmentally, socially and economically important golden perch (DRNME 2018).

5.1.4 Stakeholder engagement

In the Warrego and Moonie Valleys, planning, management, and delivery of Commonwealth water for the environment is undertaken in conjunction with a range of partners and stakeholder groups. Key stakeholders in the Warrego Valley include the Queensland Departments of Regional Development, Manufacturing and Water (DRDMW), Environment and Science (DES), and Agriculture and Fisheries (DAF), NSW Department of Planning, Industry and Environment (DPIE), NSW Department of Primary Industries (DPI) – Fisheries, NSW National Parks and Wildlife Service (NPWS) and the Toorale Joint Management Committee.

Local Engagement Officers from the Commonwealth Environmental Water Office (CEWO) also work with different stakeholders as part a broader program of engagement around the management of the Commonwealth’s portfolio of environmental water entitlements. As part of this work, the CEWO’s Local Engagement Officers have been engaging directly with members of the local Aboriginal community. This work has focused on aligning priorities for water use with Aboriginal community objectives for sites, values and species significant to all Nations in the Warrego and Moonie Valleys.

Map WMV1 Warrego and Moonie River Valleys



Source: Department of Agriculture, Water and the Environment (n.d.)

5.2 Environmental objectives

Based on long-term environmental objectives in the Basin Plan, state long-term watering plans, site management plans, and best available knowledge, the following objectives are relevant for environmental watering in the Warrego Valley. These objectives will continue to be revised as part of the CEWO’s commitment to adaptive management.

- Vegetation – Maintain and improve the condition, growth and survival of riparian, in-channel, floodplain and wetland vegetation.
- Waterbirds – Maintain foraging, roosting and breeding habitats at targeted sites on the floodplain to support waterbirds.
- Native fish – Improve habitat condition, and support different life stages (migration, spawning, recruitment and refuge), natural flow variability, and connectivity between river channels, wetlands, anabranches and floodplains.
- Invertebrates – Maintain and improve the micro- and macro-invertebrate communities by providing a variety of habitat and flow conditions.
- Other vertebrates – Support survival and recruitment of other native aquatic species, including frogs and turtles.
- Connectivity – Support longitudinal connectivity, including with the Barwon River, and lateral connectivity between the river(s), wetlands and floodplain.

- Processes/water quality/resilience – Support key ecosystem functions, biotic dispersal, and promote productivity; maintain water quality in channels and pools; and maintain drought refuge habitat.

5.3 First Nations environmental watering objectives

The CEWO is committed to working with First Nations groups to better understand their objectives. The CEWO will use environmental flows to contribute to these objectives where possible and where this is consistent with the Commonwealth Environmental Water Holder's statutory responsibility of protecting and restoring environmental assets in the Basin (see [Chapter 2](#)).

As the next steps, the CEWO will develop and implement a work program to work with First Nations groups in the northern Basin. This work program will be developed in collaboration with First Nations groups and will be integral in continuing to build relationships and our capacity with First Nations groups. It will also ensure First Nations groups actively participate in the planning and management of environmental flows.

5.4 Recent conditions and seasonal outlook

5.4.1 Recent conditions and environmental water use

During the first half of the 2020–21 water year, the Moonie catchment experienced largely average to drier than average rainfall conditions and warmer than average temperatures (BOM 2021f-k). Wetter conditions occurred in summer and autumn 2020–21, particularly in January to March 2021 (BOM 2021f-k). There was around 450 mm of rainfall recorded at the Flinton gauge in the upper Moonie catchment in 2020–21 (with minimal rainfall in April and May 2021), and around 400 millimetres of rainfall at the Nindigully gauge over the same period (DRDMW 2021b). There were flood warnings issued for the Moonie river at Flinton and Nindigully in January-April 2021.

The Commonwealth's unregulated Queensland licenses in the Moonie were triggered in January through to April 2021, with an estimated total contribution of around 5.7 gigalitre and all licence volumes exhausted by mid April 2021. Around 114 gigalitres flowed past the most downstream gauge at Gundablouie from 1 January 2021 to the end of May 2021, contributing an estimated 100 gigalitres of inflows to the Barwon-Darling (WaterNSW 2021c).

There was periodic rainfall across the Warrego Valley throughout the water year (BOM 2021a). Most rainfall occurred in March 2021 with the upper and lower Warrego catchment receiving 100 to 200 mm and central areas around Charleville, Wyandra and Cunnamulla receiving up to 100 mm (BOM 2021b,c).

Unregulated licences in the Queensland portion of the Warrego Valley were triggered in March and April 2021, with an estimated environmental contribution of 5.2 gigalitres in the Lower Queensland Warrego (gauged at Cunnamulla weir) and 198 megalitres in the upper Warrego (gauged at Augathella).

Commonwealth environmental water in combination with natural flows entered the nationally significant Cuttaburra and Yantabulla wetland areas downstream of Cunnamulla, with around 27 gigalitres flowing past the Turra gauge (WaterNSW 2021a). This was a much smaller event

compared to 2019–20, for example around 95 gigalitres total volume past the Cunnamulla gauge in 2020–21, compared to around 1,000 gigalitres in 2019–20 (DRDMW 2021a).

The Commonwealth’s Toorale licences on the Warrego River were not activated in 2020–21, as the multi-year account limit was reached last year. The high flow licence at Toorale was also not triggered in 2020–21. Around five gigalitres flowed from the Warrego River into the Darling River between March and April 2021, helping meet downstream environmental demands (WaterNSW 2021b). While the Western Floodplain at and around Toorale National Park received local rainfall in March 2021, there was no flow from the Warrego River onto the Western Floodplain in 2020–21 (Paul Frazier [2 Rog Consulting] 2021, pers. comm. 11 May).

Native fish in the upper Warrego have responded well to flows over the last two years, with refuge pools near Charleville supporting abundant golden perch and some Murray cod, with a relatively low carp presence (Marshall & Lobegeiger 2020). Waterbirds in the Cuttaburra and Yantabulla area have also benefited from flows to the area (Kingsford & Wainwright 2020; Thorburn 2020).

Vegetation on the Western Floodplain at Toorale near the junction of the Warrego and Darling rivers dried back during the first half of 2020–21, with lignum showing a decrease in condition (UNE & 2 Rog Consulting 2020b). However, plant height and size increased, showing longer term benefits of flows to the area (UNE & 2 Rog Consulting 2020b).

Drier conditions in the first half of 2020–21 may have confined native fish to refuge pools along the system (UNE & 2 Rog Consulting 2020b). However, the flow events in March and April 2021 improved conditions for golden perch and other native fish species, and would likely have provided spawning and recruitment opportunities and connectivity with the Barwon-Darling river system (UNE & 2 Rog Consulting 2021).

A return to dry conditions before flows in early 2021 also limited the abundance and diversity of waterbirds and frogs, although the longer-term productivity and food web benefits of flows are apparent in resident bird species including sea eagles (UNE & 2 Rog Consulting 2020b). These species are expected to respond positively to the most recent flows. Yabbies and turtles are also doing well in the Toorale area, showing the benefits of both environmental water and natural flows (UNE & 2 Rog Consulting, 2021).

Learn more about [Learn more about previous Commonwealth environmental water use in the Warrego and Moonie valleys.](#)

5.4.2 Seasonal outlook

According to the Bureau of Meteorology’s outlook issued on 3 June 2021, there is some chance of above average rainfall across the Warrego and Moonie Valleys from June to September 2021 (BOM 2021c). Maximum temperatures are also forecast to remain average or above average over the coming months (BOM 2021d,e).

This forecast suggests weather patterns may further improve the condition of rivers and wetlands across the Warrego and Moonie Valleys (and other Northern Basin systems). However, it is also possible that dry conditions may re-eventuate over coming months, which would hinder recovery.

5.4.3 Water availability

The Warrego and Moonie Valleys have fewer regulating structures than other areas of the Murray–Darling Basin, which limits options for the managed delivery of water for the environment at a predetermined volume and time. Instead, Commonwealth water for the environment in these two river systems can generally only be sourced as a share of an unregulated flow event or in some cases targeted management within an event. Most Commonwealth unregulated entitlements are left in-stream to provide environmental benefits by restoring flows that were formerly extracted, which improves flow variability.

Water availability depends on the flow events that occur. Unregulated entitlements provide opportunistic access to river flows when water levels exceed trigger values at certain locations, as specified in entitlement conditions. Each triggered Commonwealth environmental water entitlement leaves water in the river which could otherwise be extracted. This makes a contribution to restoring natural flows, reflecting its particular flow access windows, take rates and location. Daily, instantaneous, annual or multi-year limits cap overall diversions in any given year or flow event, and likewise the in-stream contributions that can be attributed to unregulated Commonwealth entitlements.

There is some capacity to direct flows at the junction of the Warrego and Darling rivers through infrastructure on the Toorale site (managed by the NSW National Parks and Wildlife Service in consultation with the Toorale Joint Management Committee). However, this is limited by the nature of the Commonwealth’s entitlements in the Warrego and Darling rivers and day to day operations of the Toorale infrastructure. Upgrades and changed management of the Toorale structures is underway through the Toorale Infrastructure Project (NSW DPIE 2021).

5.4.4 Environmental demands

For the environmental water demands for assets in the Warrego and Moonie Valleys in 2021–22, see Table WMV1 (Moonie Valley) and Table WMV2 (Warrego Valley). The capacity to contribute to these environmental demands is contingent on the Commonwealth licences being triggered by natural flow events.

Table WMV1 Environmental demands in 2021–22 for the Moonie Valley

Environmental assets	Target values	Indicative demand (for all sources of water in the system)			Environmental demands for water (all sources) in 2021-22
		Flow/volume	Required frequency (maximum dry interval)	Watering history (from all sources of water)	
Moonie River (at Gundablouie)	Native fish dispersal and condition	Very low flow (VLF) (>30 ML/day) Timing in line with natural (anytime).	At least 96% of years. (Max. interval 70 days (but not more than 283 days))	Met in all years since 2010–11 excluding 2018–19. Required annually therefore a high demand for water in 2021–22, remaining high in 2022–23 if watering occurs.	High
	Native fish spawning and recruitment	Minimum duration: typically 60 days/year exceed VLF threshold but not less than nine days/yr.			
	Native vegetation	Small fresh 1: >300 ML/day any time (ideally October to April). Minimum duration ten days	3 to 8 years in 10 (55%). (Max. interval four and a half years)	Met or partially met in seven of the last ten years, including in 2019–20 and 2020–21. Low environmental demand in 2021–22, remaining low in 2022–23 if watering occurs.	Low
	Aquatic ecosystem function	Small fresh 2: >314 ML/day (September to April) Minimum duration 14 days	1 to 5 years in 10 (30%) (Max. interval seven years)	Met or partially met in six of the last 10 years, including in 2019–20 and 2020–21. Low environmental demand in 2021–22, remaining low in 2022–23 if watering occurs.	Low
		Large fresh 1: >3,900 ML/day (any time) duration five days	2 to 6 years in 10 (45%). (Max. interval 6.5 years)	Met or partially met in six of the last 10 years, including being partially met in 2019–20 and fully met in 2020–21. Low environmental demand in 2021–22, remaining low in 2022–23 if watering occurs.	Low
		Large fresh 2: >3,900 ML/day (October to April) duration five days.	2 to 5 years in 10 (35%) (Max interval 6.5 years)	Met or partially met in six of the past 10 years, including being partially met in 2019–20 and met in 2020–21. Low environmental demand in 2021–22, remaining low in 2022–23 if watering occurs.	Low
		Large fresh 3: 5,100–18,800 ML/day (any time) duration three days	2 to 7 years in 10 (45%). (Max. interval 5 years)	Met or partially met in five of the last 10 years, including in 2020–21. Moderate environmental demand in 2021–22, moving to low in 2022–23 if watering occurs.	Moderate
	Overbank: >18,800 ML/day (any time) duration three days.	0 to 3 years in 10 (10%). (Max. interval 20 years)	Met in three years in the last 10 years, but not met since 2013–14. High environmental demand, moving to moderate in 2022–23 if watering occurs.	High	

Note: All watering history sourced from NSW Department of Planning, Industry and Environment, WaterNSW Water Balance Reports, and data from the following gauge (WaterNSW 2021a): 417001 – Moonie River at Gundablouie.

Key

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)
- 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)

Table WMV2 Environmental demands in 2021–22 for the Warrego Valley

Environmental assets	Target values	Indicative demand (for all sources of water in the system)			Environmental demands for water (all sources) in 2021-22
		Flow/volume	Required frequency (maximum dry interval)	Watering history (from all sources of water)	
Cuttaburra Creek (at Turra)	Native fish dispersal and condition	Small fresh 1: <1,000 ML/d for 23 days (anytime)	4 years in 10	Met or partially met in nine out of the last 10 years, including in 2019–20 and 2020–21. Low environmental demand in 2021–22, remaining low in 2022–23 if watering occurs.	Low
	Native fish spawning and recruitment	<20% wetland inundation – foraging and feeding habitat, small breeding of non-colonial species	1 to 2 years in 10 (Maximum dry interval three years)	Met in 5 out of the last 10 years including 2019–20, but not met in 2020–21. Low environmental demand in 2021–22, remaining low in 2022–23 if watering occurs.	Low
	Native vegetation	82,000 ML in 60 days (anytime)			
	Aquatic ecosystem function	50% wetland inundation – small waterbird breeding events may occur	1 to 2 years in 10	Met in 3 out of the last 10 years, including in 2019–20. Not met in 2020–21. Low environmental demand in 2021–22, remaining low in 2022–23 if watering occurs.	Low
	Wetland inundation	166,000 ML in 90 days			
	Waterbird breeding				
Warrego River at Barrington	Native fish dispersal and condition	Small fresh 1: >220 ML/day anytime (ideally October to April) for 10 days (native fish dispersal and condition	Annual (Maximum dry interval one and a half years)	Met or partially met in 9 of the last 10 years, including in 2019–20 and 2020–21. These flows are required annually, therefore the environmental demand is high in both 2021–22 and 2022–23.	High




Environmental assets	Target values	Indicative demand (for all sources of water in the system)			Environmental demands for water (all sources) in 2021-22
		Flow/volume	Required frequency (maximum dry interval)	Watering history (from all sources of water)	
	Native fish spawning and recruitment	Small fresh 2: 220 to 2,200 ML/day (September to April) for 14 days (spawning of in-channel specialists and generalists)	5 to 10 years in 10 (75% of years). (Maximum dry interval five years)	Met or partially met in 9 out of the last 10 years, including 2019–20 and 2020–21. Low environmental demand in 2021–22, remaining low in 2022–23 if watering occurs.	Low
	Native vegetation				
	Support refuge habitat (frogs, fish, waterbirds)				
	Aquatic ecosystem function	Large fresh 1: >2,200 ML/day any time for 5 days	5 to 10 years in 10 (75% of years) (Maximum dry interval four years)	Met or partially met in 6 out of the last 10 years, including being fully met in 2019–20 and partly met in 2020–21. Moderate demand in 2021–22, remaining moderate in 2022–23 if watering occurs.	Moderate
		Large fresh 2: >2,200 ML/day (October to April) for 5 days	4 to 5 years in 10 (40%) (Maximum dry interval five years)	Met or partially met in 6 out of the last 10 years, including being fully met in 2019–20 and partially met in 2020–21 (duration not met). Therefore there is a low demand in 2021–22, remaining low in 2022–23 if watering occurs.	Low
		Overbank flows: >5,400 ML/day any time for 2 days	4 to 5 years in 10 (Maximum dry interval nine years)	Met in 4 out of the last 10 years, including 2019–20 but not met in 2020–21. Moderate demand in 2021–22 reducing to low in 2022–23 if watering occurs.	Moderate
Warrego River (Boera Dam to Darling)	Refuge habitat (waterbirds, frogs, fish)	Flows to replenish refuges and connect to the Darling River.	Annually (Maximum dry interval one year)	Met every year except 2012–13. Required annually, therefore high demand in 2021–22, remaining high in 2022–23 if watering occurs.	High
	Instream aquatic ecosystems				
	Riparian vegetation	In-channel flows: Up to 600 ML/day for minimum 10 days to enable fish passage and movement	Ideally: 5 to 10 in 10 years (Maximum dry interval two years)	Met every year except 2012–13. Moderate environmental demand in 2021–22, moving to low in 2022–23 if watering occurs.	Moderate
	In-stream aquatic ecosystems				
	Fish connectivity and movement				
	Riparian vegetation				
Toorale Western Floodplain	Wetland and floodplain vegetation	Wetland inundating flow(WL1) Minor inundation: Cumulative volume 7,000 ML past Fords Bridge (combined) over 30 days (anytime). Minor inundation to inundate vegetation such as lignum, coolibah, river cooba, chenopod, forbs.	Preferably: 1 to 1.5 years (lignum); One to three years (river cooba, river red gum, black box);	Met in 5 out of the last 10 years, including 2018–19 and 2019–20. Not met in 2020–21. Cumulative volume past Fords Bridge combined between 3 April and 3 May 2021 was almost 12 gigalitres, however all of this water was passed through Boera Dam, meaning minimal wetland inundation occurred (Paul Frazier [2 Rog Consulting] 2021, pers. comm. 11 May). High environmental demand in 2021–22, moving to moderate in 2022–23 if watering occurs.	High
	Threatened species (Atriplex infrequens, Dentella minutissima, and Osteocarpum scleropterum) and ecological communities such as coolibah-blackbox woodland	Northern and Central parts of the floodplain (2,420 ha)	7 to 15 years (Coolibah). 5 to 10 years in 10 (Maximum dry interval 2 years)		
	Migratory birds (e.g. Eastern great egret; glossy ibis; oriental pranticole; rainbow bee-eater)	Wetland inundating flow (WL2) – half inundation: Cumulative volume 16,000 ML past Fords Bridge combined over 30 days.	Anytime Ideally: 4 to 8 in 10 years (Maximum dry interval 3 years)	Met or partially met in five out of the last 10 years, including in 2018–19 and 2019–20. Not met in 2020–21. Moderate environmental demand in 2021–22.	Moderate
	Native fish nursery and frog habitat	Inundation of around half the floodplain to inundate vegetation such as lignum, coolibah, river cooba, chenopod, forbs. (4,459 ha)			

Environmental assets	Target values	Indicative demand (for all sources of water in the system)		Watering history (from all sources of water)	Environmental demands for water (all sources) in 2021-22
		Flow/volume	Required frequency (maximum dry interval)		
		Wetland inundating flow (WL3) – full inundation: Cumulative volume of 33,000 ML past Fords Bridge combined over 30 days. Inundation of around the full floodplain to inundate vegetation such as lignum, coolibah, river cooba, chenopod, forbs. (7,104 ha)	Any time Ideally: 3 to 6 years in 10 (Maximum dry interval six years)	Met in 3 out of the last 10 years, including in 2019–20. Not met in 2020–21. Moderate environmental demand in 2021–22.	Moderate
		Boom inundation of more than entire Western Floodplain, Uteara lake, reconnections to Darling and return flows to the Warrego. Darling may backup to provide greater inundation. (11,847 ha) 75,000 ML/year to the Western Floodplain to inundate vegetation such as lignum, coolibah, river cooba, chenopod and forbs.	Any time Ideally: 1 to 3 years in 10 (Maximum dry interval 10 years)	Met in two of the last 10 years, including in 2019–20, not met in 2020–21. Low environmental demand in 2021–22.	Low
Darling River (downstream of the junction with the Warrego)	Native fish habitat, movement, refuge and spawning In-stream aquatic ecosystems and riparian vegetation Provides connectivity and movement between Darling and Warrego catchments Support refuge habitat Frog and waterbird habitat and refuge Improve water quality	Darling River is considered a priority (above all other priorities) when conditions in the Darling River at Louth exceed one or more environmental water requirements from the Barwon Darling Long -Term Water Plan: When cease to flow conditions have occurred for more than 110 days; There has been more than 135 days of flow less than 450 ML/day, or; It has been more than one year since a small fresh of at least 1,500 ML/day occurred for at least 10 days as measures at the Louth gauge.	Annually	Refer to Barwon–Darling Plan 2021–22 for a detailed watering history. As of 27 May 2021 nearly 1,255 GL had passed the Louth gauge with flows receding to a rate of 1,619 ML/day. Therefore this demand has been assessed as moderate in 2021–22, remaining moderate in 2022–23 if watering occurs.	Moderate

Note: All watering history sourced from NSW Department of Planning, Industry and Environment and Queensland partner agencies, WaterNSW Water Balance Reports, and data from the following gauges (WaterNSW 2021a and DRDMW 2021a,b): 423005 – Cuttaburra Channel at Turra, 423004 – Warrego River at Barrington, 423001 Warrego River at Fords Bridge, 423002 Warrego River at Fords Bridge Bywash and 425004 – Darling River at Louth.

Key

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)
-  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)

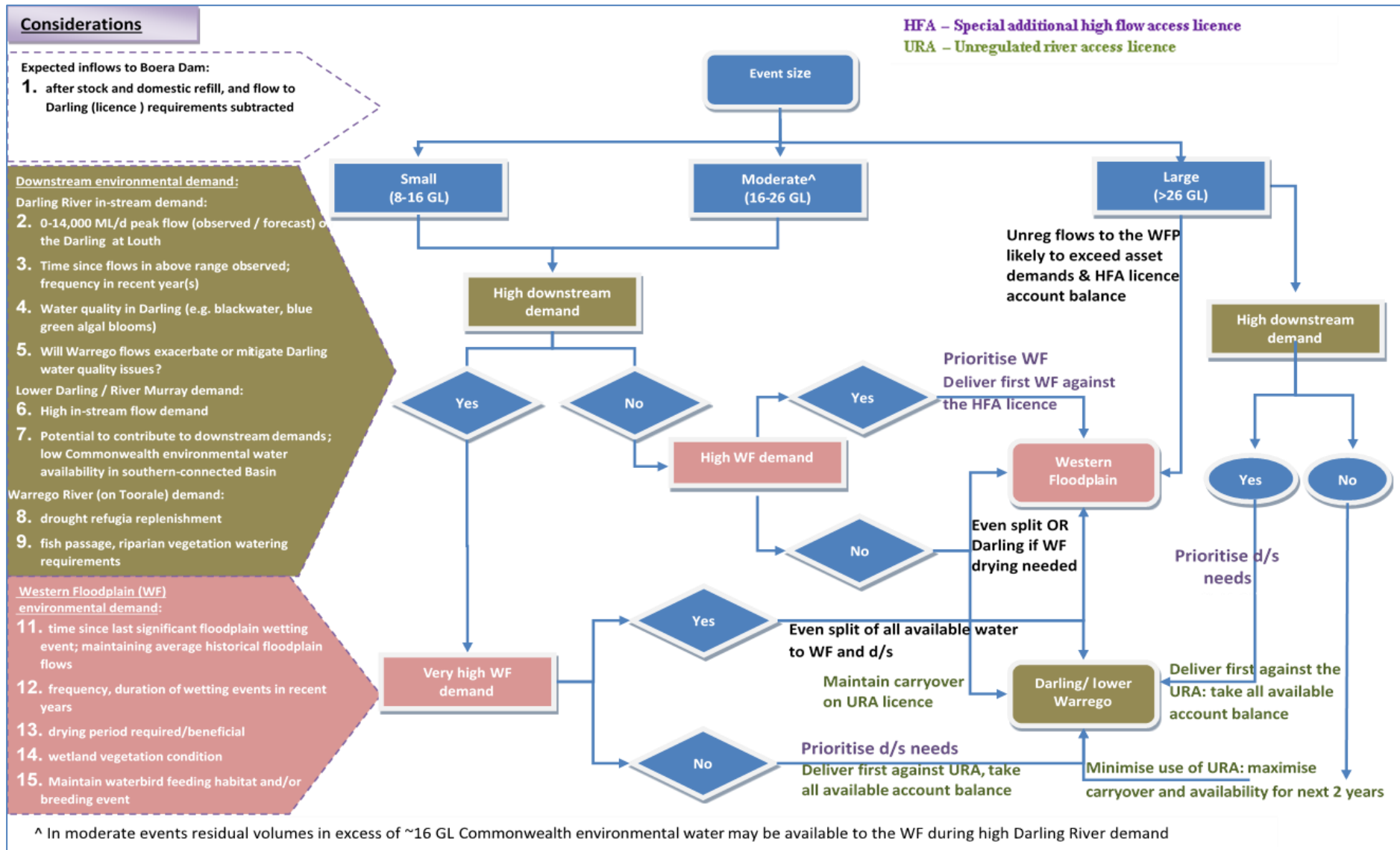
5.5 Water delivery in 2021–22

Commonwealth environmental water entitlements in the Warrego and Moonie are unregulated (or ‘unsupplemented’ in the Queensland portion of each Valley) and are left instream to contribute to environmental outcomes. In 2021-22, the volumes of Commonwealth environmental water that reach the NSW border will be recorded by Queensland DRDMW on a daily basis. It is expected that the portion of these flows that reaches the Barwon-Darling River will then be protected from extraction by WaterNSW using active management.

The Commonwealth’s unregulated holdings on the Warrego River at Toorale are managed in accordance with the management strategy for use of these licences at Boera Dam (Figure WMV1) to meet environmental demands outlined in Table WMV2. The CEWO will have access to the Toorale Warrego River licences in 2021–22. Operation of the Toorale infrastructure will continue to be managed by the NSW National Parks and Wildlife Service and DPIE, in consultation with the Toorale Joint Management Committee and the CEWO. The management strategy will be revised in 2022 upon completion of the Toorale Water Infrastructure project (NSW DPIE 2021).

Further information on environmental demands in the Barwon–Darling is provided in the [CEWO Water Management Plan 2021–22: Chapter 9 Barwon–Darling](#).

Figure WMV1 Management strategy for Commonwealth environmental water at Toorale



5.6 Monitoring and lessons learned

5.6.1 Monitoring

Operational monitoring is undertaken for all Commonwealth environmental watering actions and involves collecting on-ground data about Commonwealth environmental watering such as volumes used, impact on the river systems hydrograph, area of inundation and river levels. It can also include observations of environmental outcomes.

In the Warrego Valley, the five-year Long-Term Intervention Monitoring (LTIM) Project (2013–2014 to 2018–19) included the junction of the Warrego and Darling Rivers as a focus area. It aimed to understand the environmental response from Commonwealth environmental watering with respect to the targeted objectives by carrying out monitoring of site condition over many years.

This monitoring is being continued under the CEWO Monitoring, Evaluation and Research three-year program from 2019–20 to mid-2022.

The CEWO has also co-funded a short-term intervention monitoring project with Queensland DES to better understand native fish resilience following severe drought in the Northern Murray-Darling Basin, including the upper Warrego. Results from this project will be available in early 2022. The CEWO does not currently fund any monitoring in the Moonie Valley.

Learn more about [monitoring and research funded by the CEWO in the Warrego and Moonie Valleys](#).

5.6.2 Lessons learned

Outcomes from monitoring and lessons learned in previous years are a critical component for the effective and efficient use of Commonwealth water for the environment. These learnings are incorporated into the way environmental water is managed.

Key findings from fish, aquatic habitat and flow monitoring in the Warrego and Moonie Valleys are summarised in Table WMV3.

Table WMV3 Key lessons learned in the Warrego and Moonie Valleys

Theme	Lessons learned
Native fish and aquatic invertebrates	<ul style="list-style-type: none"> Flows in the Warrego River, including environmental water, support breeding and recruitment of many fish species. During ‘wetter’ times, multiple species have been observed to breed, recruit and maintain their population structure, e.g. golden perch, spangled perch, bony herring, Hyrtl’s tandan (ELA 2019; UNE & 2 Rog Consulting 2020a; Marshall & Lobegeiger 2021). Golden perch spawn on river rises in the Warrego River, and recruits from within this river system are likely to be contributing to the wider Murray–Darling Basin golden perch population (UNE & 2 Rog Consulting 2020a). The upper Warrego River supports a strong golden perch population, supported by natural spawning and recruitment events. Murray cod are also present in the upper Warrego River, with relatively low carp presence (Marshall & Lobegeiger 2020). The fish community in the Warrego River are highly resilient and can survive highly variable flow conditions, including drying down. Fish communities were able to recolonise and recruit following larger flow events. Golden perch, spangled perch and bony herring have demonstrated an ability to move, colonise and opportunistically recruit in the Warrego River in response to increased flows (ELA 2019; Marshall & Lobegeiger 2021).

Theme	Lessons learned
Waterbirds	<ul style="list-style-type: none"> • Retaining water at all times in at least some of the five main waterholes on the Warrego River will ensure that when the system is reconnected, there are populations present that can distribute and recolonise across the lower sections of the Warrego. This helps prepare native fish populations for the next drying phase (ELA 2019; Marshall & Lobegeiger 2021). • The Moonie has relatively long and deep waterholes that have been shown to be critical refugia for sustaining native fish populations in the often-long periods between flows in the system. Species including golden perch, bony bream, eel tailed catfish and smelt moved significant distances (up to 70 kilometres) in response to waterhole reconnecting flows, enabling recolonisation of the system and genetic mixing (Marshall et al. 2016). • The Moonie has also been identified as a source population for golden perch in the Northern Murray–Darling Basin (along with the Condamine–Balonne and Border Rivers) with consistent recruitment over the past decade (Price et al. 2019; Greg Ringwood [Murray–Darling Basin Authority] 2021, pers. comm., 20 May). <ul style="list-style-type: none"> • In the Queensland Warrego River, the Cuttaburra channels represent 10% abundance of each species (one of only four wetlands in the Murray–Darling Basin, with the others being the Lowbidgee, Lower Coorong and Thallon wetlands). The Cuttaburra has been identified as important for waterbirds at a whole-of-Basin scale during wet times (Bino et al. 2015). • Surveys in March 2021 found waterbirds at all sites at Toorale, with the highest bird count at Boera Dam and lower waterbird numbers on the Western Floodplain (UNE & 2 Rog Consulting 2021). Birds detected at Boera included brolgas and the listed migratory species sharp-tailed sandpiper (UNE & 2 Rog Consulting, 2021). Sea eagles were also recorded breeding at Boera Dam in early 2021, unusual in an inland area (UNE & 2 Rog Consulting 2021). • While not recognised as nationally or internationally significant, the Thallon waterholes on the Moonie are important for waterbirds, with representation of 10% abundance for each species between 1983–2012 (only four other wetlands achieved this including the Cuttaburra channels, Lowbidgee and Lower Coorong) (Bino et al. 2015). • Waterbirds tracked by CSIRO Land & Water have been recorded visiting the Moonie Valley in 2020–21 including straw-necked ibis ‘Elf’ and ‘Dani’ (CSIRO 2021).
Connectivity	<ul style="list-style-type: none"> • Environmental water has been observed to successfully increase longitudinal connectivity between the Warrego and Darling rivers, and laterally, with parts of the Western Floodplain (ELA 2019). By increasing connectivity, water for the environment improves water quality, increases available habitat and productivity, and supports native fish movement between rivers (ELA 2019). The resulting productivity booms can also generate an increase in the abundance and diversity of invertebrates, frogs and waterbirds on the floodplain (ELA 2019). • Environmental water can successfully increase the size of flows through the Warrego system, increasing connectivity between the Warrego and Darling rivers (ELA 2019). This is important for improving water quality, increasing productivity and allowing the movement of native fish between rivers for spawning, dispersal and recruitment (ELA 2019). Around 5 gigalitres of water from the Warrego is estimated to have contributed to flows in the downstream Darling in 2020–21 (WaterNSW 2021b). • The Moonie can provide important tributary inflows to the Barwon–Darling during unregulated flow events (around 100 gigalitres in 2020–21) (WaterNSW 2021d). While the Commonwealth’s environmental water entitlements in the Moonie are a relatively small proportion of these natural flows, better cross-border accounting arrangements being worked out between Queensland and NSW with input from the Commonwealth will help us track environmental water from the Queensland Moonie into the NSW catchment and downstream to the Barwon–Darling. Active management arrangements in NSW will also provide better protection of the Commonwealth’s environmental water in the Moonie and other unregulated Barwon–Darling tributaries.
Water quality	<ul style="list-style-type: none"> • Water for the environment delivered through the Warrego River consistently helps improve the quality of Darling River water downstream of the confluence (ELA 2019; UNE & 2 Rog Consulting 2020a). Observed improvements include reduced

Theme	Lessons learned
Food webs/ productivity	<p>pH, conductivity, turbidity and algal productivity, and increased nutrient cycling and habitat when compared with periods without environmental water (ELA 2019; UNE & 2 Rog Consulting 2020a).</p> <ul style="list-style-type: none"> • Environmental water that contributes to connection with the floodplain for a long duration (more than six months) stimulates a boom in productivity, which provides food for higher order predators such as waterbirds (ELA 2019; UNE & 2 Rog Consulting 2020a). • The Western Floodplain is important for highly dense and species rich invertebrate communities. More diverse macroinvertebrate communities may offer a wider range of feeding opportunities for higher level consumers such as frogs, fish, waterbirds and other aquatic vertebrates (ELA 2019; UNE & 2 Rog Consulting 2020a). • The Warrego and Western Floodplain are productive systems, species such as shrimps and tadpoles responded quickly to inundation (ELA 2019, UNE & 2 Rog consulting 2020a). Species such as fairy and shield shrimps are known to rely on an egg bank that is desiccation resistant, which may help survival and responsiveness (ELA 2019; UNE & 2 Rog Consulting 2020a; UNE & 2 Rog Consulting 2021).
Vegetation	<ul style="list-style-type: none"> • The condition of vegetation communities on the Western Floodplain is driven by inundation, which has been enhanced by Commonwealth environmental water (ELA 2019; UNE & 2 Rog Consulting 2020a). Flooding of the Western Floodplain increased the cover and richness of vegetation communities, including annual herbaceous ground cover species (ELA 2019; UNE & 2 Rog Consulting 2020a). Vegetation surveys in early 2021 found groundcover percentage remained low, but most sites had groundcover persistence and relatively high diversity (UNE & 2 Rog Consulting 2021). Floodplain trees were looking healthy in February 2021, with a number of mature river cooba in flower observed along the Western Floodplain (UNE & 2 Rog Consulting 2021). • Lignum condition improved when inundated more frequently. Extended dry periods (greater than two and a half years) on the floodplain resulted in declines in vegetation cover and condition (ELA 2019; UNE & 2 Rog Consulting 2020a), However, lignum condition improved again in response to inundation in 2019 and early 2020 (ELA 2019; UNE & 2 Rog Consulting 2020a). Monitoring of lignum in early 2021 suggested that plant condition decreased as the area dried back following the 2020 flows, however average height and size of plants increased (UNE & 2 Rog Consulting 2021). • Grazing and competition for resources are likely to impact on tree recruitment more than inundation alone (ELA 2019; UNE & 2 Rog Consulting 2020a).
Refuges	<ul style="list-style-type: none"> • Around 8% of river channels in the Warrego River are estimated as remaining ‘wet’ during the peak drought of 2018–2020 (Marshall & Lobegeiger 2020). In relation to loss of connectivity, much of the upper Warrego is classed as at ‘extreme risk’ (100% loss of connectivity flows), with much of the lower part of the catchment at high risk (>70% risk of loss of connectivity flows). Reconnection of these refuge habitats following flows in 2020 and 2021 is likely to allow for movement of native fish (Marshall & Lobegeiger 2020). • Warrego River waterholes act as longer-term refuges for native fish, waterbirds, turtles and frogs (ELA 2019; UNE & 2 Rog Consulting 2020a). Boera and Booka dams provide the most persistent refuges. Environmental water can help replenish and re-connect refuge habitat in the Warrego River and the Darling River near Toorale (ELA 2019; UNE & 2 Rog Consulting 2020a). • The Moonie river has around 8.8% of refuge waterholes that remain wet even during peak drought (for example 2018–2020). This is considerably less than the Border Rivers (at 22%, but more than catchments further west (Warrego and Paroo) (Marshall & Lobegeiger 2020). • Of the 7.6 square kilometres of waterhole habitat that exists in the Moonie River three months after flow (McGregor et al., 2018), only 5% persisted in January 2020 at the peak of the drought, representing 95% habitat loss (Marshall & Lobegeiger 2020).

Theme	Lessons learned
Other aquatic animals	<ul style="list-style-type: none"> • Surveys in March 2021 found frogs across all sites in the Warrego Selected Area, with Booka Dam having the highest count (mostly desert froglet) (UNE & 2 Rog Consulting 2020b). • Frog species are expected to recover further following the 2020–21 flows in the Warrego catchment. • Large turtles were detected in most dams at Toorale in early 2021. Some turtles exceeded 7 kilograms in weight, which suggests that food resources were still relatively abundant, despite the drier conditions during the first half of the water year (UNE & 2 Rog Consulting 2020b).

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