DEPARTMENT OF PLANNING, INDUSTRY & ENVIRONMENT

Barwon–Darling Long Term Water Plan

Part B: Barwon–Darling planning units

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Cover photo: Darling River, Darling River campground, Toorale National Park. Photo Joshua Smith/DPIE

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Acknowledgement of Traditional Owners

The NSW Department of Planning, Industry and Environment pays its respect to the Traditional Owners and their Nations of the Murray–Darling Basin. The contributions of earlier generations, including the Elders, who have fought for their rights in natural resource management are valued and respected.

In relation to the Barwon–Darling river system, the NSW Department of Planning, Industry and Environment pays its respects to Barkindji, Murrawarri, Ngemba and Ngiyampaa Traditional Owners past, present and future, as well as those of other nations for whom this river is significant. We look forward to building upon existing relationships to improve the health of our rivers, wetlands and floodplains including in recognition of their traditional and ongoing cultural and spiritual significance.

Abbreviations

AER	NSW DPI-F Aquatic Ecosystems Research (database) of catch data
AHIMS	Aboriginal Heritage Information Management System
Basin Plan	Murray–Darling Basin Plan 2012
BF	Baseflow
BK	Bankfull
BPEOM	Basin Plan Environmental Outcome Monitoring
BWS	Basin-wide environmental watering strategy
CAG	Customer Advisory Group
CAMBA	China – Australia Migratory Bird Agreement
CEWO	Commonwealth Environmental Water Office
CtF	Cease-to-flow
CtP	Cease-to-pump
DO	Dissolved oxygen
DPIE–BC	NSW Department of Planning, Industry and Environment – Biodiversity and Conservation Division
DPIE–W	NSW Department of Planning, Industry and Environment – Water
DPI Fisheries	NSW Department of Primary Industries Fisheries
EEC	Endangered ecological community
EWAG	Environmental Water Advisory Group
EWR	Environmental water requirement
FFDI	Forest Fire Danger Index
GCM	Global Climate Model
GDE	Groundwater-dependent ecosystem
GL/yr	gigalitres per year
ha	hectares
HEW	Held environmental water
IUFMPNW	Interim Unregulated Flow Management Plan for the NSW North West
JAMBA	Japan–Australia Migratory Bird Agreement
LF	Large fresh
LLS	Local Land Services (NSW)
LTIM	Long-Term Intervention Monitoring
LTWP	Long Term Water Plan
m/s	metres per second
MDBA	Murray–Darling Basin Authority
MER	Monitoring, evaluation and reporting
mg/L	milligrams per litre
ML	megalitre
ML/d	megalitres per day
NPWS	NSW National Parks and Wildlife Services

NRAR	Natural Resources Access Regulator
NSW	New South Wales
OB	Overbank
PCT	Plant community type
PEW	Planned environmental water
PU	Planning unit
RAS	Resource availability scenario
RCM	Regional Climate Model
ROKAMBA	Republic of Korea – Australia Migratory Bird Agreement
SDL	Sustainable diversion limit
SF	Small fresh
VLF	Very low flow
WL	Wetland inundating flow
W-LF	Wetland connecting large fresh
WQA	Water quality allowance
WSP	Water sharing plan

Glossary: for general text

Allocation	The volume of water made available to water access licence or environmental water accounts in a given year by DPIE – Water, which is determined within the context of demand, inflows, rainfall forecasts and stored water.
Alluvial	Comprised of material deposited by water.
Bankfull flow	River flows at maximum channel capacity with little overflow to adjacent floodplains. These flows engage the riparian zone, anabranches, flood runners and wetlands located within the meander train. They inundate all in-channel habitats including benches, snags and backwaters.
Baseflow (BF)	Reliable background flow levels within a river channel that are generally maintained by seepage from groundwater storage, but also by surface inflows. They typically inundate geomorphic units such as pools and riffle areas.
Murray–Darling Basin Plan (Basin Plan)	The Basin Plan as developed by the Murray–Darling Basin Authority under the *Water Act 2007*.
Cease-to-flow (CtF)	The absence of flowing water in a river channel that leads to partial or total drying of the river channel. Streams contract to a series of isolated pools.
Cease-to-pump (access rule in WSP)	Pumping is not permitted: • from in-channel pools when the water level is lower than its full capacity • from natural off-river pools when the water level is lower than its full capacity • from pump sites when there is no visible flow. These rules apply unless there is a commence-to-pump access rule that specifies a higher flow rate that licence holders can begin pumping.
Consumptive water	Water that is removed from available supplies without return to a water resource system (such as water removed from a river for agriculture).
Cultural water-dependent asset	A place that has social, spiritual and cultural value based on its cultural significance to Aboriginal people. Related to the water resource.
Cultural water-dependent value	An object, plant, animal, spiritual connection or use that is dependent on water and has value based on its cultural significance to Aboriginal people.
Discharge	The amount of water moving through a river system, most commonly expressed in megalitres per day (ML/d).
Ecological function	The resources and services that sustain human, plant and animal communities and are provided by the processes and interactions occurring within and between ecosystems.
Ecological objective	The defined goal for a state, condition or characteristic of an ecological asset or function.
Ecological target	Level of measured performance that must be met in order to achieve the defined objective. The targets in this long term water plan are SMART (Specific/Measurable/Achievable/Realistic/Time-bound).
Ecological value	An object, plant or animal which has value based on its ecological significance.
Ecosystem	A biological community of interacting organisms and their physical environment. It includes all the living things in that community, interacting with their non-living environment (weather, earth, sun, soil, climate and atmosphere) and with each other.

Environmental water	Water for the environment. It serves a multitude of benefits to not only the environment, but communities, industry and society. It includes water held in reservoirs (held environmental water) or protected from extraction from waterways (planned environmental water) for the purpose of meeting the water requirements of water-dependent ecosystems.
Environmental water requirement (EWR)	The water required to support the completion of all elements of a lifecycle of an organism or group of organisms (taxonomic or spatial), consistent with the objective/target, measured at the most appropriate gauge. It includes all water in the system including natural inflows, held environmental water and planned environmental water.
Flow category	The type of flow in a river defined by its magnitude (e.g. bankfull).
Flow regime	The pattern of flows in a waterway over time that will influence the response and persistence of plants, animals and their ecosystems.
Freshes	Temporary in-channel increased flow in response to rainfall or release from water storages.
Groundwater	Water that is located below the earth's surface in soil pore spaces and in the fractures of rock formations. Groundwater is recharged from, and eventually flows to, the surface naturally.
Held environmental water (HEW)	Water available under a water access licence for the purposes of achieving environmental outcomes (including water that is specified in a water access right to be for environmental use).
Hydrology	The occurrence, distribution and movement of water.
Key ecological value	A species or community that is identified for its special conservation significance based on selected temporal and spatial criteria. Examples include Murray cod or river red gum woodlands.
Large fresh (LF)	High-magnitude flow pulse that remains in-channel. These flows may engage flood runners with the main channel and inundate low-lying wetlands. They connect most in-channel habitats and provide partial longitudinal connectivity, as some low-level weirs and other in-channel barriers may be drowned out.
Long Term Water Plan (LTWP)	A component of the Basin Plan. Long term water plans give effect to the Basin-wide environmental watering strategy (MDBA 2014) relevant for each river system and will guide the management of water over the longer term. These plans will identify the environmental assets that are dependent on water for their persistence, and match that need to the water available to be managed for or delivered to them. The plan will set objectives, targets and watering requirements for key plants, waterbirds, fish and ecosystem functions. DPIE-BC is responsible for the development of nine plans for river catchments across NSW, with objectives for five, 10 and 20-year timeframes.
Overbank flow (OB)	Flows that spill over the riverbank or extend to floodplain surface flows.
Planned environmental water (PEW)	Water that is committed by the Basin Plan, a WRP or a plan made under state water management law to achieving environmental outcomes.
Planning Unit (PU)	A division of a WRP area based on water requirements (in catchment areas in which water is actively managed), or a sub-catchment boundary (all other areas).
Recruitment	Successful development and growth of offspring; such that they have the ability to contribute to the next generation.
Refuge	An area in which a population of plants or animals can survive through a period of decreased water availability.

Riffle	A rocky or shallow part of a river where river flow is rapid and broken.
Riparian	The part of the landscape adjoining rivers and streams that has a direct influence on the water and aquatic ecosystems within them.
Small fresh (SF)	Low-magnitude in-channel flow pulse. Unlikely to drown out any significant barriers but can provide limited connectivity and a biological trigger for animal movement.
Supplementary access	A category of water entitlement where water is made available to licence holder accounts during periods of high river flows that cannot otherwise be controlled by river operations. Water can be taken and debited from licence accounts during a declared period of high flow.
Surface water	Water that exists above the ground in rivers, streams creeks, lakes and reservoirs. Although separate from groundwater, they are interrelated and over extraction of either will impact on the other.
Sustainable diversion limit (SDL)	The grossed-up amount of water that can be extracted from Murray–Darling Basin rivers for human uses while leaving enough water in the system to achieve environmental outcomes.
Very low flow (VLF)	Small flow in the very-low flow class that joins river pools, thus providing partial or complete connectivity in a reach. These flows can improve DO saturation and reduce stratification in pools.
Water sharing plan (WSP)	A plan made under the NSW *Water Management Act 2000* that sets out specific rules for sharing and trading water between the various water users and the environment in a specified water management area. It forms part of a WRP.
Water source	Under WSPs catchments have been divided into smaller areas called water sources. Water sources may have listed access and trading rules.
Water-dependent system	An ecosystem or species that depends on periodic or sustained inundation, waterlogging or significant inputs of water for natural functioning and survival.

Explanatory text for environmental water requirements

Flow category	Flows in rivers vary over time in response to rainfall, river regulation, extractions and other factors. The sequence of flows over time can be considered as a series of discrete events. These events can be placed into different flow categories (e.g. baseflows, freshes, bankfull, overbank and wetland flows) according to the magnitude of flow discharge or height within a watercourse, and the types of outcomes associated with the events (e.g. inundation of specific features such as channel benches, riparian zones or the floodplain). Flow categories used in LTWPs are illustrated and defined in Figure 9 and Table 7 in Part A of each LTWP.
Environmental water requirement (EWR)	An environmental water requirement (EWR, singular) describes the characteristics of a flow event (e.g. magnitude, duration, timing, frequency, and maximum dry period) within a particular flow category (e.g. small fresh), that are required for that event to achieve a specified ecological objective or set of objectives (e.g. to support fish spawning and in-channel vegetation). There may be multiple EWRs defined within a flow category, and numerous EWRs across multiple flow categories within a Planning Unit (PU). Achievement of each of the EWRs will be required to achieve the full set of ecological objectives for a planning unit.
EWR code	Each EWR is given a specific code that abbreviates the EWR name (e.g. SF1 for small fresh 1). This code is used to link ecological objectives and EWRs.
Gauge	The flow gauging station that best represents the flow within the planning unit, for the purpose of the respective EWR and associated ecological objective(s). To assess the achievement of the EWR, flow recorded at this gauge should be used.
Flow rate or flow volume	The flow rate (typically ML/d) or flow volume (typically GL over a defined period of time) that is required to achieve the relevant ecological objective(s) for the EWR. Most EWRs are defined using a flow rate, whilst flow volumes are used for EWRs that represent flows into some large wetland systems.
Timing	The required timing (or season, typically expressed as a range of months within the year) for a flow event to achieve the specified ecological objective(s) of the EWR. In some cases, a preferred timing is provided, along with a note that the event may occur at ‘anytime’. This indicates that ecological objectives may be achieved outside the preferred timing window, but perhaps with sub-optimal outcomes. In these instances, for the purposes of managing and delivering environmental water, the preferred timing should be used to give greater confidence in achieving ecological objectives. Natural events may occur at other times and still achieve ecological objectives.
Duration	The duration for which flows must be above the specified flow rate for the flow event to achieve the specified ecological objective(s) of the EWR. Typically this is expressed as a minimum duration. Longer durations will often be desirable and deliver better ecological outcomes. Some species may suffer from extended durations of inundation, and where relevant a maximum duration may also be specified. Flows may persist on floodplains and within wetland systems after a flow event has past. Where relevant a second duration may also be specified, representing the duration for which water should be retained within floodplain and wetland systems.

Frequency	The frequency at which the flow event should occur to achieve the ecological objective(s) associated with the EWR. Frequency is expressed as the number of years that the event should occur within a 10-year period. In most instances, more frequent events will deliver better outcomes, and maximum frequencies may also be specified, where relevant. Clustering of events over successive years can occur in response to climate patterns. Clustering can be ecologically desirable for the recovery and recruitment of native fish, vegetation and waterbirds populations, however extended dry periods between clustered events can be detrimental. Achieving ecological objectives will require a pattern of events over time that achieves both the frequency and maximum inter-flow period, and the two must be considered together when evaluating outcomes or managing systems. Where a range of frequencies is indicated (e.g. 3–5 years in 10), the range reflects factors including the natural variability in population requirements, uncertainty in the knowledge base, and variability in response during different climate sequences (e.g. maintenance of populations during dry climate sequences at the lower end of the range, and population improvement and recovery during wet climate sequences at the upper end of the range). The lower end of the frequency range (when applied over the long term) may not be sufficient to maintain populations and is unlikely to achieve any recovery or improvement targets. As such, when evaluating EWR achievement over the long-term through statistical analysis of modelled or observed flow records, the LTWP recommends using a minimum long-term average (LTA) target frequency that is at least the middle of the recommended frequency range but may be higher than the average where required to achieve recovery or improvement objectives. For example, for a recommended frequency range of 3-5 years in 10, the minimum LTA frequency should be at least 40% of years but may be up to 50% of years at sites where a higher frequency should be targeted over the long term to ensure recovery in certain species/populations. Whilst these higher frequencies may exceed modelled natural event frequency in some cases, recovery in particularly degraded systems will be unlikely should lower (i.e. average) frequencies be targeted. Minimum LTA target frequencies in this LTWP are reported predominantly as the mid-point of the recommended frequency range, however this may be refined during implementation of the LTWP and in future revisions of the LTWP based on the results of ongoing ecological monitoring.
Maximum inter-flow or inter-event period	The maximum time between flow events before a significant decline in the condition, survival or viability of a particular population is likely to occur, as relevant to the ecological objective(s) associated with the EWR. This period should not be exceeded wherever possible. *Annual planning of environmental water should consider placing priority on EWRs that are approaching (or have exceeded) the maximum inter-event period, for those EWRs that can be achieved or supported by the use of environmental water or management.*
Additional requirements and comments	Other conditions that should occur to assist ecological objectives to be met – for example rates of rise and fall in flows. Also comments regarding limitations on delivering environmental flows and achieving the EWR.

1. Introduction

To address variation along the Barwon–Darling River, the Long Term Water Plan (LTWP) has been divided into 14 planning units (PUs) (Figure 1). This document, which forms Part B of the LTWP, provides the following local-scale information for each planning unit:

- the location of priority environmental assets identified as part of LTWP development.
- the ecological values, including native fish and waterbird species[1], and native vegetation communities that occur within the planning units' priority environmental assets.
- objectives for native fish, showing relevant species. The objectives for each planning unit are outlined in Part A of the LTWP (Appendix B). Only native fish objectives are shown in Part B as these objectives are highly species specific, so the species are listed with the objectives here.
- environmental water requirements (EWRs) to support key ecological values and related LTWP objectives and targets are presented for representative gauge/s in the planning unit.
- an evaluation of the impact of water resource development on local hydrology and recommended management strategies for mitigating these changes to meet LTWP objectives and targets.

1.1 Planning units

The planning unit boundaries typically align with water management area boundaries in the *Water Sharing Plan for the Barwon–Darling Unregulated and Alluvial Water Sources 2012* (hereafter Barwon–Darling WSP). However, the LTWP has purposefully included the floodplain of the Barwon–Darling in the planning unit boundaries. Talyawalka Creek has also been included in the most downstream planning unit but is not part of the Barwon–Darling WSP.

Figure 1 shows the Barwon–Darling area and planning units addressed under this LTWP. Since the Barwon–Darling WSP is for reaches along the river and not a polygon boundary, the LTWP adopted planning units and a boundary that are derived from Healthy Floodplain mapping in the north, TVD Floodplain modelling in the south and The Mitchell landscapes boundary at the far south to define the area around the Talyawalka Creek. Planning unit boundaries align with the management zones defined by the Barwon–Darling WSP.

Talyawalka Creek is considered part of Planning Unit 14: Wilcannia to Upstream Lake Wetherell. Talyawalka Creek carries water at flows above about 32,000 ML/d at Wilcannia. Overbank flow EWRs specified at the Wilcannia gauge will deliver flows to Talyawalka Creek.

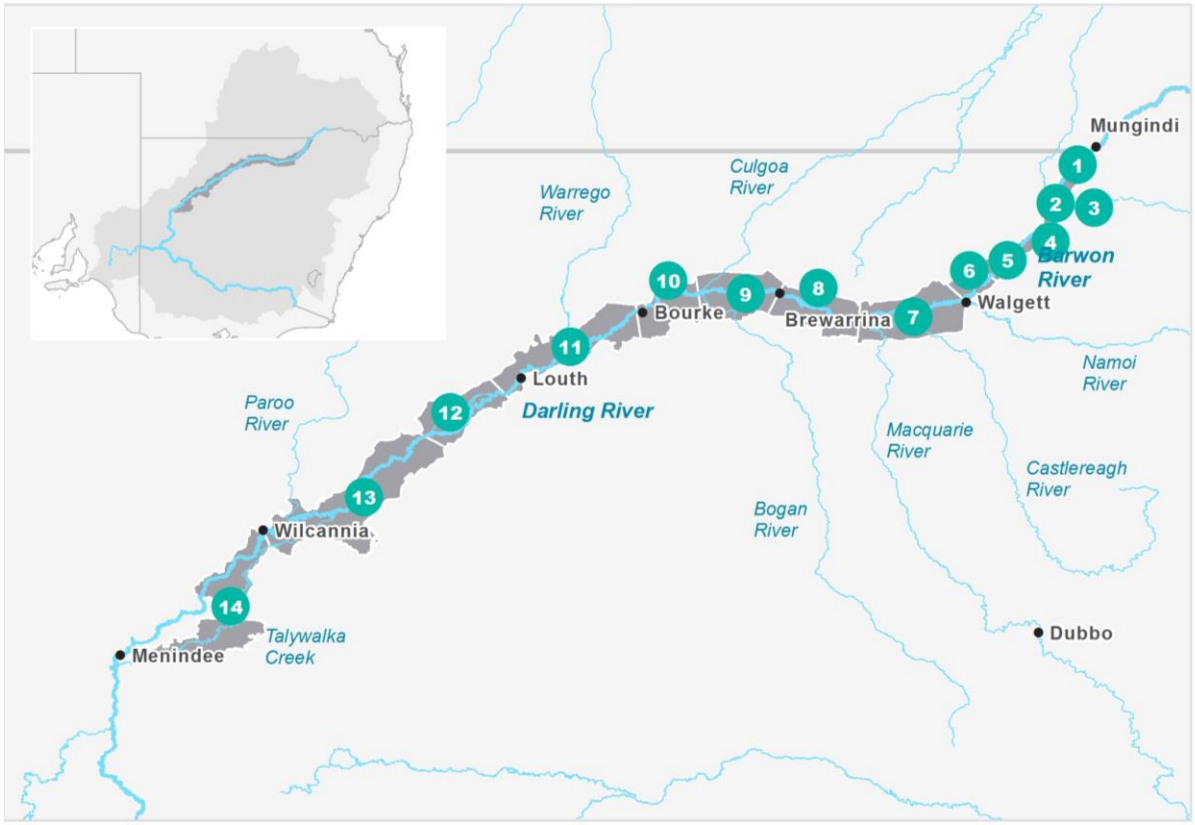
For each planning unit information is presented the degree of alteration, as determined by DOI–W in their Barwon-Darling *Water Resource Plan Risk Assessment* (NSW DPIE 2019), by comparing flows under modelled near natural conditions (with no dams or water extractions) and flows under modelled current (post development) conditions.

Table 1 describes how the hydrology changes are presented for each planning unit.

[1] The waterbird species that are listed in each PU are primarily informed by spot records, which are influenced by inconsistent survey effort across the WRPA. Therefore, caution should be used in interpreting this information. Future work should focus on more rigorous monitoring or the development of models to predict species occurrence.

Table 1 Key to hydrological alteration used in this document

Key to hydrological alteration from *Risk assessment for the Barwon-Darling water resource plan area* (NSW DPIE-Water 2019)		
L = Low: less than 20% departure (+/-) from the base case for each hydrologic metric		
M = Medium: 20–50% departure (+/-); from the base case for each hydrologic metric		
H = High: greater than 50% departure (+/-) from the base case for each hydrologic metric		
N/A = no risk outcome or modelling available due to no hydrological data available		
$^{+}$ increase from near-natural condition	- decrease from near-natural condition	^{0} no change from near-natural condition



Legend

Barwon-Darling Catchment

Murray-Darling Basin

N

0 80 160

Kilometers

Planning Units

1. Mungindi to Boomi River Confluence
2. Boomi River Confluence to Upstream Mogil Mogil Weir Pool
3. Mogil Mogil Weir Pool
4. Downstream Mogil Mogil to Collarenebri
5. Collarenebri to Upstream Walgett Weir
6. Walgett Weir Pool
7. Downstream Walgett to Boorooma
8. Boorooma to Brewarrina
9. Brewarrina to Culgoa River Junction
10. Culgoa River Junction to Bourke
11. Bourke to Louth
12. Louth to Tilpa
13. Tilpa to Wilcannia
14. Wilcannia to Upstream Lake Wetherell

Figure 1 Planning units in the Barwon–Darling LTWP

1.2 Methods for determining flow rate thresholds

Flow rate thresholds for planning units are presented in Section 2. These thresholds were selected after considering multiple information sources:

- expert opinion from regional water managers, DPI Fisheries staff and local landholders.
- analysis of gauge rating tables using guidelines developed by DPI Fisheries (unpublished) that classifies flow types and outcomes for fish according to depth and velocity:
    - Very-low-flows: ideally velocity 0.03–0.05 m/s
    - Baseflows: ideally depth >0.3 m above cease-to-flow (CtF)
    - Small Freshes: ideally depth >0.5 m above CtF; flow 0.3–0.4 m/s
    - Large Freshes: ideally depth >2 m above CtF; flow >0.3 m/s.
- flow percentiles described in Alluvium (2010):
    - the 20th percentile flow[2] as an indicator of the baseflow
    - the 40th percentile flow as an indicator the 'low-flow-season fresh', which may be taken as similar to our 'small fresh'
    - the 87th percentile flow as an indicator the 'high-flow-season fresh', which may be taken as similar to our 'large fresh'. We looked at both the 80th and 90th percentile.
- analysis of gauge rating tables using the approach described by Stewardson and Guarino (2017) that classifies flows according to the height of the flow in relation to channel depth/height:
    - 'low freshes': flow events where water level rises to at least one-eighth of the height of the bank above the baseflow level
    - 'high freshes': flow events where water level rises to at least half of the height of the bank above the baseflow.
- monitoring, evaluation and other observations of outcomes in response to flow. For example, Stuart and Sharpe (2017) which identifies flow events that have been associated significant golden perch spawning in the Barwon Darling.
- Several methods were used to help indicate the bank full level:
    - analysis of Sentinel satellite imagery of a flow event in 2016 that approximated bank full conditions along much of the Barwon-Darling system;
    - review of SES flood warning levels (minor and moderate), at gauges where these are specified;
    - identifying the level in a channel cross section where the channel widens out to a floodplain (Wolman and Leopold 1957 and Nixon 1959 cited in Copeland et al, 2000). This point is not, however, always clear-cut.
- analysis of modelled and observed data to check that the EWRs are consistent with the historic flow regime and likely to have occurred in the past. Analysis included checking against the long term average frequency of events and the 95th percentile duration between events (dry spell).

[2] That is 80th percentile exceedance. Other percentiles are similarly percentiles of occurrence rather than exceedance.

1.3 Information sources for ecological values occurring within priority environmental assets

Native fish species occurrence in planning units was determined from a range of sources including:

- the NSW Department of Primary Industries (DPI) Aquatic Ecosystem Research (AER) database (the database includes a range of site-specific catch data and information from various fish related projects in NSW from 1970 through to the present depending on the project and location)
- threatened and common species distribution models (MaxEnt 3.3.3)
- expert opinion from DPI Fisheries officers where applicable.

Water (flow)-dependent native vegetation communities were identified from a collated water (flow)-dependent vegetation map for the Barwon–Darling WRPA developed by DPIE-BC as part of LTWP development. This collated map is based on best available vegetation mapping, including Plant Community Type (PCT) mapping[3].

Water (flow)-dependent bird and waterbird species records were collated from:

- NSW (Bionet – Atlas of NSW Wildlife 1980–2016) and Commonwealth (Australian Living Atlas) Government databases (1977–2015)
- University of New South Wales (UNSW) aerial survey datasets (1983–2016)
- NSW OEH ground surveys (2007–16).

Significant Aboriginal cultural water dependent sites that are registered in the NSW Aboriginal Heritage Information Management System (AHIMS) were also included as water-dependent assets in the LTWP. This includes areas such as Aboriginal ceremony and dreaming sites, fish traps, scar trees and waterholes.

1.4 Information on Water Access Licences

In additional to A, B and C Class licensed, information has been provided for both Local Water Utility and Domestic and Stock licensing. While these volumes are usually smaller than environmental and irrigation holdings in a planning unit, they have a higher order use which is particularly relevant during dry periods and drought. Allocations for Native Title and Aboriginal cultural access have not been included as they are undefined at the time of writing.

The information provided in the planning unit tables below has been drawn from the NSW Water Register (https://waterregister.waternsw.com.au), which should be accessed for up-to-date information. This information was accessed in July 2019 and may change regularly due to trading activity.

Spatial representation of this information in the planning unit figures below was accessed from an October 2018 data source and is indicative only. Spatial data is not updated regularly from the licensing database. Spatial representation is also problematic in representing a WAL against a works approvals (pump), as these may change regularly.

[3] 1) DarlingFloodplain2014_E_4186, 2) Balonne_vegetation_201603001, 3) Darling_vegetation_20160301, 4) ParooDarlingNP_Coonavitra_E_3965, 5) ParooDarlingNP_MtMurch_E_3966, 6) ParooDarlingNP_Peery_E_3968, 7) ParooDarlingNP_Thiltakarra_E_968, 8) ParooDarlingNP_Wilga_E_3967, 9) TooraleNP_2012_E_4027, 10) WarramboolSCA_2012_E_3985, 11) SVTM_Western_PCTv0p1_5m

1.5 Selection of recommended management strategies

Table 2 Recommended management strategies

Management strategy		Purpose & description	For consideration in planning units where:
1	Reduce extraction pressure on in-channel flows		• Medium or greater consequence score in the NSW DPIE 2019, OR • Supports endangered native fish species OR • Has native fish objectives NF7-NF9
	1A: Review existing cease-to-pump thresholds based on identified ecological requirements	Currently, in many cases, extraction can occur until there is no visible flow (i.e. until the stream stops flowing). Cease-to-pump rules are sometimes referenced to a gauge that is distant from the pump site, so flow may cease at the pump site even when the reference gauge has flow. To decrease cease-to-flow periods and support more ecologically relevant low flow/baseflows. In reviewing, consider the effect of seasonal (dry vs wet period) in the identified ecological requirements	Criteria for (1) are met AND • Management zone has Medium or High degree of alteration for cease-to-flow or low flows/baseflows
	1B: review access (commence-to-pump) thresholds for each flow class based on identified ecological requirements	This protects variability in flow to allow wetting at various levels, incorporating water quality, ecosystem function, vegetation and native fish objectives.	Criteria for (1) are met AND • Management zone has Medium or High degree of alteration for freshes
	1C: Consider flow sharing mechanisms that would enable limits to extraction on a daily or event basis.	Options include: Active management, implementing IDELS/TDELS, rostering landholder water access IDELs/TDELs could be set at different levels for different flow sizes, so the proportion of any flow taken is able to be better managed and highly impacted and important flow types could be preserved. 'Active management' type river operations protect water for the environment while achieving the hierarchy of water supply under the NSW *Water Management Act 2000*.	Criteria for (1) are met
2	Ensure that floodplain harvesting is regulated within the SDL and LTAAEL of the WRP.		All planning units

Management strategy		Purpose & description	For consideration in planning units where:
3	A resumption of flow rule which restricts access to flows following an identified cease-to-flow event.	It would normally be relevant to the first flow event after extended dry conditions. Typically, first flush rules are time/duration based and when determined, provide certainty to license holders compared to ad hoc pumping restrictions.	All planning units
4A	Protect HEW and EWA inflows from tributary catchments and through the Barwon-Darling	Rules-based restrictions can be placed on consumptive water extraction in the Barwon-Darling and connected unregulated water sources (eg Lower Macquarie River) when held environmental water is ordered in regulated tributaries. Accounting would need to recognise held environmental water and EWA when it enters the unregulated system from a regulated system and allow for losses associated with the flows. This would replace ad hoc protections available to provide increased certainty, particularly during dry times.	Held and discretionary environmental water enters Barwon-Darling from tributary catchments with these provisions. At the time of writing, this is under consideration for Gwydir and Macquarie WRPA.
4B	Protect HEW held in Barwon-Darling[4]	HEW could be protected via WSP rules aimed to prevent unregulated licensed access to environmental flows. Currently there is limited legal protection of these flows.	Licensed environmental water is held, and downstream.
5	End-of-system flow requirements	A flow requirement at the end of a system designed to maintain connectivity, which is met from natural flows or releases from upstream storage, could be useful to ensure fish movement and refugia are supported, along with related stock and domestic, social and cultural outcomes.	All planning units with junctions from tributaries.
6A	Use of downstream environmental requirements as a trigger to manage upstream access.	This framework is in place in some water sharing plans and uses identified downstream flow requirements for prevention of supplementary take in regulated catchments.	From junctions with Border Rivers, Gwydir, Namoi catchments, to the points of identified requirements (Bourke weir, Wilcannia weir, other locations in IUFMPNW)
6B		This framework is in place in the Barwon-Darling water sharing plans and uses identified downstream flow requirements for prevention of B and C class take. At the time of writing this is not a	From locations of B and C Class holdings in Barwon-Darling, to the points of identified requirements (Bourke weir, Wilcannia weir, other locations in IUFMPNW).

[4] Holdings of environmental water correct at July 2019. See https://waterregister.waternsw.com.au for current data.

Management strategy		Purpose & description	For consideration in planning units where:
		statutory provision of the Barwon-Darling WSP.	
7	Targeted purchase of water entitlements.	Targeted purchase of water entitlement in the Barwon-Darling WRPA.	EWR flow categories that are at risk of not being met by planned environmental water and WSP rules.
8	Continue and refine temporary access restrictions such as through WMA s324 orders	Temporary protection measures, using s324 orders, are currently available and decision-making on these could be refined and made more transparent with all catchment community members.	Where there are inflows from tributary catchments which would otherwise be taken.

2. Planning units

PU1: Mungindi to Boomi River confluence

This planning unit includes the Barwon River from Mungindi near the NSW-Queensland border to the Boomi River junction, the lower reaches of the Boomi River; and all associated floodplains. The Barwon River is a tightly meandering channel within a relatively narrow floodplain along the broader reach from Mungindi to Walgett. It has a complex morphology characterised by in-channel benches at various heights in the channel, deep pools associated with meander bends and bedrock outcrops (Thoms et al. 1996) and many floodplain wetlands, predominantly anabranches (also known as floodrunners) and billabongs (Brennan et al. 2002; NSW DPI 2018). The large majority (78%) of wetlands between Mungindi and Prestbury Weir fill at flows of less than 4000 ML/d with the remaining 22% at 9000-17,000 ML/d (Brennan et al. 2002).

Tributaries entering this reach of the Barwon River include Weir River, Little Weir River and Boomi River. River channel capacity is approximately 4000 to 9000 ML/d at Mungindi. Two weirs are located along the Barwon River in this Planning Unit: Comilaroy Weir (Darling River Weir No.1) and Presburys Weir (Darling River Weir No.2). Low to moderate flows are restricted in this planning unit by the Boomi weir, located on the Barwon River upstream of the PU in Queensland. Additionally, three pumps with offtakes >200mm occur in this planning unit which could potentially entrain fish.

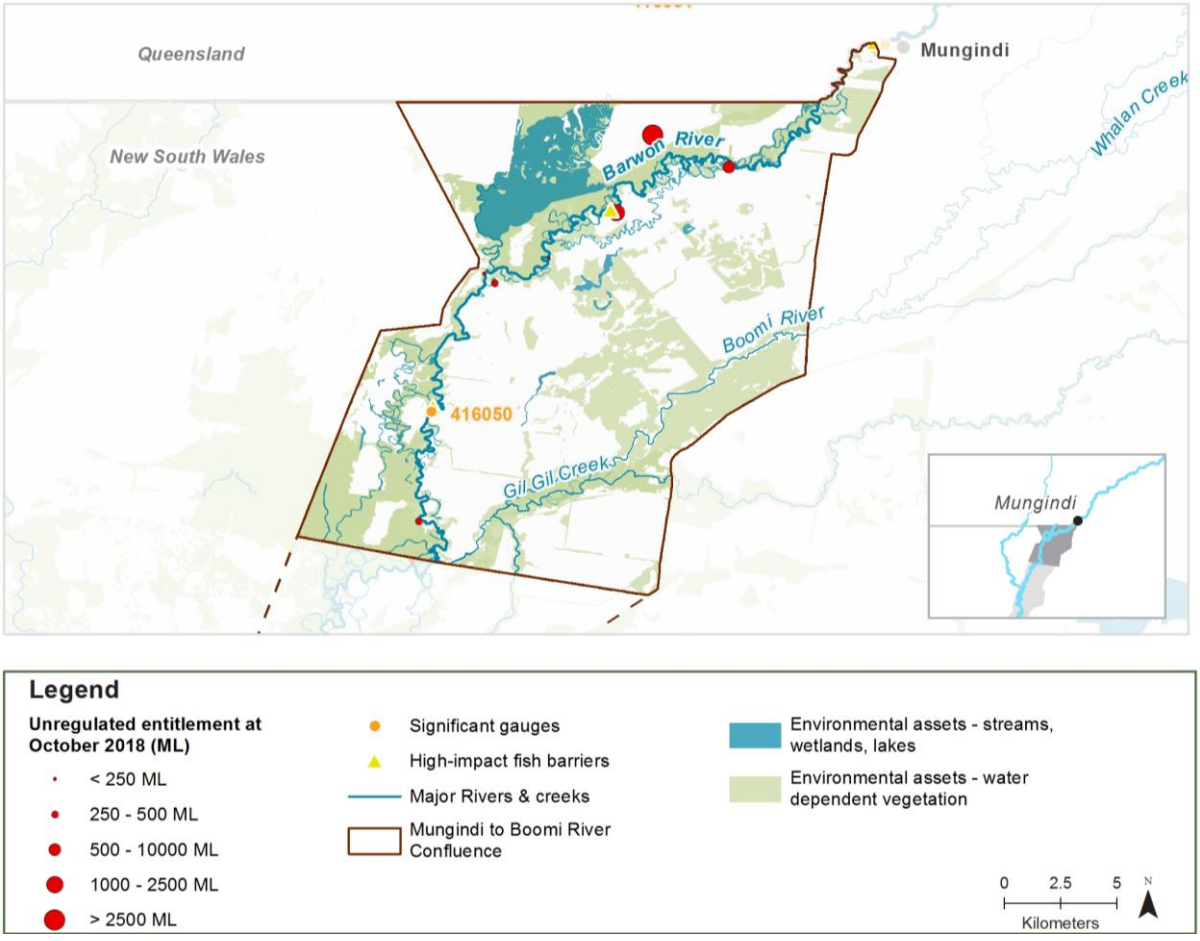


Figure 2 **Map of Mungindi to Boomi River Confluence Planning Unit**
Area outside of planning unit has been faded. Significant gauges relevant to the planning unit are Barwon River at Mungindi (gauge 416001) and Barwon River upstream of Presbury (gauge 416050).

Key ecological values (CE = Critically Endangered, E = Endangered, V = Vulnerable, EP= Endangered Population in MDB, C = CAMBA, J = JAMBA, R = ROKAMBA, X = species recorded in this PU via catch records & or Australian Museum Records where they exist, Y = species expected to occur based on MaxEnt modelling)			
Native fish	• Carp gudgeon Y+X • Murray–Darling rainbowfish Y+X • Bony herring Y+X	• Australian smelt Y+X • Spangled perch Y+X • Golden perch Y+X	• Silver perch (V) Y+X • Murray cod (V) Y+X • Olive perchlet Y+X • Purple-spotted gudgeon (E) Y
Waterbirds	2 waterbird species recorded, banded lapwing & black-fronted dotterel		
Native vegetation	• River red gum 1453 ha • Black box 523 ha • Coolibah 11,615 ha	• Floodplain 168 ha • Lignum 217 ha • Non-woody wetland 50 ha	
Registered water-dependent cultural assets	Ceremonial ring & modified tree. It is acknowledged that other Aboriginal values such as sites, objects, landscapes, resources & beliefs that are important to Aboriginal people as part of their continuing culture may be present but not registered.		

Hydrology

Hydrological alteration See Table 1 for key	**River reach**	**CtF**	**Low flow & baseflow**	**Freshes**	**High & infrequent flows** **1.5ARI**	**2.5ARI**	**5ARI**
	Mungindi to Walgett	H^-	L^+	M^-	M^-	M^-	M^-

Relevant rules from WSP

Current access rules: Users must cease-to-pump when the flow at the reference point is equal to or less than the flow rate specified below for each category of water access licence.

Domestic & stock	0 ML/day	0 ML/day
A class	230 ML/day	220 ML/day
B class	230 ML/day	270 ML/day
C class	230 ML/day	1500 ML/day
Reference points	Barwon River at Mungindi (gauge 416001)	Barwon River upstream of Presbury (gauge 416050)

There are 4 very small, 3 small, 1 medium, 1 large and 1 very large water access licences distributed throughout the planning unit. The total volume of unregulated entitlements for the planning unit is 7549 ML.

There is no held environmental water in this planning unit and 4 ML of licensed domestic and stock.

# WAL (share component)	Very small (<250 ML)	Small (250-500 ML)	Medium (500-1000 ML)	Large (1000-2500 ML)	Very large (>2500 ML)
A Class	1	-	-	-	-
B Class	2	3	1	1	1 (3014 ML)
C Class	1	-	-	-	-

Recommended management strategies

MS1: Reduce extraction pressure on in-channel flows

- **1a:** Review existing cease-to-pump thresholds based on identified ecological requirements
- **1b:** Review access (commence-to-pump) thresholds for each flow class based on identified ecological requirements
- **1c:** Consider flow sharing mechanisms that would enable limits to extraction on a daily or event basis

MS2: Ensure that floodplain harvesting is regulated within the SDL and LTAAEL of the WRP.

MS3: A resumption of flow rule which restricts access to flows following an identified cease-to-flow event.

MS4a: Protect HEW and EWA inflows from tributary catchments and through the Barwon-Darling. **Not yet applicable from Border Rivers WRPA.**

MS5: End-of-system flow requirements. **Applies from Border Rivers WRPA.**

MS6a: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending supplementary access. **Incorporated into NSW Border Rivers WSP.**

MS6b: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending B and C Class access. **Not statutory at the time of writing.**

MS7: Targeted purchase of water entitlements for the Barwon-Darling

MS8: Continue and refine temporary access restrictions such as through WMA s324 orders

Table 3 Environmental Water Requirements for the Mungindi to Boomi River Planning Unit (Barwon River at Mungindi 416001)

Flow category and EWR code[5]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
Cease-to-flow	CtF	<1 ML/d	Anytime	Maximum duration: Typically, events should not persist for more than 20 days. In very dry years, events should not persist for more than 95 days	CtF events should occur in no more than 50% of years	NA	When managing water to restart flows, avoid harmful water quality impacts, such as de-oxygenation of refuge pools.
Very-low-flow	VLF	>45 ML/d	Anytime	In typical years, at least 310 days per year. In very dry years, at least 220 days per year.	Every year	In accordance with maximum duration of cease-to-flow events	Flows that provide replenishment volumes to refuge pools along the Barwon-Darling. Waterhole persistence can also be supported by groundwater.
Baseflows	BF1	>160 ML/d	Anytime	In typical years, at least 220 days per year. In very dry years, at least 110 days per year.	Every year	130 days	Aiming to provide a depth of 0.3 m to allow fish passage. Also to manage water quality, prevent destratification and reduce risk of blue-green algal blooms.
	BF2	>160 ML/d	September to March	In typical years, at least 145 days per year (within timing window). In very dry years, at least 80 days per year (within timing window).	Every year	205 days	Aiming to provide a depth of 0.3 m to allow fish passage.
Small fresh	SF1	>540 ML/d	Anytime – but ideally October to April	10 days minimum	Annual (100% of years)	1 year	Ideal timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod.

[5] Refer to Glossary for definitions of terms and explanatory text for EWRs

Flow category and EWR code[5]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
							Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish. Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form). Ideally shortly after LF2 for increased likelihood of successful recruitment of fish, productivity and dispersal.
	SF2	540-3,000 ML/d	September to April	14 days minimum	5–10 years in 10 (75% of years)	2 years	Timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod. Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish. Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form).
Large fresh	LF1	>3,000 ML/d	Anytime, but ideally July to September	15 days minimum	5–10 years in 10 (75% of years)	2 years	This flow in Jul to Sep will improve pre-spawning fish condition. Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form).
	LF2	>3,000 ML/d	October to April	15 days minimum	3–5 years in 10 (42% of years)	2 years	Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form). Temp preferably >17°C to maximise spawning outcomes. Ideally shortly before SF1.
Bankfull	BK1	>7,900 ML/d	Anytime	5 days minimum	5 in 10 years (50% of years)	4 years	

Flow category and EWR code[5]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
Overbank	OB1	>10,000 ML/d	Anytime	5 days minimum	2 to 4 years in 10 (30% of years)	5 years	Clustered events (i.e. multiple events over 2–3 years) will provide improved conditions for native vegetation recruitment. Multiple events in close proximity will also improve the condition of native veg communities.
	OB2	>13,000 ML/d	Anytime	5 days minimum	1 to 3 years in 10 (20% of years)	10 years	
	OB3	>19,000 ML/d	Anytime	5 day minimum	0.5 to 1 years in 10 (10% of years)	15 years	

Table 4 Environmental Water Requirements for the Mungindi to Boomi River Planning Unit (Barwon River at Presbury 416050)

Flow category and EWR code[6]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
Cease-to-flow	CtF	<1 ML/d	Anytime	Maximum duration: Typically, events should not persist for more than 20 days. In very dry years, events should not persist for more than 95 days	CtF events should occur in no more than 50% of years	NA	When managing water to restart flows, avoid harmful water quality impacts, such as de-oxygenation of refuge pools.
Very-low-flow	VLF	>35 ML/d	Anytime	In typical years, at least 320 days per year. In very dry years, at least 230 days per year.	Every year	In accordance with maximum duration of cease-to-flow events	Flows that provide replenishment volumes to refuge pools along the Barwon-Darling. Waterhole persistence can also be supported by groundwater.
Baseflows	BF1	>140 ML/d	Anytime	In typical years, at least 240 days per year. In very dry years, at least 120 days per year.	Every year	125 days	Aiming to provide a depth of 0.3 m to allow fish passage. Also to manage water quality, prevent destratification and reduce risk of blue-green algal blooms.
	BF2	>140 ML/d	September to March	In typical years, at least 150 days per year (within timing window). In very dry years, at least 80 days per year (within timing window).	Every year	210 days	Aiming to provide a depth of 0.3 m to allow fish passage.
Small fresh	SF1	>500 ML/d	Anytime – but ideally October to April	10 days minimum	Annual (100% of years)	1 year	Ideal timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod.

[6] Refer to Glossary for definitions of terms and explanatory text for EWRs

Flow category and EWR code[6]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
							Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish. Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form). Ideally shortly after LF2 for increased likelihood of successful recruitment of fish, productivity and dispersal.
	SF2	500-2,700 ML/d	September to April	14 days minimum	5–10 years in 10 (75% of years)	2 years	Timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod. Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish. Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form).
Large fresh	LF1	>2,700 ML/d	Anytime, but ideally July to September	15 days minimum	5–10 years in 10 (75% of years)	2 years	This flow in Jul to Sep will improve pre-spawning fish condition. Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form).
	LF2	>2,700 ML/d	October to April	15 days minimum	3–5 years in 10 (42% of years)	2 years	Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form). Temp preferably >17°C to maximise spawning outcomes. Ideally shortly before SF1.
Bankfull	BK1	>7,400 ML/d	Anytime	5 days minimum	5 in 10 years (50% of years)	4 years	
Overbank	OB1	>12,000 ML/d	Anytime	5 days minimum	2 to 4 years in 10	5 years	

Flow category and EWR code[6]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
					(30% of years)		Clustered events (i.e. multiple events over 2–3 years) will provide improved conditions for native vegetation recruitment. Multiple events in close proximity will also improve the condition of native veg communities.
	OB2	>15,000 ML/d	Anytime	5 days minimum	1 to 3 years in 10 (20% of years)	10 years	
	OB3	>23,000 ML/d	Anytime	5 days minimum	0.5 to 1 years in 10 (10% of years)	15 years	

PU2: Boomi River Confluence to Upstream Mogil Mogil Weir Pool

This section of the Barwon River and floodplain from the Boomi River confluence to the upstream extent of the Mogil Mogil (Banarway) Weir pool has a similar morphology to planning unit 1: a relatively narrow floodplain with a tightly meandering channel characterised by benches at various heights in the channel and deep pools associated with meander bends and bedrock outcrops (Thoms et al. 1996). There are many floodplain wetlands, predominantly anabranches/flood runners and billabong type wetlands. The majority of these commence to fill at flows of 19,000-30,000 ML/d, while 30% fill at lower flows of 2000-5000 ML/d and a smaller proportion (10%) fill at higher flows of 60,000 ML/d (Brennan et al. 2002; NSW DPI 2018).

Tributaries entering this reach of the Barwon River include the Boomi and Moonie rivers. There are no weirs in the planning unit, however the Banarway (Mogil Mogil) Weir is located a short distance (approximately 3km) downstream in planning unit 3.

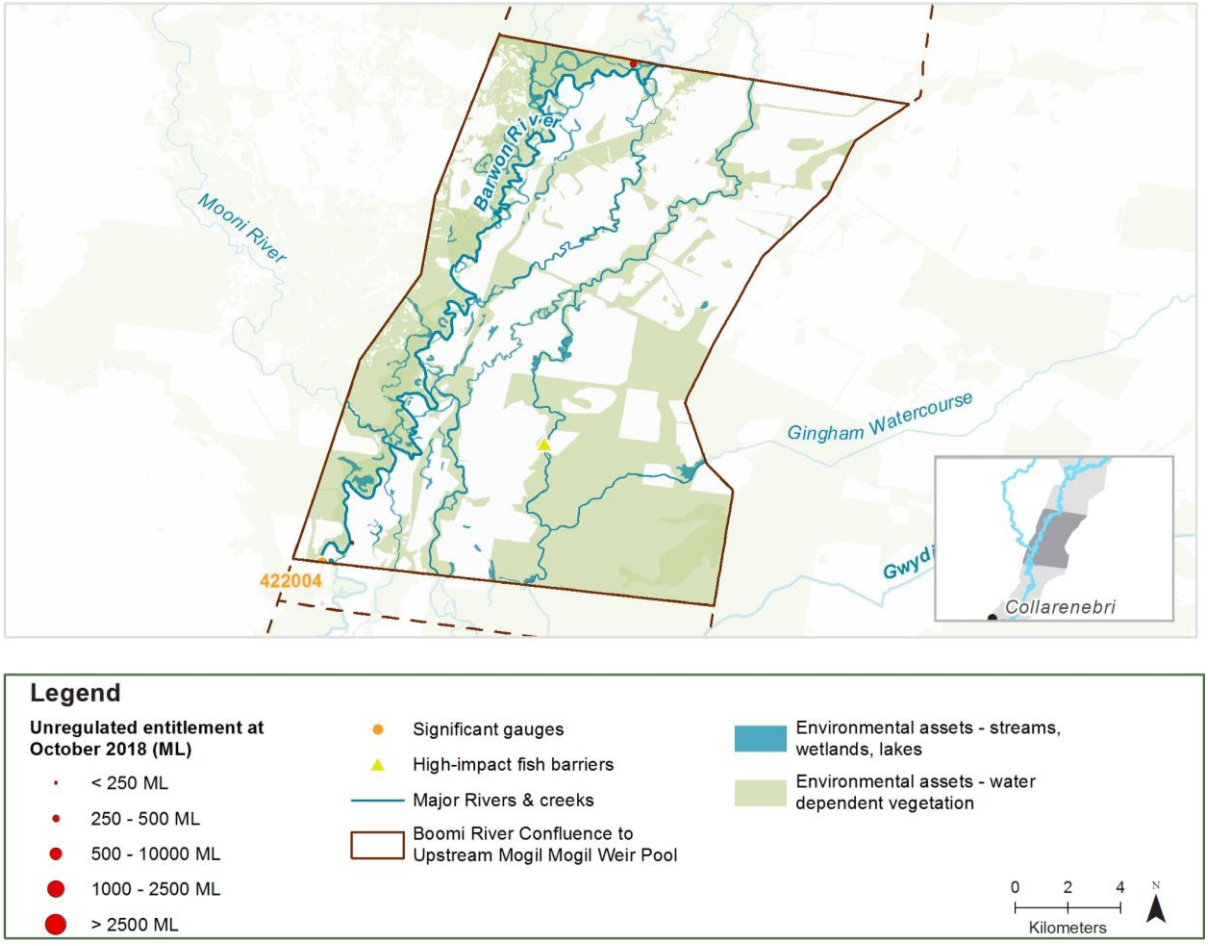


Figure 3 **Map of Boomi River Confluence to Upstream Mogil Mogil Weir Pool planning unit**
Area outside of planning unit has been faded. Significant gauges relevant to the planning unit are Barwon River at Mogil Mogil (gauge 422004)

Key ecological values (CE = Critically Endangered, E = Endangered, V = Vulnerable, EP= Endangered Population in MDB, C = CAMBA, J = JAMBA, R = ROKAMBA, X = species recorded in this planning unit via catch records & or Australian Museum Records where they exist, Y = species expected to occur based on MaxEnt modelling)	
Native fish	• Carp gudgeon X+Y • Murray–Darling rainbowfish X+Y • Bony herring X+Y • Australian smelt Y • Spangled perch X+Y • Silver perch (V) Y • Golden perch X+Y • Murray cod (V) X+Y • Olive perchlet X+Y
Waterbirds	16 waterbird species recorded including brolga (V) & Latham's snipe (J,K)
Native vegetation	• River red gum 975 ha • Black box 8068 ha • Coolibah 3589 ha • Floodplain 756 ha • Lignum 8 ha • Non-woody wetland 44 ha
Registered water-dependent cultural assets	• Modified tree It is acknowledged that other Aboriginal values such as sites, objects, landscapes, resources & beliefs that are important to Aboriginal people as part of their continuing culture may be present but not registered.

Hydrology

Hydrological alteration	**River reach**	**CtF**	**Low flow & baseflow**	**Freshes**	**High & infrequent flows**		
					1.5ARI	**2.5ARI**	**5ARI**
See Table 1 for key	Mungindi to Walgett	H^-	L^+	M^-	M^-	M^-	M^-

Relevant rules from WSP			
	Access rules: Users must cease-to-pump when the flow at the reference point is equal to or less than the flow rate specified below for each category of water access licence in the respective management zones.		
	Domestic & stock	0 ML/day	0 ML/day
	A class	220 ML/day	190 ML/day
	B class	270 ML/day	230 ML/day
	C class	270 ML/day	1,800 ML/day
	Reference points	Barwon River upstream of Presbury (gauge 416050)	Barwon River at Mogil Mogil (gauge 422004)

There is 1 very small & 1 small water access licence in the planning unit. The total volume of unregulated irrigation entitlements for the planning unit is 186 ML.

There is one very large B Class WAL for environmental water.

# WAL (share component)	Very small (<250 ML)	Small (250-500 ML)	Medium (500-1000 ML)	Large (1000-2500 ML)	Very large (>2500 ML)
A Class	1	-	-	-	-
B Class	1	-	-	-	***1 HEW (3731 ML)***
C Class	-	-	-	-	-

Recommended management strategies

MS1: Reduce extraction pressure on in-channel flows

- **1a:** Review existing cease-to-pump thresholds based on identified ecological requirements
- **1b:** Review access (commence-to-pump) thresholds for each flow class based on identified ecological requirements
- **1c:** Consider flow sharing mechanisms that would enable limits to extraction on a daily or event basis

MS2: Ensure that floodplain harvesting is regulated within the SDL and LTAAEL of the WRP.

MS3: A resumption of flow rule which restricts access to flows following an identified cease-to-flow event.

MS4a: Protect HEW and EWA inflows from tributary catchments and through the Barwon-Darling. **Not yet applicable from Border Rivers or Intersecting Streams (Moonie River) WRPA.**

MS4b: Protect HEW held in Barwon-Darling

MS5: End-of-system flow requirements. **Applies from Border Rivers WRPA. Not applicable from Intersecting Streams (Moonie River) WRPA.**

MS6a: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending supplementary access. **Incorporated into NSW Border Rivers WSP.**

MS6b: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending B and C Class access. **Not statutory at the time of writing.**

MS8: Continue and refine temporary access restrictions such as through WMA s324 orders

Table 5 Environmental Water Requirements for the Boomi River to Mogil Mogil Planning Unit (Barwon River at Mogil Mogil 422004)

Flow category and EWR code[7]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
Cease-to-flow	CtF	<1 ML/d	Anytime	Maximum duration: Typically, events should not persist for more than 5 days. In very dry years, events should not persist for more than 45 days	CtF events should occur in no more than 50% of years	NA	When managing water to restart flows, avoid harmful water quality impacts, such as de-oxygenation of refuge pools.
Very-low-flow	VLF	>75 ML/d	Anytime	In typical years, at least 320 days per year. In very dry years, at least 215 days per year.	Every year	In accordance with maximum duration of cease-to-flow events	Flows that provide replenishment volumes to refuge pools along the Barwon-Darling. Waterhole persistence can also be supported by groundwater.
Baseflows	BF1	>220 ML/d	Anytime	In typical years, at least 240 days per year. In very dry years, at least 120 days per year.	Every year	110 days	Aiming to provide a depth of 0.3 m to allow fish passage. Also to manage water quality, prevent destratification and reduce risk of blue-green algal blooms.
	BF2	>220 ML/d	September to March	In typical years, at least 155 days per year (within timing window). In very dry years, at least 80 days per year (within timing window).	Every year	190 days	Aiming to provide a depth of 0.3 m to allow fish passage.
Small fresh	SF1	>680 ML/d	Anytime – but ideally October to April	10 days minimum	Annual (100% of years)	1 year	Ideal timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod.

[7] Refer to Glossary for definitions of terms and explanatory text for EWRs

Flow category and EWR code[7]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
							Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish. Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form). Ideally shortly after LF2 for increased likelihood of successful recruitment of fish, productivity and dispersal.
	SF2	680-5,200 ML/d	September to April	14 days minimum	5–10 years in 10 (75% of years)	2 years	Timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod. Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish. Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form).
Large fresh	LF1	>5,200 ML/d	Anytime, but ideally July to September	15 days minimum	5–10 years in 10 (75% of years)	2 years	This flow in Jul to Sep will improve pre-spawning fish condition. Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form).
	LF2	>5,200 ML/d	October to April	15 days minimum	3–5 years in 10 (42% of years)	2 years	Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form).

Flow category and EWR code[7]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
							Temp preferably >17°C to maximise spawning outcomes. Ideally shortly before SF1.
Bankfull	BK1	>13,000 ML/d	Anytime	5 days minimum	5 in 10 years (50% of years)	4 years	
Overbank	OB1	>15,000 ML/d	Anytime	5 days minimum	2 to 4 years in 10 (30% of years)	5 years	Clustered events (i.e. multiple events over 2–3 years) will provide improved conditions for native vegetation recruitment. Multiple events in close proximity will also improve the condition of native veg communities.
	OB2	>18,000 ML/d	Anytime	5 days minimum	1 to 3 years in 10 (20% of years)	10 years	
	OB3	>26,000 ML/d	Anytime	5 days minimum	0.5 to 1 years in 10 (10% of years)	15 years	

PU3: Mogil Mogil Weir Pool

This planning unit includes the Mogil Mogil weir pool on the Barwon River, otherwise known as Banarway weir pool, and adjacent floodplain. The weir pool extends approximately 3km upstream of the Banarway (Mogil Mogil) Weir.

No specific EWRs are provided for this planning unit, with environmental water requirements for assets in this planning unit met by those specified for upstream and downstream planning units.

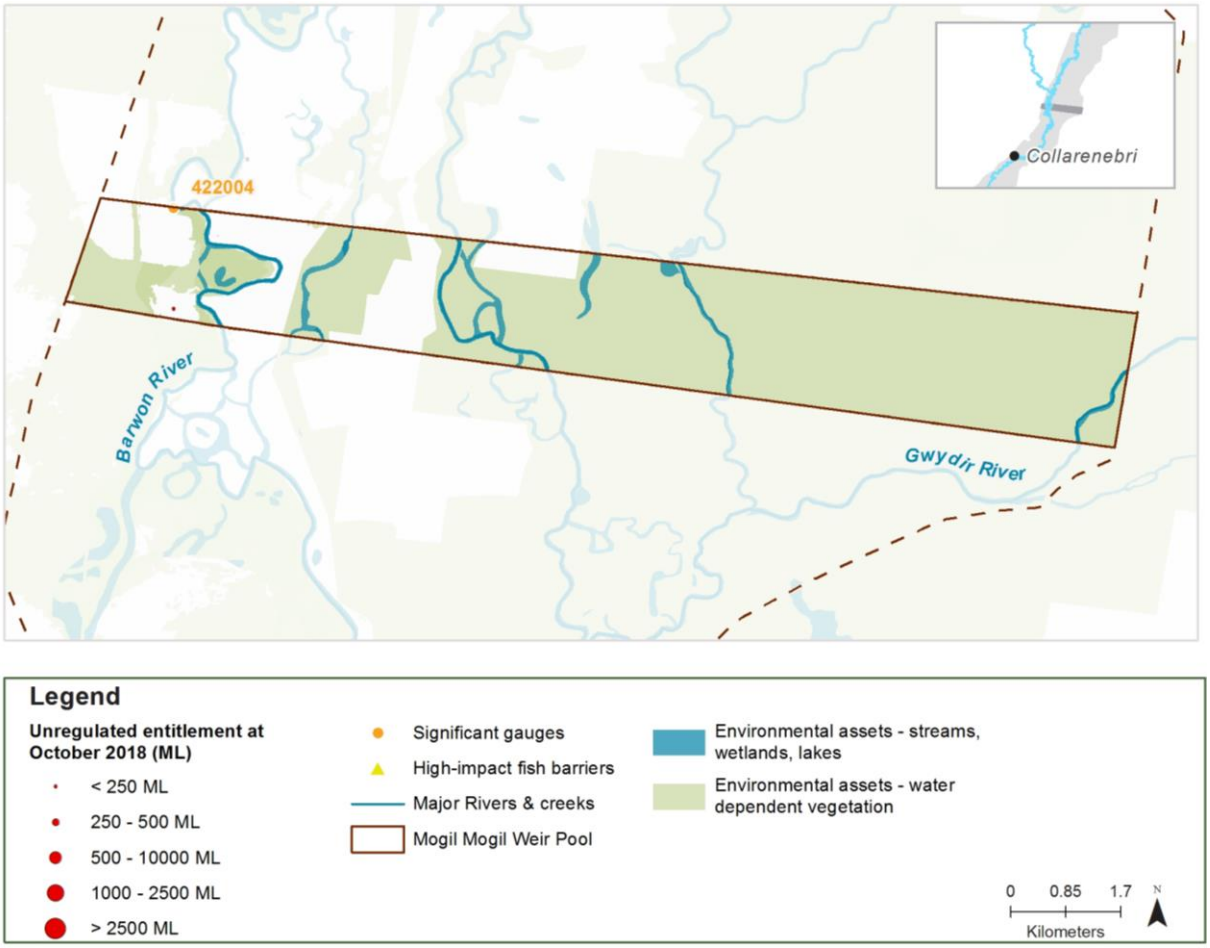


Figure 4 **Map of Mogil Mogil Weir Pool planning unit**
Area outside of planning unit has been faded.

Key ecological values (CE = Critically Endangered, E = Endangered, V = Vulnerable, EP= Endangered Population in MDB, C = CAMBA, J = JAMBA, R = ROKAMBA, X = species recorded in this planning unit via catch records & or Australian Museum Records where they exist, Y = species expected to occur based on MaxEnt modelling)	
Native fish	• Carp gudgeon X+Y • Murray–Darling rainbowfish Y • Australian smelt Y • Bony herring X+Y • Spangled perch X+Y • Golden perch X+Y • Silver perch (V) Y • Murray cod (V) Y • Purple spotted gudgeon (E) Y • Olive perchlet Y
Waterbirds	0 waterbird species recorded
Native vegetation	• River red gum 39 ha • Black box 2023 ha • Coolibah 187 ha • Floodplain 44 ha
Registered water-dependent cultural assets	N/A It is acknowledged that other Aboriginal values such as sites, objects, landscapes, resources & beliefs that are important to Aboriginal people as part of their continuing culture may be present but not registered.

Hydrology

Hydrological alteration	**River reach**	**CtF**	**Low flow & baseflow**	**Freshes**	**High & infrequent flows**		
					1.5ARI	**2.5ARI**	**5ARI**
See Table 1 for key	Mungindi to Walgett	H^-	L^+	M^-	M^-	M^-	M^-

Relevant rules from WSP

Access rules: Users must cease-to-pump when the flow at the reference point is equal to or less than the flow rate specified below for each category of water access licence in the respective management zones.

Domestic & stock	0 ML/day
A class	190 ML/day
B class	570 ML/day
C class	1800 ML/day
Reference point	Barwon River at Mogil Mogil (gauge 422004)

There are no water access licenses in this planning unit.

Recommended management strategies

MS1: Reduce extraction pressure on in-channel flows

- **1a:** Review existing cease-to-pump thresholds based on identified ecological requirements
- **1b:** Review access (commence-to-pump) thresholds for each flow class based on identified ecological requirements
- **1c:** Consider flow sharing mechanisms that would enable limits to extraction on a daily or event basis

MS2: Ensure that floodplain harvesting is regulated within the SDL and LTAAEL of the WRP.

MS3: A resumption of flow rule which restricts access to flows following an identified cease-to-flow event.

MS4a: Protect HEW and EWA inflows from tributary catchments and through the Barwon-Darling. **Not yet applicable from Border Rivers or Intersecting Streams (Moonie River) WRPA.**

MS4b: Protect HEW held in Barwon-Darling

MS5: End-of-system flow requirements. **Applies from Border Rivers WRPA. Not applicable from Intersecting Streams (Moonie River) WRPA.**

MS6a: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending supplementary access. **Incorporated into NSW Border Rivers WSP.**

MS6b: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending B and C Class access. **Not statutory at the time of writing.**

MS8: Continue and refine temporary access restrictions such as through WMA s324 orders

PU4: Downstream Mogil Mogil to Collarenebri

This planning unit includes the Barwon River from Mogil Mogil (Banaway) Weir to Collarenebri and the adjacent floodplain. The planning unit has a similar morphology to planning units 1 and 2: a relatively narrow floodplain with a tightly meandering channel characterised by benches at various heights in the channel and deep pools associated with meander bends and bedrock outcrops (Thoms et al. 1996). Similar to upstream reaches (planning units 1-2), wetlands are predominantly anabranches/flood runners and billabongs. Approximately 30% of wetlands between Prestbury Weir and Collarenebri (covering planning units 2-4) are low-lying and fill at flows of 1000-2000 ML/day, while 60% commence filling at higher flows of 19,000-30,000 ML/day (Brennan et al. 2002; NSW DPI 2018).

Tributaries entering this reach of the Barwon include the Gwydir and Mehi rivers. Grawan Creek splits off from the Barwon River in the planning unit before re-entering downstream of Collarenebri. Two weirs are located along the Barwon River in the planning unit, Temporary Weir No.10 and Collarenebri Weir (Darling River Weir No. 5). Collarenebri Weir is drowned out at approximately 18,000 ML/d, which is the highest drown out value of all 15 barriers along the Barwon-Darling River (NSW DPI, 2006; 2015).

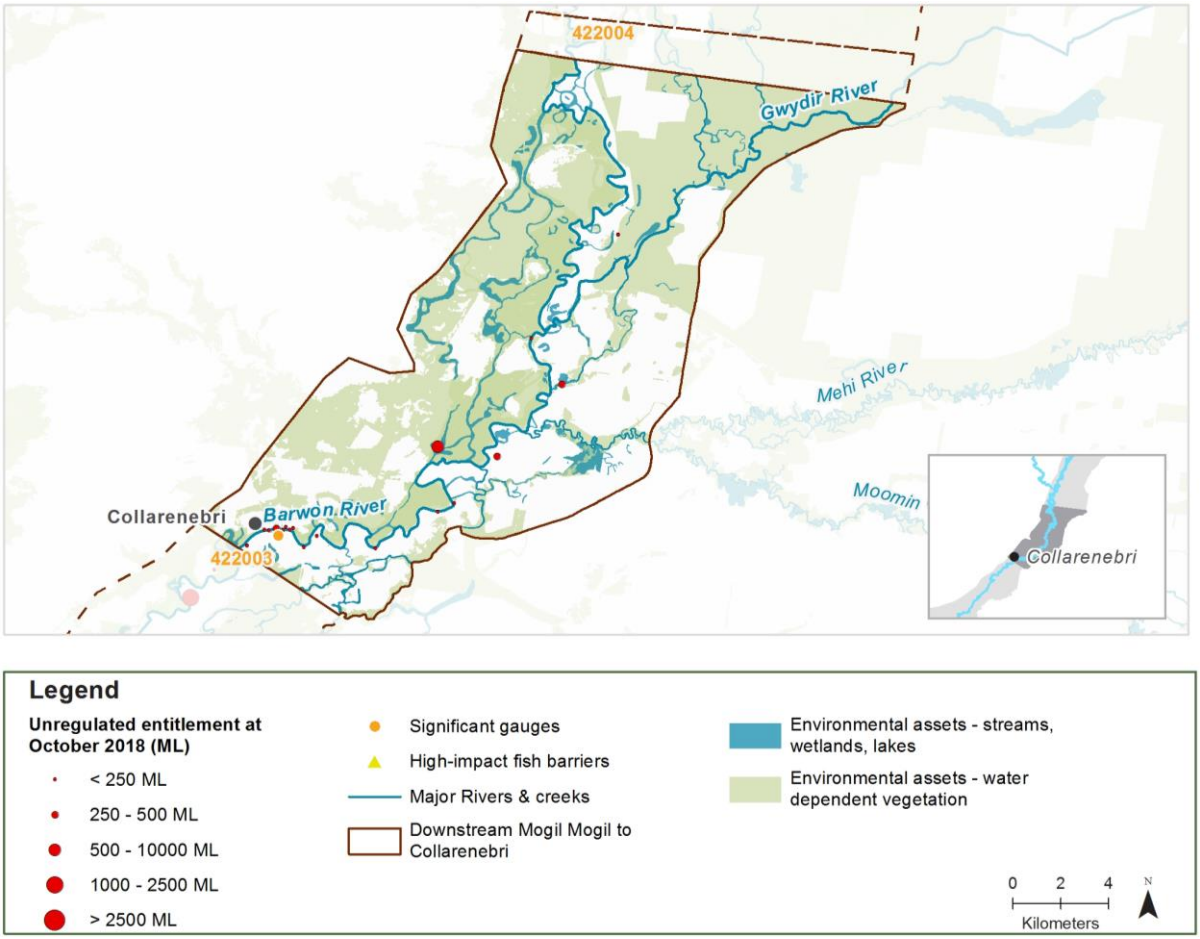


Figure 5 **Map of Downstream Mogil Mogil to Collarenebri planning unit**
Area outside of planning unit has been faded. Significant gauges relevant to the planning unit are Barwon River at Collarenebri (422003)

Key ecological values (CE = Critically Endangered, E = Endangered, V = Vulnerable, EP= Endangered Population in MDB, C = CAMBA, J = JAMBA, R = ROKAMBA, X = species recorded in this planning unit via catch records & or Australian Museum Records where they exist, Y = species expected to occur based on MaxEnt modelling)			
Native fish	• Carp gudgeon X+Y • Murray–Darling rainbowfish X+Y • Bony herring X+Y	• Australian smelt X+Y • Golden perch X+Y • Spangled perch X+Y • Silver perch (V) X+Y	• Murray cod (V) X+Y • Purple spotted gudgeon (E) Y • Olive perchlet X+Y
Waterbirds	6 waterbird species recorded		
Native vegetation	• River red gum 1154 ha • Black box 6663 ha • Coolibah 7681 ha	• Floodplain 493 ha • Lignum 12 ha	
Registered water-dependent cultural assets	• Ceremony & Dreaming • Modified trees • Ceremonial ring It is acknowledged that other Aboriginal values such as sites, objects, landscapes, resources & beliefs that are important to Aboriginal people as part of their continuing culture may be present but not registered.	• Artefacts • Resource & Gathering	

Hydrology

Hydrological alteration	**River reach**	**CtF**	**Low flow & baseflow**	**Freshes**	**High & infrequent flows**		
					1.5ARI	**2.5ARI**	**5ARI**
See Table 1 for key	Mungindi to Walgett	H^-	L^+	M^-	M^-	M^-	M^-
Relevant rules from WSP	**Access rules:** Users must cease-to-pump when the flow at the reference point is equal to or less than the flow rate specified below for each category of water access licence in the respective management zones.						
	Domestic & stock	0 ML/day	0 ML/day				
	A class	190 ML/day	165 ML/day				
	B class	570 ML/day	500 ML/day				
	C class	570 ML/day	2900 ML/day				
	Reference points	Barwon River at Mogil Mogil (gauge 422004)	Barwon River at Collarenebri Main Channel (gauge 422003)				

There are no large or very large irrigation water access licences within the planning unit. The total volume of unregulated irrigation entitlement for the planning unit is 1738 ML

There is one very large B Class and one very large C Class HEW license in this planning unit.

There is also 448 ML licensed for local water utility and 72 ML of licensed domestic and stock entitlement.

# WAL (share component)	Very small (<250 ML)	Small (250-500 ML)	Medium (500-1000 ML)	Large (1000-2500 ML)	Very large (>2500 ML)
A Class	8	-	-	-	-
B Class	2	2	1	-	***1 HEW (9252 ML)***
C Class	-	-	-	-	***1 HEW (6963 ML)***

Recommended management strategies

MS1: Reduce extraction pressure on in-channel flows

1a: Review existing cease-to-pump thresholds based on identified ecological requirements

1b: Review access (commence-to-pump) thresholds for each flow class based on identified ecological requirements

1c: Consider flow sharing mechanisms that would enable limits to extraction on a daily or event basis

MS2: Ensure that floodplain harvesting is regulated within the SDL and LTAAEL of the WRP.

MS3: A resumption of flow rule which restricts access to flows following an identified cease-to-flow event.

MS4a: Protect HEW and EWA inflows from tributary catchments and through the Barwon-Darling. **In draft for Gwydir WRPA at time of writing.**

MS4b: Protect HEW held in Barwon-Darling

MS5: End-of-system flow requirements. **Applies from Border Rivers WRPA. Not applicable from Gwydir or Intersecting Streams WRPAs.**

MS6a: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending supplementary access. **Incorporated into NSW Border Rivers and Gwydir WSPs.**

MS6b: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending B and C Class access. **Not statutory at the time of writing.**

MS7: Targeted purchase of water entitlements for the Barwon-Darling

MS8: Continue and refine temporary access restrictions such as through WMA s324 orders

Table 6 Environmental Water Requirements for the Mogil Mogil to Collarenebri Planning Unit (Barwon River at Collarenebri 422003)

Flow category and EWR code[8]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
Cease-to-flow	CtF	<1 ML/d	Anytime	Maximum duration: Typically, events should not persist for more than 5 days. In very dry years, events should not persist for more than 35 days	CtF events should occur in no more than 50% of years	NA	When managing water to restart flows, avoid harmful water quality impacts, such as de-oxygenation of refuge pools.
Very-low-flow	VLF	>80 ML/d	Anytime	In typical years, at least 315 days per year. In very dry years, at least 205 days per year.	Every year	In accordance with maximum duration of cease-to-flow events	Flows that provide replenishment volumes to refuge pools along the Barwon-Darling. Waterhole persistence can also be supported by groundwater.
Baseflows	BF1	>280 ML/d	Anytime	In typical years, at least 245 days per year. In very dry years, at least 130 days per year.	Every year	100 days	Aiming to provide a depth of 0.3 m to allow fish passage. Also to manage water quality, prevent destratification and reduce risk of blue-green algal blooms.
	BF2	>280 ML/d	September to March	In typical years, at least 160 days per year (within timing window). In very dry years, at least 75 days per year (within timing window).	Every year	185 days	Aiming to provide a depth of 0.3 m to allow fish passage.
Small fresh	SF1	>650 ML/d	Anytime – but ideally October to April	10 days minimum	Annual (100% of years)	1 year	Ideal timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod. Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish.

[8] Refer to Glossary for definitions of terms and explanatory text for EWRs

Flow category and EWR code[8]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
							Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form). Ideally shortly after LF2 for increased likelihood of successful recruitment of fish, productivity and dispersal.
	SF2	650-4,200 ML/d	September to April	14 days minimum	5–10 years in 10 (75% of years)	2 years	Timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod. Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish. Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form).
Large fresh	LF1	>4,200 ML/d	Anytime, but ideally July to September	15 days minimum	5–10 years in 10 (75% of years)	2 years	This flow in Jul to Sep will improve pre-spawning fish condition. Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form).
	LF2	>4,200 ML/d	October to April	15 days minimum	3–5 years in 10 (42% of years)	2 years	Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form).

Flow category and EWR code[8]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
							Temp preferably >17°C to maximise spawning outcomes. Ideally shortly before SF1.
Bankfull	BK1	>16,000 ML/d	Anytime	5 days minimum	5 in 10 years (50% of years)	4 years	
Overbank	OB1	>18,000 ML/d	Anytime	5 days minimum	2 to 4 years in 10 (30% of years)	5 years	Clustered events (i.e. multiple events over 2–3 years) will provide improved conditions for native vegetation recruitment. Multiple events in close proximity will also improve the condition of native veg communities.
	OB2	>25,000 ML/d	Anytime	5 days minimum	1 to 3 years in 10 (20% of years)	10 years	
	OB3	>32,000 ML/d	Anytime	5 days minimum	0.5 to 1 years in 10 (10% of years)	15 years	

PU5: Collarenebri to Upstream Walgett Weir

This planning unit includes the Barwon River from Collarenebri to the upstream extent of Walgett Weir pool, and the adjacent floodplain. The planning unit has a similar morphology to upstream reaches (planning units 1-4): a relatively narrow floodplain with a tightly meandering channel characterised by benches at various heights in the channel and deep pools associated with meander bends and occasional bedrock outcrops (Thoms et al. 1996). Wetlands are predominantly billabong and anabranches/flood runner-type wetlands (Thoms et al. 1996).

The Grawan Creek anabranch re-enters the Barwon River in the planning unit and several other anabranches/flood runners occur on the floodplain, including Thalaba and Deadman's creeks and Sparkes Warrambool. Calmundy weir (No 8) is located on the in this planning unit.

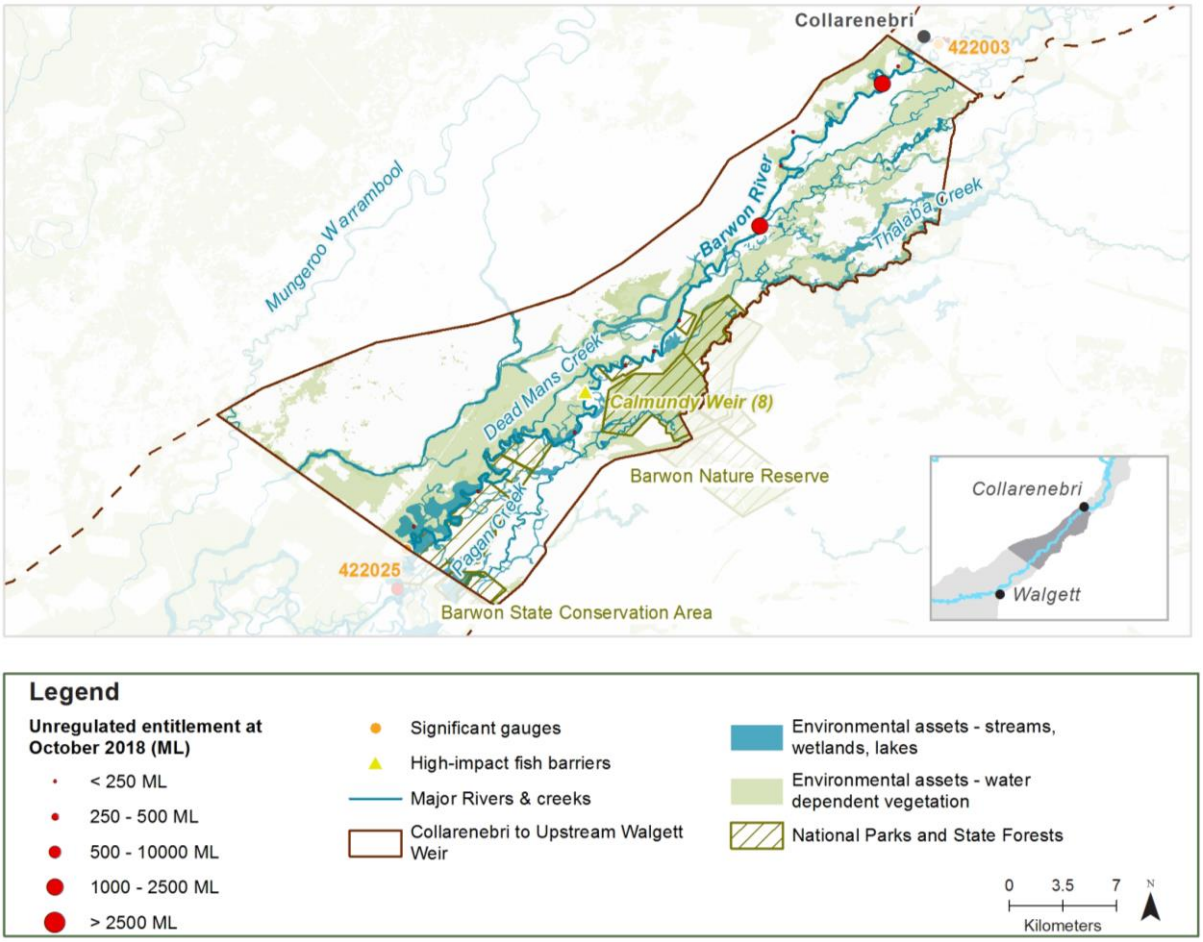


Figure 6 **Map of Collarenebri to Upstream Walgett Weir planning unit**
Area outside of planning unit has been faded. Significant gauge relevant to the planning unit is Barwon River at Tara (422025).

Key ecological values (CE = Critically Endangered, E = Endangered, V = Vulnerable, EP= Endangered Population in MDB, C = CAMBA, J = JAMBA, R = ROKAMBA, X = species recorded in this planning unit via catch records & or Australian Museum Records where they exist, Y = species expected to occur based on MaxEnt modelling)			
Native fish	• Carp gudgeon X+Y • Murray–Darling rainbowfish X+Y • Bony herring X+Y • Australian smelt Y	• Spangled perch X+Y • Golden perch X+Y • Silver perch (V) Y	• Murray cod (V) X+Y • Purple spotted gudgeon (E) Y • Olive perchlet Y
Waterbirds	13 waterbird species recorded including brolga (V)		
Native vegetation	• River red gum 2135 ha • Black box 24,667 ha • Coolibah 7346 ha	• Floodplain 60 ha • Lignum 304 ha • Non-woody wetland 45 ha	
Registered water-dependent cultural assets	• Resource & gathering • Artefacts	• Modified trees • Grinding grooves	
	It is acknowledged that other Aboriginal values such as sites, objects, landscapes, resources & beliefs that are important to Aboriginal people as part of their continuing culture may be present but not registered.		

Hydrology

Hydrological alteration	**River reach**	**CtF**	**Low flow & baseflow**	**Freshes**	**High & infrequent flows**		
					1.5ARI	**2.5ARI**	**5ARI**
See Table 1 for key	Mungindi to Walgett	H^-	L^+	M^-	M^-	M^-	M^-
Relevant rules from WSP	**Current access rules:** Users must cease-to-pump when the flow at the reference point is equal to or less than the flow rate specified below for each category of water access licence in the respective management zones.						
	Domestic & stock		0 ML/day		0 ML/day		
	A class		165 ML/day		100 ML/day		
	B class		500 ML/day		430 ML/day		
	C class		500 ML/day		3050 ML/day		
	Reference points		Barwon River at Collarenebri Main Channel (gauge 422003)		Barwon River at Tara (gauge 422025)		

There are 11 very small, 2 large and 1 very large water access licences distributed throughout the planning unit. The total volume of unregulated irrigation entitlements for the planning unit is 9249 ML.

Two very small A class HEW licenses with a total volume of 80 ML are in this planning unit. One very small B class HEW licenses is in this planning unit.

There is 17 ML of license domestic and stock entitlement in this planning unit.

# WAL (share component)	Very small (<250 ML)	Small (250-500 ML)	Medium (500-1000 ML)	Large (1000-2500 ML)	Very large (>2500 ML)
A Class	8 and ***2 HEW (39, 41 ML)***	-	-	-	-
B Class	1 and ***1 HEW (51 ML)***	-	-	2	1 (4683 ML)
C Class	-	-	-	-	-

Recommended management strategies

MS1: Reduce extraction pressure on in-channel flows

1a: Review existing cease-to-pump thresholds based on identified ecological requirements

1b: Review access (commence-to-pump) thresholds for each flow class based on identified ecological requirements

1c: Consider flow sharing mechanisms that would enable limits to extraction on a daily or event basis

MS2: Ensure that floodplain harvesting is regulated within the SDL and LTAAEL of the WRP.

MS3: A resumption of flow rule which restricts access to flows following an identified cease-to-flow event.

MS4a: Protect HEW and EWA inflows from tributary catchments and through the Barwon-Darling. **In draft for Gwydir WRPA at time of writing.**

MS4b: Protect HEW held in Barwon-Darling

MS5: End-of-system flow requirements. **Applies from Border Rivers WRPA. Not applicable from Gwydir or Intersecting Streams WRPAs.**

MS6a: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending supplementary access. **Incorporated into NSW Border Rivers and Gwydir WSPs.**

MS6b: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending B and C Class access. **Not statutory at the time of writing.**

MS7: Targeted purchase of water entitlements for the Barwon-Darling

MS8: Continue and refine temporary access restrictions such as through WMA s324 orders

Table 7 Environmental Water Requirements for the Collarenebri to Upstream Walgett Planning Unit (Barwon River at Tara 422025)

Flow category and EWR code[9]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
Cease-to-flow	CtF	<1 ML/d	Anytime	Maximum duration: Typically, events should not persist for more than 10 days. In very dry years, events should not persist for more than 40 days	CtF events should occur in no more than 50% of years	NA	When managing water to restart flows, avoid harmful water quality impacts, such as de-oxygenation of refuge pools.
Very-low-flow	VLF	>75 ML/d	Anytime	In typical years, at least 320 days per year. In very dry years, at least 200 days per year.	Every year	In accordance with maximum duration of cease-to-flow events	Flows that provide replenishment volumes to refuge pools along the Barwon-Darling. Waterhole persistence can also be supported by groundwater.
Baseflows	BF1	>250 ML/d	Anytime	In typical years, at least 245 days per year. In very dry years, at least 130 days per year.	Every year	105 days	Aiming to provide a depth of 0.3 m to allow fish passage. Also to manage water quality, prevent destratification and reduce risk of blue-green algal blooms.
	BF2	>250 ML/d	September to March	In typical years, at least 160 days per year (within timing window). In very dry years, at least 75 days per year (within timing window).	Every year	200 days	Aiming to provide a depth of 0.3 m to allow fish passage.
Small fresh	SF1	>500 ML/d	Anytime – but ideally October to April	10 days minimum	Annual (100% of years)	1 year	Ideal timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod. Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish.

[9] Refer to Glossary for definitions of terms and explanatory text for EWRs

Flow category and EWR code[9]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
							Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form). Ideally shortly after LF2 for increased likelihood of successful recruitment of fish, productivity and dispersal.
	SF2	500-3,500 ML/d	September to April	14 days minimum	5–10 years in 10 (75% of years)	2 years	Timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod. Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish. Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form).
Large fresh	LF1	>3,500 ML/d	Anytime, but ideally July to September	15 days minimum	5–10 years in 10 (75% of years)	2 years	This flow in Jul to Sep will improve pre-spawning fish condition. Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form).
	LF2	>3,500 ML/d	October to April	15 days minimum	3–5 years in 10 (42% of years)	2 years	Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form).

Flow category and EWR code[9]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
							Temp preferably >17°C to maximise spawning outcomes. Ideally shortly before SF1.
Bankfull	BK1	>20,000 ML/d	Anytime	5 days minimum	5 in 10 years (50% of years)	4 years	
Overbank	OB1	>27,000 ML/d	Anytime	5 days minimum	2 to 4 years in 10 (30% of years)	5 years	Clustered events (i.e. multiple events over 2–3 years) will provide improved conditions for native vegetation recruitment. Multiple events in close proximity will also improve the condition of native veg communities.
	OB2	>40,000 ML/d	Anytime	5 days minimum	1 to 3 years in 10 (20% of years)	10 years	
	OB3	>50,000 ML/d	Anytime	5 days minimum	0.5 to 1 years in 10 (10% of years)	15 years	

PU6: Walgett Weir Pool

This planning unit covers the Walgett Weir pool, which extends approximately 4-5km upstream of the weir. Walgett Weir is also known as Darling River Weir No.11A. The township of Walgett (population ~2200[10]) is located just downstream of the planning unit.

Tributaries entering this section of the Barwon River include the Namoi River and Pagan Creek. Several billabongs and anabranch/flood-runners occur on the floodplain (Brennan et al. 2002), including Sparks Warrambool and Mungaroo Warrambool. Flows of 14,000 ML/d or more are needed to drown out Walgett Weir (NSW DPI 2015).

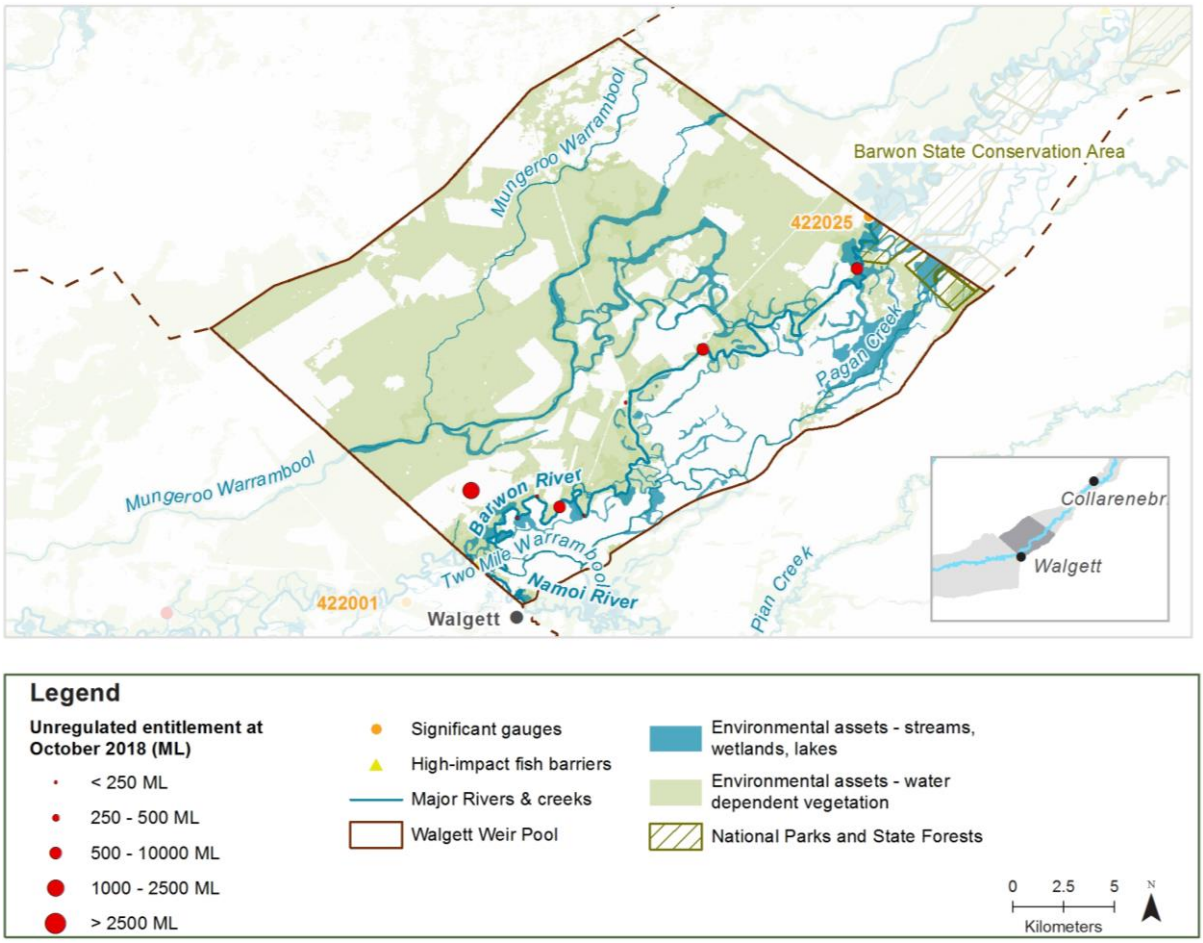


Figure 7 **Map of Walgett Weir Pool planning unit**
Area outside of planning unit has been faded. Significant gauges relevant to the planning unit are Barwon River at Dangar Bridge (422001).

[10] Australian Bureau of Statistics (2016 census) – population of Walgett at the locality scale (State Suburb (SSC) scale).

Key ecological values (CE = Critically Endangered, E = Endangered, V = Vulnerable, EP= Endangered Population in MDB, C = CAMBA, J = JAMBA, R = ROKAMBA, X = species recorded in this planning unit via catch records & or Australian Museum Records where they exist, Y = species expected to occur based on MaxEnt modelling)			
Native fish	• Carp gudgeon X+Y • Murray–Darling rainbowfish X+Y	• Bony herring X+Y • Australian smelt Y • Spangled perch X+Y	• Golden perch X+Y • Silver perch (V) Y • Murray cod (V) X+Y • Olive perchlet Y
Waterbirds	9 waterbirds recorded		
Native vegetation	• River red gum 1244 ha • Black box 22,770 ha • Coolibah 7432 ha	• Floodplain 946 ha • Lignum 76 ha • Non-woody wetland 1 ha	
Registered water-dependent cultural assets	Modified trees It is acknowledged that other Aboriginal values such as sites, objects, landscapes, resources & beliefs that are important to Aboriginal people as part of their continuing culture may be present but not registered.		

Hydrology

Hydrological alteration	**River reach**	**CtF**	**Low flow & baseflow**	**Freshes**	**High & infrequent flows**		
					1.5ARI	**2.5ARI**	**5ARI**
See Table 1 for key	Mungindi to Walgett	H^-	L^+	M^-	M^-	M^-	M^-

Relevant rules from WSP		
	Current access rules: Users must cease-to-pump when the flow at the reference point is equal to or less than the flow rate specified below for each category of water access licence in the respective management zones.	
	Domestic & stock	0 ML/day
	A class	600 ML/day
	B class	900 ML/day
	C class	5650 ML/day
	Reference point	River at Dangar Bridge (gauge 422001)

There are 4 very small, 3 medium, & 1 large water access licences distributed throughout the planning unit. The total volume of unregulated entitlements for the planning unit is 3261 ML.

There is 8.5 ML of domestic and stock entitlement in this planning unit.

# WAL (share component)	Very small (<250 ML)	Small (250-500 ML)	Medium (500-1000 ML)	Large (1000-2500 ML)	Very large (>2500 ML)
A Class	4	-	-	-	-
B Class	2	-	2	1	-
C Class	-	-	-	-	-

Recommended management strategies

MS1: Reduce extraction pressure on in-channel flows

1a: Review existing cease-to-pump thresholds based on identified ecological requirements

1b: Review access (commence-to-pump) thresholds for each flow class based on identified ecological requirements

1c: Consider flow sharing mechanisms that would enable limits to extraction on a daily or event basis

MS2: Ensure that floodplain harvesting is regulated within the SDL and LTAAEL of the WRP.

MS3: A resumption of flow rule which restricts access to flows following an identified cease-to-flow event.

MS4a: Protect HEW and EWA inflows from tributary catchments and through the Barwon-Darling. **In draft for Gwydir WRPA at time of writing. Not yet applicable from Namoi WRPA.**

MS4b: Protect HEW held in Barwon-Darling

MS5: End-of-system flow requirements. **Applies from Border Rivers and Namoi WRPAs. Not applicable from Gwydir or Intersecting Streams WRPAs.**

MS6a: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending supplementary access. **Incorporated into NSW Border Rivers, Gwydir and Namoi WSPs.**

MS6b: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending B and C Class access. **Not statutory at the time of writing.**

MS7: Targeted purchase of water entitlements for the Barwon-Darling

MS8: Continue and refine temporary access restrictions such as through WMA s324 orders

Table 8 Environmental Water Requirements for the Walgett Weir Pool Planning Unit (Barwon River at Dangar Bridge 422001)

Flow category and EWR code[11]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
Cease-to-flow	CtF	<1 ML/d	Anytime	Maximum duration: Typically, events should not persist for more than 10 days. In very dry years, events should not persist for more than 45 days	CtF events should occur in no more than 40% of years	NA	When managing water to restart flows, avoid harmful water quality impacts, such as de-oxygenation of refuge pools.
Very-low-flow	VLF	>95 ML/d	Anytime	In typical years, at least 350 days per year. In very dry years, at least 225 days per year.	Every year	In accordance with maximum duration of cease-to-flow events	Flows that provide replenishment volumes to refuge pools along the Barwon-Darling. Waterhole persistence can also be supported by groundwater.
Baseflows	BF1	>320 ML/d	Anytime	In typical years, at least 285 days per year. In very dry years, at least 130 days per year.	Every year	115 days	Aiming to provide a depth of 0.3 m to allow fish passage. Also to manage water quality, prevent destratification and reduce risk of blue-green algal blooms.
	BF2	>320 ML/d	September to March	In typical years, at least 180 days per year (within timing window). In very dry years, at least 75 days per year (within timing window).	Every year	185 days	Aiming to provide a depth of 0.3 m to allow fish passage.
Small fresh	SF1	>700 ML/d	Anytime – but ideally October to April	10 days minimum	Annual (100% of years)	1 year	Ideal timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod. Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish.

[11] Refer to Glossary for definitions of terms and explanatory text for EWRs

Flow category and EWR code[11]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
							Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form). Ideally shortly after LF2 for increased likelihood of successful recruitment of fish, productivity and dispersal.
	SF2	700-6,500 ML/d	September to April	14 days minimum	5–10 years in 10 (75% of years)	2 years	Timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod. Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish. Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form).
Large fresh	LF1	>6,500 ML/d	Anytime, but ideally July to September	15 days minimum	5–10 years in 10 (75% of years)	2 years	This flow in Jul to Sep will improve pre-spawning fish condition. Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form).
	LF2	>6,500 ML/d	October to April	15 days minimum	3–5 years in 10 (42% of years)	2 years	Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form). Temp preferably >17°C to maximise spawning outcomes.

Flow category and EWR code[11]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
							Ideally shortly before SF1.
Bankfull	BK1	>22,000 ML/d	Anytime	10 days minimum	5 in 10 years (50% of years)	4 years	
Overbank	OB1	>45,000 ML/d	Anytime	10 days minimum	2 to 4 years in 10 (30% of years)	5 years	Clustered events (i.e. multiple events over 2–3 years) will provide improved conditions for native vegetation recruitment. Multiple events in close proximity will also improve the condition of native veg communities.
	OB2	>71,000 ML/d	Anytime	10 days minimum	1 to 3 years in 10 (20% of years)	10 years	
	OB3	>109,000 ML/d	Anytime	10 days minimum	0.5 to 1 years in 10 (10% of years)	15 years	

PU7: Downstream Walgett to Boorooma

This planning unit includes the Barwon River from Walgett Weir (Darling River Weir No.11A) to Boorooma (just downstream of the confluence of the Macquarie River), the lower reaches of the Macquarie and Castlereagh rivers and adjacent floodplains. The Barwon River and tributaries in this planning unit flow unrestricted over a wide floodplain with few structural controls in the form of bedrock outcrops. The Barwon River remains tightly meandering with a complex channel morphology including many in-channel benches and off-channel anabranches, billabongs and distributary channels (Thoms et al. 1996; Brennan et al. 2002; NSW DPI 2018). The majority (86%) of anabranches and billabong wetlands in the broader reach of Collarenebri to Brewarina (planning units 5-8) are connected at flows of 9000-32,000 ML/d (Brennan et al. 2002). A small proportion (6%) connect at lower flows of 2000-5000 ML/d and 8% connect at 38,000-40,000 ML/d.

Tributaries entering this reach of the Barwon River include The Big Warrambool and the Macquarie River. Anabranches include Wanourie and Womat creeks, which leave the Barwon River and re-connect via the Castlereagh and Macquarie Rivers.

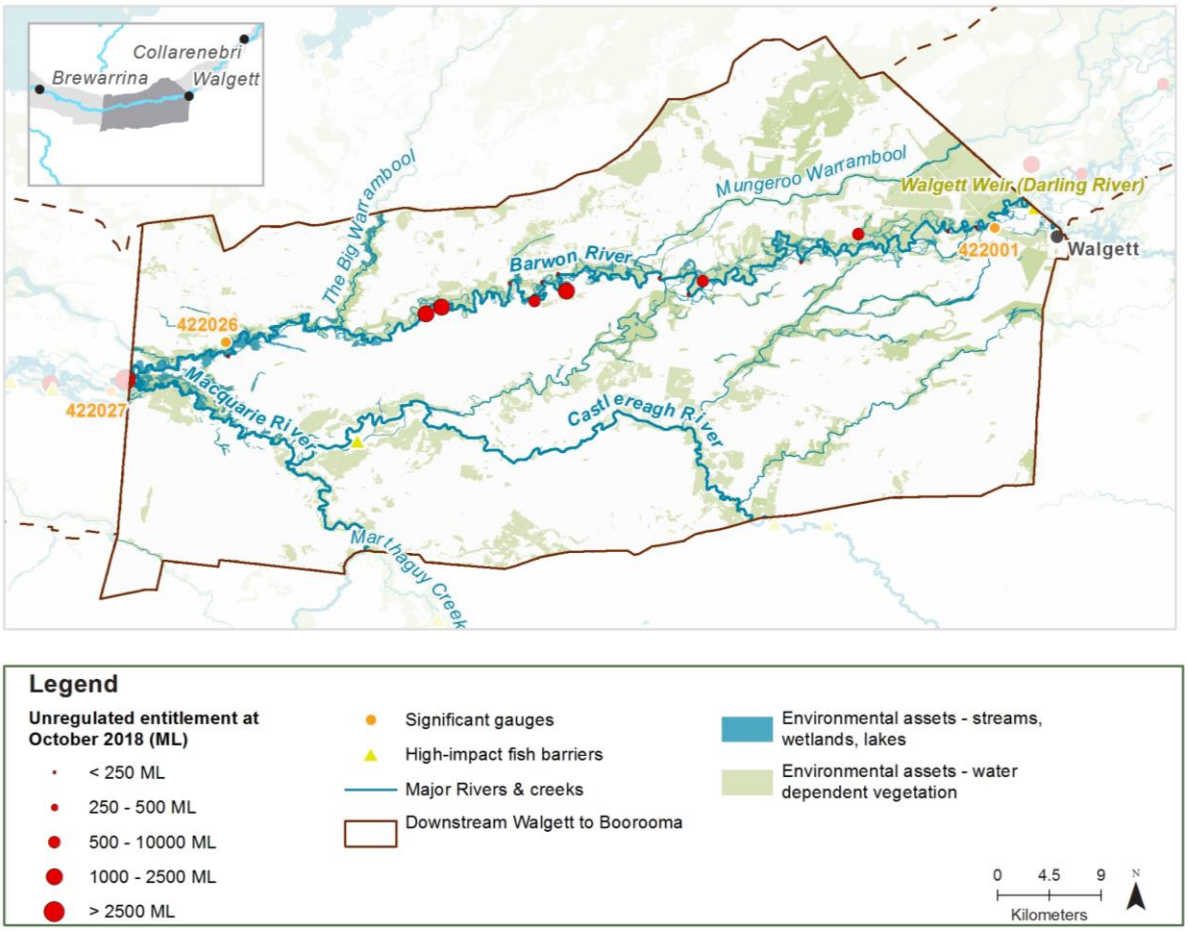


Figure 8 **Map of Downstream Walgett to Boorooma planning unit**
Area outside of planning unit has been faded. Significant gauge relevant to the planning unit is Barwon River at Boorooma (422026).

Key ecological values (CE = Critically Endangered, E = Endangered, V = Vulnerable, EP= Endangered Population in MDB, C = CAMBA, J = JAMBA, R = ROKAMBA, X = species recorded in this planning unit via catch records & or Australian Museum Records where they exist, Y = species expected to occur based on MaxEnt modelling)			
Native fish	• Unspecked hardyhead [Y] • Carp gudgeon [X+Y] • Murray–Darling rainbowfish [X+Y]	• Bony herring [X+Y] • Australian smelt [Y] • Spangled perch [X+Y] • Golden perch [X+Y]	• Hyrtl's tandan [X] • Silver perch (V) [X+Y] • Murray cod (V) [X+Y] • Olive perchlet [Y]
Waterbirds	27 waterbird species recorded including Australian gull-billed tern (C), freckled duck (V) & marsh sandpiper (CJK)		
Native vegetation	• River red gum 4906 ha • Black box 66,445 ha • Coolibah 34,158 ha	• Floodplain 23,078 ha • Lignum 1573 ha • Non-woody wetland 1890 ha	
Registered water-dependent cultural assets	• Artefacts • Hearths • Burials	• Ceremonial ring • Earth mound • Modified trees	
	It is acknowledged that other Aboriginal values such as sites, objects, landscapes, resources & beliefs that are important to Aboriginal people as part of their continuing culture may be present but not registered.		

Hydrology

Hydrological alteration See Table 1 for key	**River reach**	**CtF**	**Low flow & baseflow**	**Freshes**	**High & infrequent flows**		
					1.5ARI	**2.5ARI**	**5ARI**
	Walgett to Brewarrina	L^0	M^-	M^-	M^-	M^-	M^-

Relevant rules from WSP			
	Current access rules: Users must cease-to-pump when the flow at the reference point is equal to or less than the flow rate specified below for each category of water access licence in the respective management zones.		
	Domestic & stock	0 ML/day	0 ML/day
	A class	600 ML/day	530 ML/day
	B class	900 ML/day	870 ML/day
	C class	900 ML/day	5500 ML/day
	Reference point	Barwon River at Dangar Bridge (gauge 422001)	Barwon River at Boorooma (gauge 422026)

There are 9 very small, 3 medium, & 3 large water access licences distributed throughout the planning unit. The total volume of unregulated entitlements for the planning unit is 7168 ML.

There is 8.5 ML of licensed domestic and stock entitlement in this planning unit.

# WAL (share component)	Very small (<250 ML)	Small (250-500 ML)	Medium (500-1000 ML)	Large (1000-2500 ML)	Very large (>2500 ML)
A Class	5	-	-	-	-
B Class	5	-	2	3	-
C Class	1	-	1	-	-

Recommended management strategies

MS1: Reduce extraction pressure on in-channel flows

- **1a:** Review existing cease-to-pump thresholds based on identified ecological requirements
- **1b:** Review access (commence-to-pump) thresholds for each flow class based on identified ecological requirements
- **1c:** Consider flow sharing mechanisms that would enable limits to extraction on a daily or event basis

MS2: Ensure that floodplain harvesting is regulated within the SDL and LTAAEL of the WRP.

MS3: A resumption of flow rule which restricts access to flows following an identified cease-to-flow event.

MS4a: Protect HEW and EWA inflows from tributary catchments and through the Barwon-Darling. **In draft for Gwydir and Macquarie WRPAs at time of writing.**

MS4b: Protect HEW held in Barwon-Darling

MS5: End-of-system flow requirements. **Applies from Border Rivers and Namoi WRPAs. Not applicable from Gwydir, Macquarie or Intersecting Streams WRPAs.**

MS6a: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending supplementary access. **Incorporated into NSW Border Rivers, Gwydir and Namoi WSPs.**

MS6b: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending B and C Class access. **Not statutory at the time of writing.**

MS7: Targeted purchase of water entitlements for the Barwon-Darling

MS8: Continue and refine temporary access restrictions such as through WMA s324 orders

Table 9 Environmental Water Requirements for the Walgett to Boorooma Planning Unit (Barwon River at Boorooma 422026)

Flow category and EWR code[12]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
Cease-to-flow	CtF	<1 ML/d	Anytime	Maximum duration: Typically, events should not persist for more than 10 days. In very dry years, events should not persist for more than 35 days	CtF events should occur in no more than 30% of years	NA	When managing water to restart flows, avoid harmful water quality impacts, such as de-oxygenation of refuge pools.
Very-low-flow	VLF	>95 ML/d	Anytime	In typical years, at least 350 days per year. In very dry years, at least 225 days per year.	Every year	In accordance with maximum duration of cease-to-flow events	Flows that provide replenishment volumes to refuge pools along the Barwon-Darling. Waterhole persistence can also be supported by groundwater.
Baseflows	BF1	>350 ML/d	Anytime	In typical years, at least 285 days per year. In very dry years, at least 130 days per year.	Every year	125 days	Aiming to provide a depth of 0.3 m to allow fish passage. Also to manage water quality, prevent destratification and reduce risk of blue-green algal blooms.
	BF2	>350 ML/d	September to March	In typical years, at least 180 days per year (within timing window). In very dry years, at least 75 days per year (within timing window).	Every year	185 days	Aiming to provide a depth of 0.3 m to allow fish passage.
Small fresh	SF1	>850 ML/d	Anytime – but ideally October to April	10 days minimum	Annual (100% of years)	1 year	Ideal timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod. Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish.

[12] Refer to Glossary for definitions of terms and explanatory text for EWRs

Flow category and EWR code[12]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
							Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form). Ideally shortly after LF2 for increased likelihood of successful recruitment of fish, productivity and dispersal.
	SF2	850-7,000 ML/d	September to April	14 days minimum	5–10 years in 10 (75% of years)	2 years	Timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod. Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish. Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form).
Large fresh	LF1	>7,000 ML/d	Anytime, but ideally July to September	15 days minimum	5–10 years in 10 (75% of years)	2 years	This flow in Jul to Sep will improve pre-spawning fish condition. Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form).
	LF2	>7,000 ML/d	October to April	15 days minimum	3–5 years in 10 (42% of years)	2 years	Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form). Temp preferably >17°C to maximise spawning outcomes.

Flow category and EWR code[12]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
							Ideally shortly before SF1.
Bankfull	BK1	>17,000 ML/d	Anytime	10 days minimum	5 in 10 years (50% of years)	4 years	
Overbank	OB1	>44,000 ML/d	Anytime	10 days minimum	2 to 4 years in 10 (30% of years)	5 years	Clustered events (i.e. multiple events over 2–3 years) will provide improved conditions for native vegetation recruitment. Multiple events in close proximity will also improve the condition of native veg communities.
	OB2	>68,000 ML/d	Anytime	10 days minimum	1 to 3 years in 10 (20% of years)	10 years	
	OB3	>107,000 ML/d	Anytime	10 days minimum	0.5 to 1 years in 10 (10% of years)	15 years	

PU8: Boorooma to Brewarrina

This planning unit includes the Barwon River from Boorooma (just downstream of the Macquarie River confluence) to Brewarrina. Similar to reaches downstream of Walgett, the Barwon River flows unrestricted over a wide floodplain with few structural controls in the form of bedrock outcrops. The river remains tightly meandering with a complex channel morphology including many in-channel benches and anabranches, billabongs and distributary channels (Thoms et al. 1996; Brennan et al. 2002; NSW DPI 2018). The majority (86%) of anabranches and billabong wetlands in the broader reach of Collarenebri to Brewarrina (planning units 5-8) are connected at flows of 9000-32,000 ML/d (Brennan et al. 2002). A small proportion (6%) connect at lower flows of 2000-5000 ML/d and 8% connect at 38,000-40,000 ML/d.

Brewarrina Weir and fishway (Darling River Weir No. 15) are located at the downstream end of the planning unit. The Barwon Channel offtake supplies the irrigation area at Narran Lake.

Marra Creek is the only tributary entering the Barwon River in the reach. The anabranch Cato Creek splits from the Barwon River downstream of the Barwon Channel offtake, returning downstream of Brewarrina. Tarrion Creek also splits off and connects back to the Barwon River via the Bogan River further downstream. Other anabranches include Briery Anabranch and Briery Water.

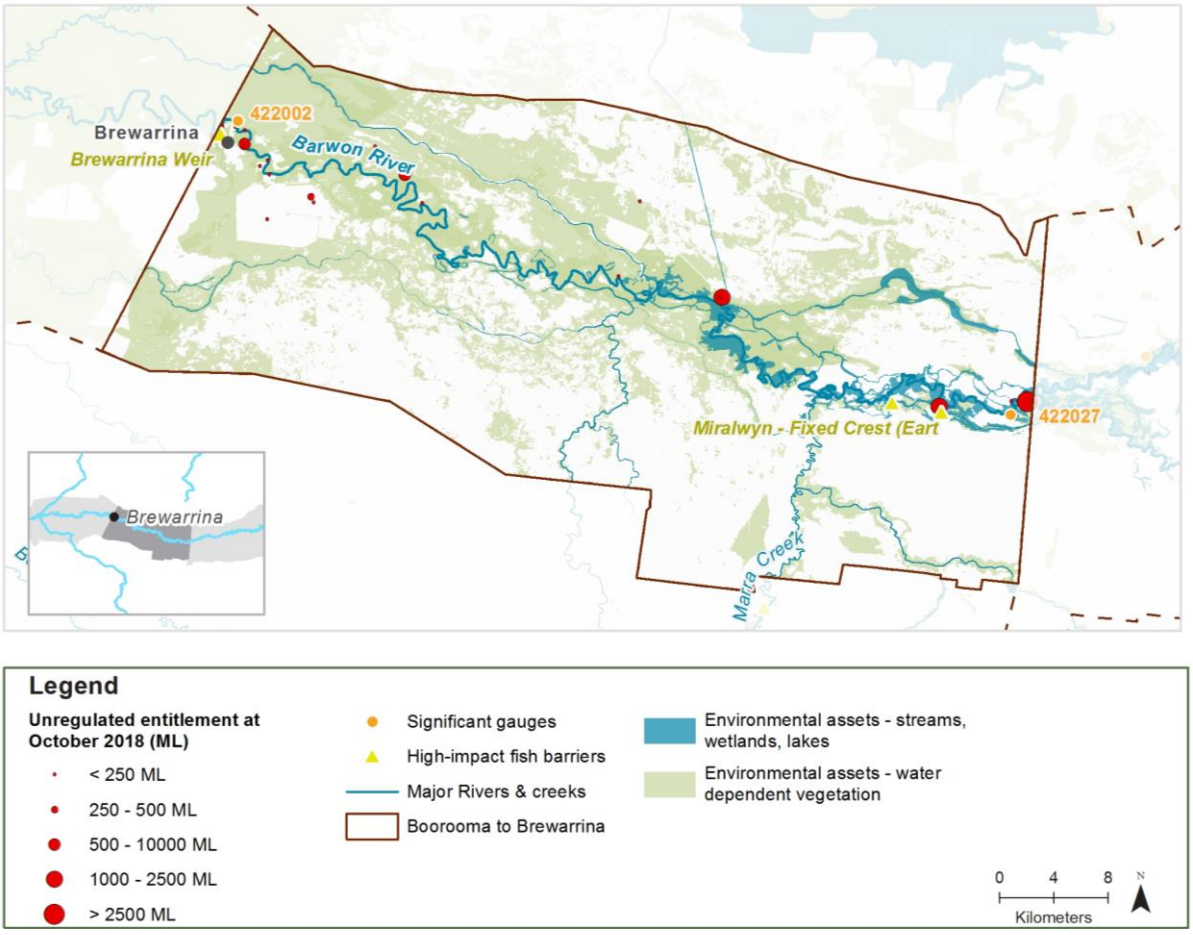


Figure 9 **Map of Boorooma to Brewarrina planning unit**
Area outside of planning unit has been faded. Significant gauge relevant to the planning unit is Barwon River at Geera (422027) and Barwon River at Brewarrina (422002)

Key ecological values (CE = Critically Endangered, E = Endangered, V = Vulnerable, EP= Endangered Population in MDB, C = CAMBA, J = JAMBA, R = ROKAMBA, X = species recorded in this planning unit via catch records & or Australian Museum Records where they exist, Y = species expected to occur based on MaxEnt modelling)			
Native fish	• Unspecked hardyhead [Y] • Carp gudgeon [X+Y] • Murray–Darling rainbowfish [X+Y]	• Bony herring [X+Y] • Australian smelt [X+Y] • Spangled perch [X+Y]	• Golden perch [X+Y] • Silver perch (V) [Y] • Murray cod (V) [X+Y] • Olive perchlet [Y]
Waterbirds	16 waterbird species recorded including Latham's snipe (JK)		
Native vegetation	• River red gum 2,832 ha • Black box 41,411 ha • Coolibah 47,602 ha	• Floodplain 24,199 ha • Lignum 1,235 ha • Non-woody wetland 155 ha	
Registered water-dependent cultural assets	• Ceremony & dreaming • Artefacts • Modified trees	• Fish trap • Shells • Habitation structure	
	It is acknowledged that other Aboriginal values such as sites, objects, landscapes, resources & beliefs that are important to Aboriginal people as part of their continuing culture may be present but not registered.		

Hydrology

Hydrological alteration	**River reach**	**CtF**	**Low flow & baseflow**	**Freshes**	**High & infrequent flows**		
					1.5ARI	**2.5ARI**	**5ARI**
See Table 1 for key	Walgett to Brewarrina	L^0	M^-	M^-	M^-	M^-	M^-
Relevant rules from WSP	**Current access rules:** Users must cease-to-pump when the flow at the reference point is equal to or less than the flow rate specified below for each category of water access licence in the respective management zones.						
	Domestic & stock	0 ML/day	0 ML/day				
	A class	530 ML/day	460 ML/day				
	B class	B class 870 ML/day	840 ML/day				
	C class	C class 870 ML/day	6800 ML/day				
	Reference point	Barwon River at Geera (gauge 422027)	Barwon River at Brewarrina (gauge 422002)				
	Amendment provision: The access rules for this management zone may be amended during the life of the plan should a study find that the rules have an adverse impact on the Aboriginal cultural value of the Brewarrina fish traps as specified in clause 78 of the plan.						

There are 10 very small, 1 small, 1 medium, 1 large & 3 very large water access licences distributed throughout the planning unit. The total volume of unregulated entitlements for the planning unit is 45,995.5 ML.

There is one small B Class HEW license in this planning unit and one 1000 ML local water utility access license in this planning unit. There is 671 ML of licensed domestic and stock entitlement in this planning unit.

# WAL (share component)	Very small (<250 ML)	Small (250-500 ML)	Medium (500-1000 ML)	Large (1000-2500 ML)	Very large (>2500 ML)
No flow class				***1 HEW (1488 ML)***[13]	
A Class	10	1	-	-	-
B Class	-	***1 HEW (323 ML)***	1	1	1 (9410 ML)
C Class	-	-	-	-	2 (5890, 26278 ML)

Recommended management strategies

MS1: Reduce extraction pressure on in-channel flows

- **1a:** Review existing cease-to-pump thresholds based on identified ecological requirements
- **1b:** Review access (commence-to-pump) thresholds for each flow class based on identified ecological requirements
- **1c:** Consider flow sharing mechanisms that would enable limits to extraction on a daily or event basis

MS2: Ensure that floodplain harvesting is regulated within the SDL and LTAAEL of the WRP.

MS3: A resumption of flow rule which restricts access to flows following an identified cease-to-flow event.

MS4a: Protect HEW and EWA inflows from tributary catchments and through the Barwon-Darling. **In draft for Gwydir and Macquarie WRPAs at time of writing.**

MS4b: Protect HEW held in Barwon-Darling

MS5: End-of-system flow requirements. **Applies from Border Rivers and Namoi WRPAs. Not applicable from Gwydir, Macquarie or Intersecting Streams WRPAs.**

MS6a: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending supplementary access. **Incorporated into NSW Border Rivers, Gwydir and Namoi WSPs.**

MS6b: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending B and C Class access. **Not statutory at the time of writing.**

MS7: Targeted purchase of water entitlements for the Barwon-Darling

MS8: Continue and refine temporary access restrictions such as through WMA s324 orders

[13] WAL#36273 is an environmental water license with no flow class and is shown in this planning unit for clarity.

Table 10 Environmental Water Requirements for the Boorooma to Brewarrina Planning Unit (Barwon River at Geera 422027)

Flow category and EWR code[14]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
Cease-to-flow	CtF	<1 ML/d	Can occur anytime of year, but more common October to March	Maximum duration: Typically, events should not persist for more than 5 days. In very dry years, events should not persist for more than 20 days	CtF events should occur in no more than 30% of years	NA	When managing water to restart flows, avoid harmful water quality impacts, such as de-oxygenation of refuge pools.
Very-low-flow	VLF	>110 ML/d	Anytime	In typical years, at least 335 days per year. In very dry years, at least 200 days per year.	Every year	In accordance with maximum duration of cease-to-flow events	Flows that provide replenishment volumes to refuge pools along the Barwon-Darling. Waterhole persistence can also be supported by groundwater.
Baseflows	BF1	>440 ML/d	Anytime	In typical years, at least 230 days per year. In very dry years, at least 90 days per year.	Every year	130 days	Aiming to provide a depth of 0.3 m to allow fish passage. Also to manage water quality, prevent destratification and reduce risk of blue-green algal blooms.
	BF2	>440 ML/d	September to March	In typical years, at least 135 days per year (within timing window). In very dry years, at least 45 days per year (within timing window).	Every year	215 days	Aiming to provide a depth of 0.3 m to allow fish passage.
Small fresh	SF1	>1000 ML/d	Anytime – but ideally October to April	10 days minimum	Annual (100% of years)	1 year	Ideal timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod.

[14] Refer to Glossary for definitions of terms and explanatory text for EWRs

Flow category and EWR code[14]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
							Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish. Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form). Ideally shortly after LF2 for increased likelihood of successful recruitment of fish, productivity and dispersal.
	SF2	1000-7,000 ML/d	September to April	14 days minimum	5–10 years in 10 (75% of years)	2 years	Timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod. Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish. Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form).
Large fresh	LF1	>7,000 ML/d	Anytime, but ideally July to September	15 days minimum	5–10 years in 10 (75% of years)	2 years	This flow in Jul to Sep will improve pre-spawning fish condition. Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form).
	LF2	>7,000 ML/d	October to April	15 days minimum	3–5 years in 10 (42% of years)	2 years	Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish.

Flow category and EWR code[14]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
							Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form). Temp preferably >17°C to maximise spawning outcomes. Ideally shortly before SF1.
Bankfull	BK1	>22,000 ML/d	Anytime	10 days minimum	5 in 10 years (50% of years)	4 years	
Overbank	OB1	>34,000 ML/d	Anytime	10 days minimum	2 to 4 years in 10 (30% of years)	5 years	Clustered events (i.e. multiple events over 2–3 years) will provide improved conditions for native vegetation recruitment. Multiple events in close proximity will also improve the condition of native veg communities.
	OB2	>43,000 ML/d	Anytime	10 days minimum	1 to 3 years in 10 (20% of years)	10 years	
	OB3	>107,000 ML/d	Anytime	10 days minimum	0.5 to 1 years in 10 (10% of years)	15 years	

Table 11 Environmental Water Requirements for the Boorooma to Brewarrina Planning Unit (Barwon River at Brewarrina 422002)

Flow category and EWR code[15]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
Cease-to-flow	CTF	<1 ML/d	Can occur anytime of year, but more common October to March	Maximum duration: Typically, events should not persist for more than 5 days. In very dry years, events should not persist for more than 20 days	CTF events should occur in no more than 20% of years	NA	When managing water to restart flows, avoid harmful water quality impacts, such as de-oxygenation of refuge pools.

[15] Refer to Glossary for definitions of terms and explanatory text for EWRs

Flow category and EWR code[15]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
Very-low-flow	VLF	>100 ML/d	Anytime	In typical years, at least 345 days per year. In very dry years, at least 185 days per year.	Every year	In accordance with maximum duration of cease-to-flow events	Flows that provide replenishment volumes to refuge pools along the Barwon-Darling. Waterhole persistence can also be supported by groundwater.
Baseflows	BF1	>500 ML/d	Anytime	In typical years, at least 275 days per year. In very dry years, at least 120 days per year.	Every year	130 days	Aiming to provide a depth of 0.3 m to allow fish passage. Also to manage water quality, prevent destratification and reduce risk of blue-green algal blooms.
	BF2	>500 ML/d	September to March	In typical years, at least 175 days per year (within timing window). In very dry years, at least 65 days per year (within timing window).	Every year	200 days	Aiming to provide a depth of 0.3 m to allow fish passage.
Small fresh	SF1	>1,000 ML/d	Anytime – but ideally October to April	10 days minimum	Annual (100% of years)	1 year	Ideal timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod. Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish. Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form). Ideally shortly after LF2 for increased likelihood of successful recruitment of fish, productivity and dispersal.
	SF2	1,000-9,000 ML/d	September to April	14 days minimum	5–10 years in 10 (75% of years)	2 years	Timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod.

Flow category and EWR code[15]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
							Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish. Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form).
Large fresh	LF1	>9,000 ML/d	Anytime, but ideally July to September	15 days minimum	5–10 years in 10 (75% of years)	2 years	This flow in Jul to Sep will improve pre-spawning fish condition. Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form).
	LF2	>9,000 ML/d	October to April	15 days minimum	3–5 years in 10 (42% of years)	2 years	Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form). Temp preferably >17°C to maximise spawning outcomes. Ideally shortly before SF1.
Bankfull	BK1	>26,000 ML/d	Anytime	10 days minimum	5 in 10 years (50% of years)	4 years	
Overbank	OB1	>38,000 ML/d	Anytime	10 days minimum	2 to 4 years in 10 (30% of years)	5 years	Clustered events (i.e. multiple events over 2–3 years) will provide improved conditions for native vegetation recruitment. Multiple events in close proximity
	OB2	>52,000 ML/d	Anytime	10 days minimum	1 to 3 years in 10 (20% of years)	10 years	

Flow category and EWR code[15]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
	OB3	>83,000 ML/d	Anytime	10 days minimum	0.5 to 1 years in 10 (10% of years)	15 years	will also improve the condition of native veg communities.

PU9: Brewarrina to Culgoa River Junction

This planning unit includes the Barwon River from Brewarrina to the Culgoa River junction, the downstream reaches of the Culgoa, Bogan and Bokhara rivers and associated floodplains. The planning unit has a similar geomorphology to planning units 7-8 (downstream of Walgett). The Barwon River and tributaries flow unrestricted over a wide floodplain with few structural controls in the form of bedrock outcrops. The Barwon River remains tightly meandering with a complex channel morphology including many in-channel benches and off-channel anabranches, billabongs and distributary channels (Thoms et al. 1996; Brennan et al. 2002; NSW DPI 2018). Billabongs are the predominant wetland type in the broader reach between Brewarrina and Bourke. Up to 86% of wetlands in the broader reach are inundated at flows of 9000-32,000 ML/d, 6% are inundated at less than 4000 ML/d and 12% at higher flows of 47,000-60,000 ML/d (Brennan et al. 2002).

Tributaries entering this reach of the Barwon River include the Bokhara, Bogan and Culgoa rivers. Beemery fixed crest weir is located in the planning unit. The Brewarrina Aboriginal fish trap (Baiame's Ngunnhu - National Heritage listed) is located immediately downstream of Brewarrina Weir.

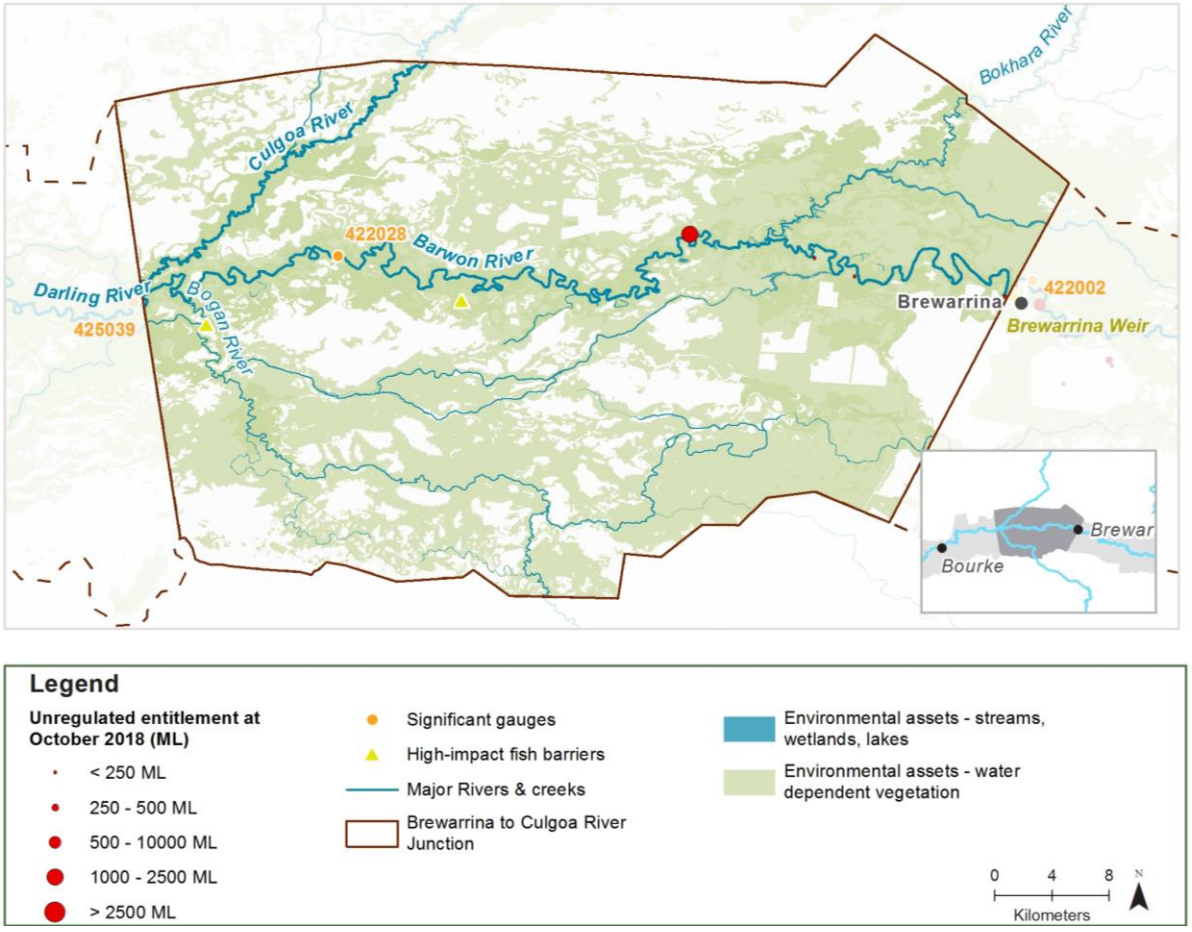


Figure 10 **Map of Brewarrina to Culgoa River Junction planning unit**
Area outside of planning unit has been faded. Significant gauges relevant to the planning unit are Barwon River at Beemery (422028).

Key ecological values (CE = Critically Endangered, E = Endangered, V = Vulnerable, EP= Endangered Population in MDB, C = CAMBA, J = JAMBA, R = ROKAMBA, X = species recorded in this planning unit via catch records & or Australian Museum Records where they exist, Y = species expected to occur based on MaxEnt modelling)			
Native fish	• Carp gudgeon X+Y • Murray–Darling rainbowfish X+Y • Bony herring X+Y	• Australian smelt X+Y • Spangled perch X+Y • Hyrtl's tandan X+Y	• Golden perch X+Y • Silver perch (V) X+Y • Murray cod (V) X+Y • Olive perchlet Y
Waterbirds	21 waterbird species recorded, including brolga (V) & common greenshank (C,J,K)		
Native vegetation	• River red gum 2721 ha • Black box 14,899 ha • Coolibah 80,044 ha	• Floodplain 39,058 ha • Lignum 3350 ha • Non-woody wetland 162 ha	
Registered water-dependent cultural assets	• Ceremony & dreaming • Modified trees	• Artefacts • Shells	
	It is acknowledged that other Aboriginal values such as sites, objects, landscapes, resources & beliefs that are important to Aboriginal people as part of their continuing culture may be present but not registered.		

Hydrology

Hydrological alteration	**River reach**	**CtF**	**Low flow & baseflow**	**Freshes**	**High & infrequent flows**		
					1.5ARI	**2.5ARI**	**5ARI**
See Table 1 for key	**Brewarrina to Bourke**	H-	L-	M-	M-	M-	M-
Relevant rules from WSP	**Current access rules:** Users must cease-to-pump when the flow at the reference point is equal to or less than the flow rate specified below for each category of water access licence in the respective management zones.						
	Domestic & stock	0 ML/day		0 ML/day			
	A class	460 ML/day		400 ML/day			
	B class	840 ML/day		760 ML/day			
	C class	840 ML/day		8,250 ML/day			
	Reference point	Barwon River at Brewarrina (gauge 422002)		Barwon River at Beemery (gauge 422028)			
	Amendment provision: Once IDELs are established, the trading rules will be amended so that there are no restrictions on assignment of rights (share component) or nomination of works. Extraction component will not be permitted to be traded between sections.						

There are 3 very small, 1 large and 1 very large water access licences distributed throughout the planning unit. The total volume of unregulated entitlements for the planning unit is 14062.3 ML.

There is 7 ML of licensed domestic and stock entitlement in this planning unit.

# WAL (share component)	Very small (<250 ML)	Small (250-500 ML)	Medium (500-1000 ML)	Large (1000-2500 ML)	Very large (>2500 ML)
A Class	3	-	-	-	-
B Class	-	-	-	1	1 (11444 ML)
C Class	3	-	-	-	-

Recommended management strategies

MS1: Reduce extraction pressure on in-channel flows

1a: Review existing cease-to-pump thresholds based on identified ecological requirements

1b: Review access (commence-to-pump) thresholds for each flow class based on identified ecological requirements

1c: Consider flow sharing mechanisms that would enable limits to extraction on a daily or event basis

MS2: Ensure that floodplain harvesting is regulated within the SDL and LTAAEL of the WRP.

MS3: A resumption of flow rule which restricts access to flows following an identified cease-to-flow event.

MS4a: Protect HEW and EWA inflows from tributary catchments and through the Barwon-Darling. **In draft for Gwydir and Macquarie WRPAs at time of writing. Not yet applicable from Intersecting Streams (Bokhara and Culgoa Rivers) WRPA.**

MS4b: Protect HEW held in Barwon-Darling

MS5: End-of-system flow requirements. **Applies from Border Rivers and Namoi WRPAs. Not applicable from Gwydir, Macquarie or Intersecting Streams (Bokhara and Culgoa Rivers) WRPAs.**

MS6a: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending supplementary access. **Incorporated into NSW Border Rivers, Gwydir and Namoi WSPs.**

MS6b: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending B and C Class access. **Not statutory at the time of writing.**

MS7: Targeted purchase of water entitlements for the Barwon-Darling

MS8: Continue and refine temporary access restrictions such as through WMA s324 orders

Table 12 Environmental Water Requirements for the Brewarrina to Culgoa River Junction Planning Unit (Barwon River at Beemery 422028)

Flow category and EWR code[16]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
Cease-to-flow	CtF	<1 ML/d	Can occur anytime of year, but more common October to March	Maximum duration: Typically, events should not persist for more than 15 days. In very dry years, events should not persist for more than 45 days	CtF events should occur in no more than 20% of years	NA	When managing water to restart flows, avoid harmful water quality impacts, such as de-oxygenation of refuge pools.
Very-low-flow	VLF	>110 ML/d	Anytime	In typical years, at least 350 days per year. In very dry years, at least 190 days per year.	Every year	In accordance with maximum duration of cease-to-flow events	Flows that provide replenishment volumes to refuge pools along the Barwon-Darling. Waterhole persistence can also be supported by groundwater.
Baseflows	BF1	>500 ML/d	Anytime	In typical years, at least 285 days per year. In very dry years, at least 120 days per year.	Every year	140 days	Aiming to provide a depth of 0.3 m to allow fish passage. Also to manage water quality, prevent destratification and reduce risk of blue-green algal blooms.
	BF2	>500 ML/d	September to March	In typical years, at least 180 days per year (within timing window). In very dry years, at least 70 days per year (within timing window).	Every year	200 days	Aiming to provide a depth of 0.3 m to allow fish passage.
Small fresh	SF1	>1,200 ML/d	Anytime – but ideally October to April	10 days minimum	Annual (100% of years)	1 year	Ideal timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod. Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish. Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form). Ideally shortly after LF2 for increased likelihood of successful recruitment of fish, productivity and dispersal.

[16] Refer to Glossary for definitions of terms and explanatory text for EWRs

Flow category and EWR code[16]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
	SF2	1,200-12,000 ML/d	September to April	14 days minimum	5–10 years in 10 (75% of years)	2 years	Timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod. Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish. Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form).
Large fresh	LF1	>12,000 ML/d	Anytime, but ideally July to September	15 days minimum	5–10 years in 10 (75% of years)	2 years	This flow in Jul to Sep will improve pre-spawning fish condition. Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form).
	LF2	>12,000 ML/d	October to April	15 days minimum	3–5 years in 10 (42% of years)	2 years	Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form). Temp preferably >17°C to maximise spawning outcomes. Ideally shortly before SF1.
Bankfull	BK1	>27,000 ML/d	Anytime	15 days minimum	5 in 10 years (50% of years)	4 years	
Overbank	OB1	>42,000 ML/d	Anytime	15 days minimum	2 to 4 years in 10 (30% of years)	5 years	Clustered events (i.e. multiple events over 2–3 years) will provide improved conditions for native vegetation recruitment. Multiple events in close proximity will also improve the condition of native veg communities.
	OB2	>53,000 ML/d	Anytime	15 days minimum	1 to 3 years in 10 (20% of years)	10 years	
	OB3	>96,000 ML/d	Anytime	15 days minimum	0.5 to 1 years in 10 (10% of years)	15 years	

PU10: Culgoa River Junction to Bourke

The Darling River begins at the junction of the Barwon and Culgoa Rivers. This planning unit includes the Darling River from the Culgoa River junction to Bourke and the associated floodplain. The Little Bogan River, an anabranch that splits from the Bogan River upstream in planning unit 9, enters the Darling River at the downstream end of this planning unit. The planning unit has a similar geomorphology to planning units 7-9 (downstream of Walgett) where the Barwon-Darling River flows unrestricted over a wide floodplain with few structural controls in the form of bedrock outcrops. The River is meandering with a complex channel morphology including many in-channel benches and off-channel anabranches, billabongs and distributary channels (Thoms et al. 1996; Brennan et al. 2002; NSW DPI 2018).

Billabongs are the predominant wetland type in the broader reach between Brewarrina and Bourke (planning units 9-10). Up to 86% of wetlands in the broader reach are inundated at flows of 9000-32,000 ML/d, 6% are inundated at less than 4000 ML/d and 12% at higher flows of 47,000-60,000 ML/d (Brennan et al. 2002). Bourke Weir is a major barrier to fish movement with a drown out flow of approximately 10,000 ML/d (NSW DPI 2015). The town of Bourke has a population of approximately 1900 people[17].

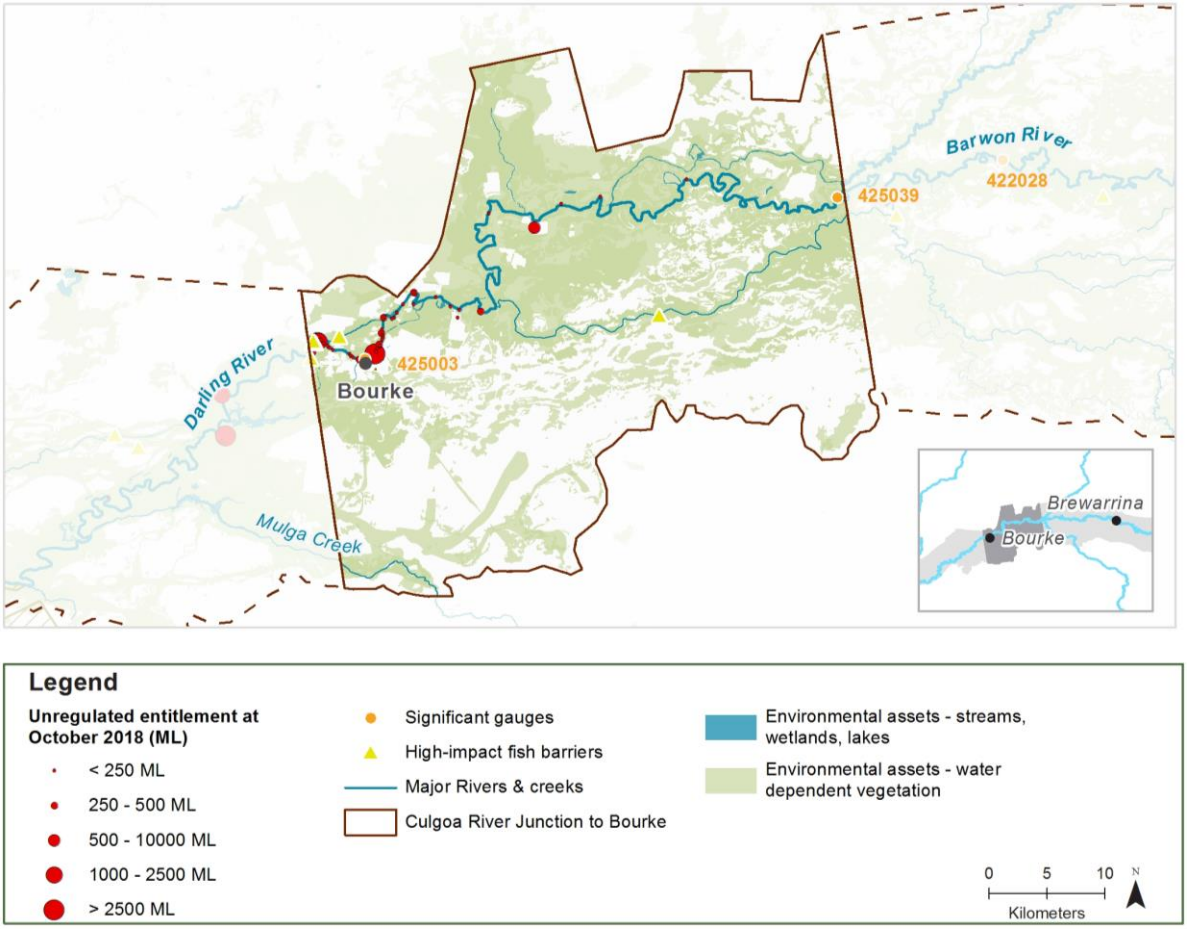


Figure 11 **Map of Culgoa River Junction to Bourke planning unit**
Area outside of planning unit has been faded. Significant gauge relevant to the planning unit is Darling River at Warraweena (425039) and Darling River at Bourke (425003).

[17] Australian Bureau of Statistics (2016 census) – population of Bourke at the locality scale (State Suburb (SSC) scale).

Key ecological values (CE = Critically Endangered, E = Endangered, V = Vulnerable, EP= Endangered Population in MDB, C = CAMBA, J = JAMBA, R = ROKAMBA, X = species recorded in this planning unit via catch records & or Australian Museum Records where they exist, Y = species expected to occur based on MaxEnt modelling)			
Native fish	• Unspecked hardyhead X+Y • Carp gudgeon X+Y • Murray–Darling rainbowfish X+Y	• Bony herring X+Y • Australian smelt X+Y • Spangled perch X+Y • Hyrtl's tandan X+Y	• Golden perch X+Y • Silver perch (V) X+Y • Murray cod (V) X+Y • Olive perchlet X+Y
Waterbirds	31 waterbird species recorded including Australian gull-billed tern (C), brolga (V), blue-billed duck (V), common greenshank (C,J,K), freckled duck (V) & sharp-tailed sandpiper (C,J,K)		
Native vegetation	• River red gum 1,743 ha • Black box 4,529 ha • Coolibah 51,058 ha	• Floodplain 43,352 ha • Lignum 7,202 ha • Non-woody wetland 224 ha	
Registered water-dependent cultural assets	• Ceremony & dreaming • Artefacts • Burials • Hearths Modified tree. It is acknowledged that other Aboriginal values such as sites, objects, landscapes, resources & beliefs that are important to Aboriginal people as part of their continuing culture may be present but not registered.	• Modified trees • Earth mounds • Shells	

Hydrology

Hydrological alteration	**River reach**	**CtF**	**Low flow & baseflow**	**Freshes**	**High & infrequent flows**		
					1.5ARI	**2.5ARI**	**5ARI**
See Table 1 for key	Brewarrina to Bourke	H-	L-	M-	M-	M-	M-

Relevant rules from WSP			
	Current access rules: Users must cease-to-pump when the flow at the reference point is equal to or less than the flow rate specified below for each category of water access licence in the respective management zones.		
	Domestic & stock	0 ML/day	0 ML/day
	A class	400 ML/day	350 ML/day
	B class	1330 ML/day	1250 ML/day
	C class	1330 ML/day	11,000 ML/day
	Reference point	Darling River at Warraweena (gauge 425029)	Darling River at Bourke (425003)

There are 42 very small, 3 small, 3 medium and 3 very large water access licence distributed throughout the planning unit. The total volume of unregulated entitlements for the planning unit is 55072.7 ML.

There is 3500 ML license for local water utility in this planning unit. There is 162.5 ML licensed domestic and stock entitlement in this planning unit.

# WAL (share component)	Very small (<250 ML)	Small (250-500 ML)	Medium (500-1000 ML)	Large (1000-2500 ML)	Very large (>2500 ML)
A Class	36	-	1	-	1 (4160 ML)
B Class	5	3	2	-	2 (13261, 33517 ML)
C Class	1	-	-	-	-

Recommended management strategies

MS1: Reduce extraction pressure on in-channel flows

1a: Review existing cease-to-pump thresholds based on identified ecological requirements

1b: Review access (commence-to-pump) thresholds for each flow class based on identified ecological requirements

1c: Consider flow sharing mechanisms that would enable limits to extraction on a daily or event basis

MS2: Ensure that floodplain harvesting is regulated within the SDL and LTAAEL of the WRP.

MS3: A resumption of flow rule which restricts access to flows following an identified cease-to-flow event.

MS4a: Protect HEW and EWA inflows from tributary catchments and through the Barwon-Darling. **In draft for Gwydir and Macquarie WRPAs at time of writing. Not yet applicable from Intersecting Streams (Bokhara and Culgoa Rivers) WRPA.**

MS4b: Protect HEW held in Barwon-Darling

MS5: End-of-system flow requirements. **Applies from Border Rivers and Namoi WRPAs. Not applicable from Gwydir, Macquarie or Intersecting Streams (Bokhara and Culgoa Rivers) WRPAs.**

MS6a: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending supplementary access. **Incorporated into NSW Border Rivers, Gwydir and Namoi WSPs.**

MS6b: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending B and C Class access. **Not statutory at the time of writing.**

MS7: Targeted purchase of water entitlements for the Barwon-Darling

MS8: Continue and refine temporary access restrictions such as through WMA s324 orders

Table 13 Environmental Water Requirements for the Culgoa River Junction to Bourke Planning Unit (Darling River at Warraweena 425039)

Flow category and EWR code[18]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
Cease-to-flow	CtF	<1 ML/d	Can occur anytime of year, but more common October to March	Maximum duration: Typically, events should not persist for more than 20 days. In very dry years, events should not persist for more than 90 days	CtF events should occur in no more than 20% of years	NA	When managing water to restart flows, avoid harmful water quality impacts, such as de-oxygenation of refuge pools.
Very-low-flow	VLF	>115 ML/d	Anytime	In typical years, at least 325 days per year. In very dry years, at least 170 days per year.	Every year	In accordance with maximum duration of cease-to-flow events	Flows that provide replenishment volumes to refuge pools along the Barwon-Darling. Waterhole persistence can also be supported by groundwater.
Baseflows	BF1	>550 ML/d	Anytime	In typical years, at least 270 days per year. In very dry years, at least 120 days per year.	Every year	135 days	Aiming to provide a depth of 0.3 m to allow fish passage. Also to manage water quality, prevent destratification and reduce risk of blue-green algal blooms.
	BF2	>550 ML/d	September to March	In typical years, at least 170 days per year (within timing window). In very dry years, at least 65 days per year (within timing window).	Every year	210 days	Aiming to provide a depth of 0.3 m to allow fish passage.
Small fresh	SF1	>1,500 ML/d	Anytime – but ideally October to April	10 days minimum	Annual (100% of years)	1 year	Ideal timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod.

[18] Refer to Glossary for definitions of terms and explanatory text for EWRs

Flow category and EWR code[18]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
							Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish. Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form). Ideally shortly after LF2 for increased likelihood of successful recruitment of fish, productivity and dispersal.
	SF2	1,500-15,000 ML/d	September to April	14 days minimum	5–10 years in 10 (75% of years)	2 years	Timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod. Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish. Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form).
Large fresh	LF1	>15,000 ML/d	Anytime, but ideally July to September	15 days minimum	5–10 years in 10 (75% of years)	2 years	This flow in Jul to Sep will improve pre-spawning fish condition. Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form).

Flow category and EWR code[18]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
	LF2	>15,000 ML/d	October to April	15 days minimum	3–5 years in 10 (42% of years)	2 years	Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form). Temp preferably >17°C to maximise spawning outcomes. Ideally shortly before SF1.
Bankfull	BK1	>30,000 ML/d	Anytime	15 days minimum	5 in 10 years (50% of years)	4 years	
Overbank	OB1	>51,000 ML/d	Anytime	15 days minimum	2 to 4 years in 10 (30% of years)	5 years	Clustered events (i.e. multiple events over 2–3 years) will provide improved conditions for native vegetation recruitment. Multiple events in close proximity will also improve the condition of native veg communities.
	OB2	>62,000 ML/d	Anytime	15 days minimum	1 to 3 years in 10 (20% of years)	10 years	
	OB3	>130,000 ML/d	Anytime	15 days minimum	0.5 to 1 years in 10 (10% of years)	15 years	

Table 14 Environmental Water Requirements for the Culgoa River Junction to Bourke Planning Unit (Darling River at Bourke 425003)

Flow category and EWR code[19]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
Cease-to-flow	CtF	<1 ML/d	Can occur anytime of year, but more common October to March	Maximum duration: Typically, events should not persist for more than 20 days. In very dry years, events should not persist for more than 100 days	CtF events should occur in no more than 40% of years	NA	When managing water to restart flows, avoid harmful water quality impacts, such as de-oxygenation of refuge pools.
Very-low-flow	VLF	>105 ML/d	Anytime	In typical years, at least 325 days per year. In very dry years, at least 170 days per year.	Every year	In accordance with maximum duration of cease-to-flow events	Flows that provide replenishment volumes to refuge pools along the Barwon-Darling. Waterhole persistence can also be supported by groundwater.
Baseflows	BF1	>500 ML/d	Anytime	In typical years, at least 275 days per year. In very dry years, at least 120 days per year.	Every year	140 days	Aiming to provide a depth of 0.3 m to allow fish passage. Also to manage water quality, prevent destratification and reduce risk of blue-green algal blooms.
	BF2	>500 ML/d	September to March	In typical years, at least 170 days per year (within timing window). In very dry years, at least 65 days per year (within timing window).	Every year	210 days	Aiming to provide a depth of 0.3 m to allow fish passage.
Small fresh	SF1	>1,550 ML/d	Anytime – but ideally October to April	10 days minimum	Annual (100% of years)	1 year	Ideal timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod. Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish.

[19] Refer to Glossary for definitions of terms and explanatory text for EWRs

Flow category and EWR code[19]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
							Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form). Ideally shortly after LF2 for increased likelihood of successful recruitment of fish, productivity and dispersal.
	SF2	1,550-15,000 ML/d	September to April	14 days minimum	5–10 years in 10 (75% of years)	2 years	Timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod. Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish. Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form).
Large fresh	LF1	>15,000 ML/d	Anytime, but ideally July to September	15 days minimum	5–10 years in 10 (75% of years)	2 years	This flow in Jul to Sep will improve pre-spawning fish condition. Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form).
	LF2	>15,000 ML/d	October to April	15 days minimum	3–5 years in 10 (42% of years)	2 years	Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form).

Flow category and EWR code[19]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
							Temp preferably >17°C to maximise spawning outcomes. Ideally shortly before SF1.
Bankfull	BK1	>30,000 ML/d	Anytime	15 days minimum	5 in 10 years (50% of years)	4 years	
Overbank	OB1	>50,000 ML/d	Anytime	15 days minimum	2 to 4 years in 10 (30% of years)	5 years	Clustered events (i.e. multiple events over 2–3 years) will provide improved conditions for native vegetation recruitment. Multiple events in close proximity will also improve the condition of native veg communities.
	OB2	>62,000 ML/d	Anytime	15 days minimum	1 to 3 years in 10 (20% of years)	10 years	
	OB3	>129,000 ML/d	Anytime	15 days minimum	0.5 to 1 years in 10 (10% of years)	15 years	

PU11: Bourke to Louth

This planning unit includes the Darling River between the town of Bourke and Louth Weir, the lower reaches of the Warrego River which enters the Darling River in the planning unit, and associated floodplains. There is a distinct change in channel morphology downstream of Bourke. The floodplain narrows as it becomes constrained by the Darling structural lineament, which controls the path of the River to Menindee. The Darling River channel is deeply incised, has many bedrock outcrops and fewer benches than upstream (Thoms et al. 1996).

There are many anabranches and wetlands, which are predominantly billabongs with a smaller number of deflation basins (lakes and swamps) and wetlands associated with distributary channels (Thoms et al. 1996; Brennan et al. 2002). The majority (77%) of wetlands and anabranches in the broader reach between Bourke to Tilpa commence to fill at below bankfull flows of 14,000-50,000 ML/d, while 17% fill at higher flows of 59,000-82,000 ML/d.

Other than the Warrego River, there are three smaller tributaries: Humes, Yanda and Kerrigundi creeks entering the Darling River in the planning unit. There are three weirs, including Darling River weirs 19A and 20A, and Louth Weir (Darling River 21) at the downstream end. The Upper Darling Salt Interception Scheme is located downstream of Weir 19A and a major irrigation offtake just downstream of Bourke supplies the Bourke Irrigation Area.

Toorale National Park is located on the Warrego River floodplain near the Darling River junction. Other notable wetlands include Orange Tree Lagoon near Bourke.

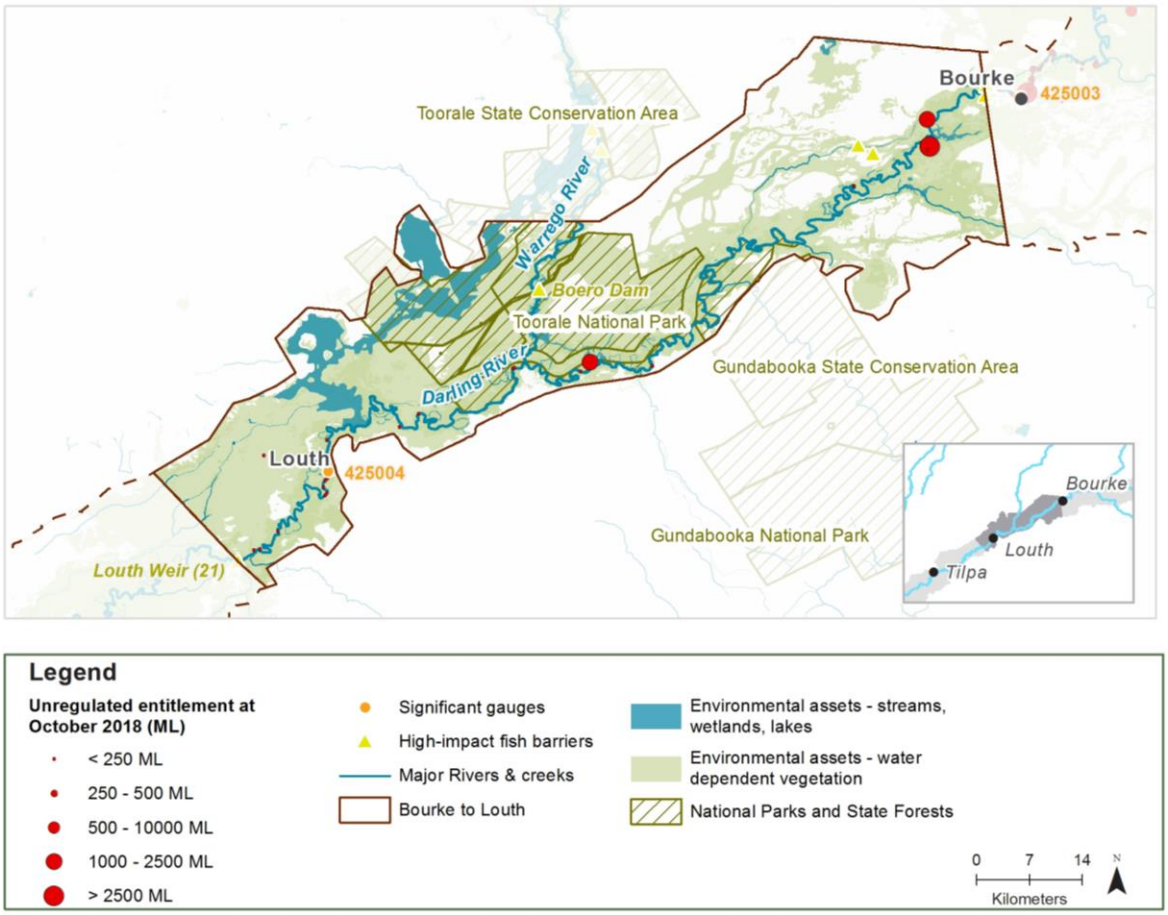


Figure 12 **Map of Bourke to Louth planning unit**
Area outside of planning unit has been faded. Significant gauges relevant to the planning unit are Darling River at Louth (425004).

Key water-dependent values (CE = Critically Endangered, E = Endangered, V = Vulnerable, EP= Endangered Population in MDB, C = CAMBA, J = JAMBA, R = ROKAMBA, X = species recorded in this planning unit via catch records & or Australian Museum Records where they exist, Y = species expected to occur based on MaxEnt modelling)	
Native fish	• Unspecked hardyhead X+Y • Carp gudgeon X+Y • Murray–Darling rainbowfish X+Y • Bony herring X+Y • Australian smelt X+Y • Spangled perch X+Y • Hyrtl's tandan X+Y • Golden perch X+Y • Silver perch (V) X+Y • Murray cod (V) X+Y • Olive perchlet Y
Waterbirds	51 waterbird species recorded including Australian gull-billed tern (C), blue-billed duck (V), black-necked stork (E), brolga (V), Caspian tern (J), common greenshank (C,J,K), freckled duck (V), oriental pratincole (C,J,K) & sharp-tailed sandpiper (C,J,K)
Native vegetation	• River red gum 4,353 ha • Black box 922 ha • Coolibah 59,533 ha • Floodplain 118,508 ha • Lignum 12,107 ha • Non-woody wetland 8 ha
Registered water-dependent cultural assets	• Ceremony & dreaming • Artefacts • Stone quarry • Modified trees • Aboriginal resource & gathering • Hearths • Shells • Habitation structures • Earth mounds • Fish trap • Stone arrangement • Waterhole • Burials
	It is acknowledged that other Aboriginal values such as sites, objects, landscapes, resources & beliefs that are important to Aboriginal people as part of their continuing culture may be present but not registered.

Hydrology

Hydrological alteration	**River reach**	**CtF**	**Low flow & baseflow**	**Freshes**	**High & infrequent flows**		
					1.5ARI	**2.5ARI**	**5ARI**
See Table 1 for key	Bourke to Louth	H-	M-	M-	M-	M-	M-

Relevant rules from WSP

Current access rules: Users must cease-to-pump when the flow at the reference point is equal to or less than the flow rate specified below for each category of water access licence in the respective management zones.

Domestic & stock	0 ML/day	0 ML/day
A class	350 ML/day	260 ML/day
B class	1,250 ML/day	1,130 ML/day
C class	1,250 ML/day	11,150 ML/day
Reference point	Darling River at Bourke Town (gauge 425003)	Darling River at Louth (gauge 425004)

Amendment provision: Once IDELs are established, the trading rules will be amended so that there are no restrictions on assignment of rights (share component) or nomination of works. Extraction component will not be permitted to be traded between sections.

There are numerous very small licenses and 3 large or very large B Class irrigation licenses in the planning unit. The total volume of unregulated irrigation entitlements for the planning unit is 11637.2 ML.

There are two very small A class HEW license in this planning unit, with a total volume of 73 ML. There are two large B Class licenses in this planning unit with a total volume of 2754 ML. There is one very large C Class HEW license of 5535 ML.

This planning unit has a 25 ML local water utility license and 17 ML licensed domestic and stock entitlement.

# WAL (share component)	Very small (<250 ML)	Small (250-500 ML)	Medium (500-1000 ML)	Large (1000-2500 ML)	Very large (>2500 ML)
A Class	14 and ***2 HEW (51, 22 ML)***	-	-	-	-
B Class	1	-	-	1 and ***2 HEW (1566, 1188 ML)***	2 (2781, 6519 ML)
C Class	2	-	-	-	***1 HEW (5535 ML)***

Recommended management strategies

MS1: Reduce extraction pressure on in-channel flows

1a: Review existing cease-to-pump thresholds based on identified ecological requirements

1b: Review access (commence-to-pump) thresholds for each flow class based on identified ecological requirements

1c: Consider flow sharing mechanisms that would enable limits to extraction on a daily or event basis

MS2: Ensure that floodplain harvesting is regulated within the SDL and LTAAEL of the WRP.

MS3: A resumption of flow rule which restricts access to flows following an identified cease-to-flow event.

MS4a: Protect HEW and EWA inflows from tributary catchments and through the Barwon-Darling

MS4b: Protect HEW held in Barwon-Darling

MS5: End-of-system flow requirements. **Applies from Border Rivers and Namoi WRPAs. Not applicable from Gwydir, Macquarie or Intersecting Streams (Warrego River) WRPAs.**

MS6a: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending supplementary access. **Incorporated into NSW Border Rivers, Gwydir and Namoi WSPs.**

MS6b: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending B and C Class access. **Not statutory at the time of writing.**

MS7: Targeted purchase of water entitlements for the Barwon-Darling

MS8: Continue and refine temporary access restrictions such as through WMA s324 orders

Table 15 Environmental Water Requirements for the Bourke to Louth Planning Unit (Darling River at Louth 425004)

Flow category and EWR code[20]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
Cease-to-flow	CtF	<1 ML/d	Can occur anytime of year, but more common October to March	Maximum duration: Typically, events should not persist for more than 20 days. In very dry years, events should not persist for more than 110 days	CtF events should occur in no more than 45% of years	NA	When managing water to restart flows, avoid harmful water quality impacts, such as de-oxygenation of refuge pools.
Very-low-flow	VLF	>70 ML/d	Anytime	In typical years, at least 330 days per year. In very dry years, at least 170 days per year.	Every year	In accordance with maximum duration of cease-to-flow events	Flows that provide replenishment volumes to refuge pools along the Barwon-Darling. Waterhole persistence can also be supported by groundwater.
Baseflows	BF1	>450 ML/d	Anytime	In typical years, at least 280 days per year. In very dry years, at least 125 days per year.	Every year	145 days	Aiming to provide a depth of 0.3 m to allow fish passage. Also to manage water quality, prevent destratification and reduce risk of blue-green algal blooms.
	BF2	>450 ML/d	September to March	In typical years, at least 175 days per year (within timing window). In very dry years, at least 65 days per year (within timing window).	Every year	210 days	Aiming to provide a depth of 0.3 m to allow fish passage.
Small fresh	SF1	>1,500 ML/d	Anytime – but ideally October to April	10 days minimum	Annual (100% of years)	1 year	Ideal timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod. Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish.

[20] Refer to Glossary for definitions of terms and explanatory text for EWRs

Flow category and EWR code[20]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
							Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form). Ideally shortly after LF2 for increased likelihood of successful recruitment of fish, productivity and dispersal.
	SF2	1,500-15,000 ML/d	September to April	14 days minimum	5–10 years in 10 (75% of years)	2 years	Timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod. Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish. Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form).
Large fresh	LF1	>15,000 ML/d	Anytime, but ideally July to September	15 days minimum	5–10 years in 10 (75% of years)	2 years	This flow in Jul to Sep will improve pre-spawning fish condition. Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form).
	LF2	>15,000 ML/d	October to April	15 days minimum	3–5 years in 10 (42% of years)	2 years	Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form). Temp preferably >17°C to maximise spawning outcomes.

Flow category and EWR code[20]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
							Ideally shortly before SF1.
Bankfull	BK1	>30,000 ML/d	Anytime	15 days minimum	5 in 10 years (50% of years)	4 years	
Overbank	OB1	>44,000 ML/d	Anytime	15 days minimum	2 to 4 years in 10 (30% of years)	5 years	Clustered events (i.e. multiple events over 2–3 years) will provide improved conditions for native vegetation recruitment. Multiple events in close proximity will also improve the condition of native veg communities.
	OB2	>57,000 ML/d	Anytime	15 days minimum	1 to 3 years in 10 (20% of years)	10 years	
	OB3	>125,000 ML/d	Anytime	15 days minimum	0.5 to 1 years in 10 (10% of years)	15 years	

PU12: Louth to Tilpa

This planning unit includes the Darling River from downstream of Louth Weir (Darling River Weir No.21) to Tilpa Weir (Darling River Weir No.24) and the adjacent floodplain. Several anabranches and distributary channels occur on the floodplain including Monday Creek, Talyawalka Creek, One Tree Creek, Compodore Creek, Stony Creek and Acres Billabong.

The Darling River is structurally controlled in the broader reach between Bourke and Menindee (planning units 11-13). It is deeply incised, has many bedrock outcrops and fewer benches than upstream of Bourke (Thoms et al. 1996).

Similar to planning unit 11 upstream, billabongs are the dominant wetland type with a smaller number of deflation basins (lakes and swamps) and wetlands associated with distributary channels (Thoms et al. 1996; Brennan et al. 2002). The majority (77%) of wetlands and anabranches in the broader reach between Bourke to Tilpa commence to fill at flows of 14,000-50,000 ML/d, while 17% fill at higher flows of 59,000-82,000 ML/d (Brennan et al. 2002).

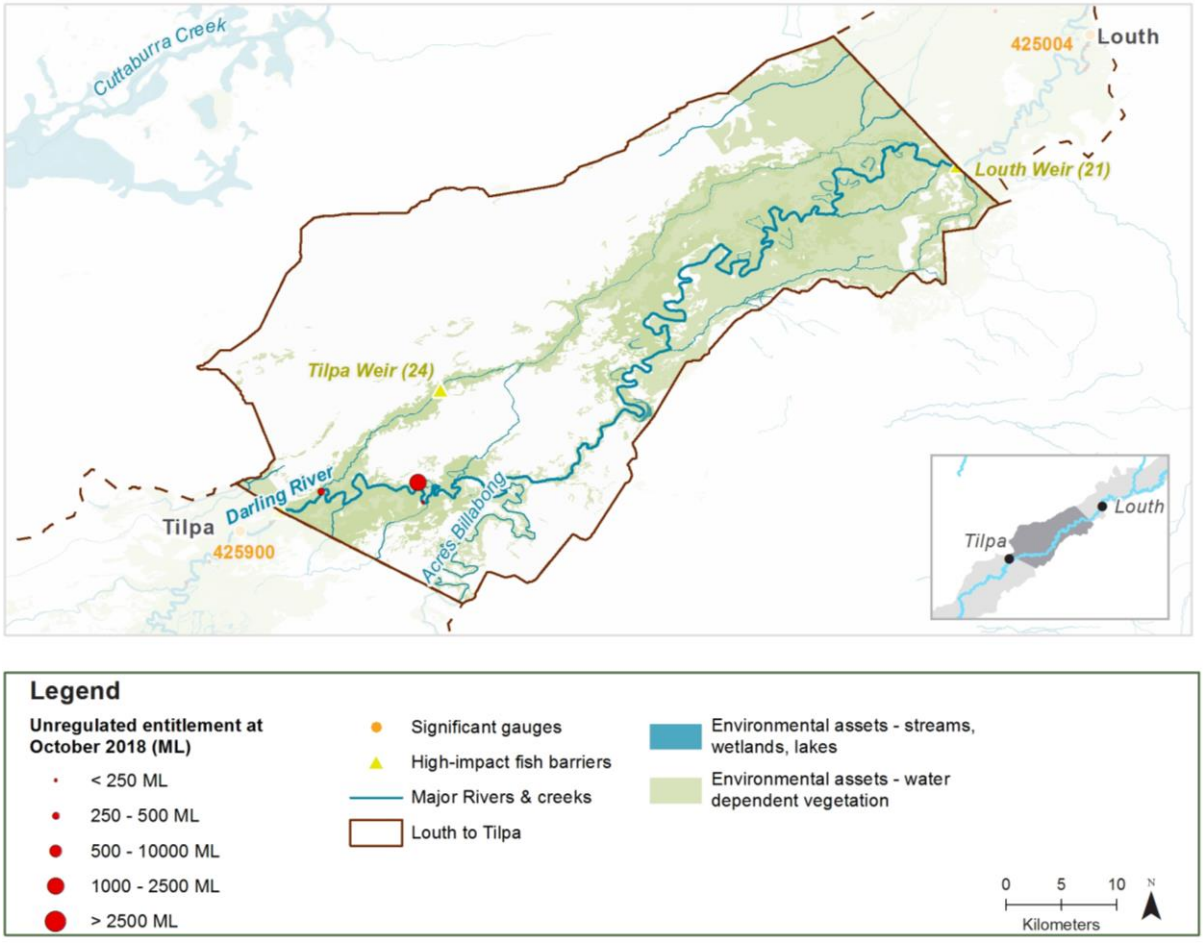


Figure 13 **Map of Louth to Tilpa planning unit**
Area outside of planning unit has been faded. Significant gauges relevant to the planning unit are Darling River at Tilpa (425900).

Key water-dependent values (CE = Critically Endangered, E = Endangered, V = Vulnerable, EP= Endangered Population in MDB, C = CAMBA, J = JAMBA, R = ROKAMBA X = species recorded in this planning unit via catch records & or Australian Museum Records where they exist, Y = species expected to occur based on MaxEnt modelling)			
Native fish	• Unspecked hardyhead [Y] • Carp gudgeon [X+Y] • Murray–Darling rainbowfish [Y]	• Australian smelt [X+Y] • Spangled perch [X+Y] • Hyrtl's tandan [Y] • Bony herring [X+Y] • Golden perch [X+Y]	• Silver perch (V) [X+Y] • Murray cod (V) [X+Y] • Freshwater catfish (E) [X+Y] • Olive perchlet [Y]
Waterbirds	22 waterbird species recorded including brolga (V) & Australian gull-billed tern (C)		
Native vegetation	• River red gum 2245 ha • Black box 2405 ha • Coolibah 33,046 ha	• Floodplain 81,489 ha • Lignum 1279 ha • Non-woody wetland 2487 ha	
Registered water-dependent cultural assets	N/A It is acknowledged that other Aboriginal values such as sites, objects, landscapes, resources & beliefs that are important to Aboriginal people as part of their continuing culture may be present but not registered.		

Hydrology

Hydrological alteration	**River reach**	**CtF**	**Low flow & baseflow**	**Freshes**	**High & infrequent flows**		
					1.5ARI	**2.5ARI**	**5ARI**
See Table 1 for key	Louth to Menindee	H$^-$	M$^-$	M$^-$	M$^-$	L$^-$	L$^-$

Relevant rules from WSP

Current access rules: Users must cease-to-pump when the flow at the reference point is equal to or less than the flow rate specified below for each category of water access licence in the respective management zones.

Domestic & stock	0 ML/day	0 ML/day
A class	260 ML/day	215 ML/day
B class	1,130 ML/day	1,010 ML/day
C class	1,130 ML/day	11,000 ML/day
Reference point	Darling River at Louth (gauge 425004)	Darling River at Tilpa (gauge 425900)

There is 1 very small, 1 small and 1 large water access licence in this planning unit. The total volume of unregulated irrigation entitlements for the water source is 860 ML. All this entitlement is allocated for irrigation (rather than stock & domestic or town water supply).

# WAL (share component)	Very small (<250 ML)	Small (250-500 ML)	Medium (500-1000 ML)	Large (1000-2500 ML)	Very large (>2500 ML)
A Class	1	-	-	-	-
B Class	1	-	1	-	-
C Class	-	-	-	-	-

Recommended management strategies

MS1: Reduce extraction pressure on in-channel flows

1a: Review existing cease-to-pump thresholds based on identified ecological requirements

1b: Review access (commence-to-pump) thresholds for each flow class based on identified ecological requirements

1c: Consider flow sharing mechanisms that would enable limits to extraction on a daily or event basis

MS2: Ensure that floodplain harvesting is regulated within the SDL and LTAAEL of the WRP.

MS3: A resumption of flow rule which restricts access to flows following an identified cease-to-flow event.

MS4a: Protect HEW and EWA inflows from tributary catchments and through the Barwon-Darling

MS4b: Protect HEW held in Barwon-Darling

MS5: End-of-system flow requirements. **Applies from Border Rivers and Namoi WRPAs. Not applicable from Gwydir, Macquarie or Intersecting Streams WRPAs.**

MS6a: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending supplementary access. **Incorporated into NSW Border Rivers, Gwydir and Namoi WSPs.**

MS6b: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending B and C Class access. **Not statutory at the time of writing.**

MS7: Targeted purchase of water entitlements for the Barwon-Darling

MS8: Continue and refine temporary access restrictions such as through WMA s324 orders

Table 16 Environmental Water Requirements for the Louth to Tilpa Planning Unit (Darling River at Tilpa 425900)

Flow category and EWR code[21]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
Cease-to-flow	CtF	<1 ML/d	Can occur anytime of year, but more common October to March	Maximum duration: Typically, events should not persist for more than 25 days. In very dry years, events should not persist for more than 135 days	CtF events should occur in no more than 50% of years	NA	When managing water to restart flows, avoid harmful water quality impacts, such as de-oxygenation of refuge pools.
Very-low-flow	VLF	>60 ML/d	Anytime	In typical years, at least 330 days per year. In very dry years, at least 170 days per year.	Every year	In accordance with maximum duration of cease-to-flow events	Flows that provide replenishment volumes to refuge pools along the Barwon-Darling. Waterhole persistence can also be supported by groundwater.
Baseflows	BF1	>400 ML/d	Anytime	In typical years, at least 280 days per year. In very dry years, at least 130 days per year.	Every year	145 days	Aiming to provide a depth of 0.3 m to allow fish passage. Also to manage water quality, prevent destratification and reduce risk of blue-green algal blooms.
	BF2	>400 ML/d	September to March	In typical years, at least 180 days per year (within timing window). In very dry years, at least 65 days per year (within timing window).	Every year	210 days	Aiming to provide a depth of 0.3 m to allow fish passage.
Small fresh	SF1	>1,450 ML/d	Anytime – but ideally October to April	10 days minimum	Annual (100% of years)	1 year	Ideal timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod.

[21] Refer to Glossary for definitions of terms and explanatory text for EWRs

Flow category and EWR code[21]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
							Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish. Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form). Ideally shortly after LF2 for increased likelihood of successful recruitment of fish, productivity and dispersal.
	SF2	1,450-14,500 ML/d	September to April	14 days minimum	5–10 years in 10 (75% of years)	2 years	Timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod. Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish. Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form).
Large fresh	LF1	>14,500 ML/d	Anytime, but ideally July to September	15 days minimum	5–10 years in 10 (75% of years)	2 years	This flow in Jul to Sep will improve pre-spawning fish condition. Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form).
	LF2	>14,500 ML/d	October to April	15 days minimum	3–5 years in 10 (42% of years)	2 years	Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish.

Flow category and EWR code[21]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
							Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form). Temp preferably >17°C to maximise spawning outcomes. Ideally shortly before SF1.
Bankfull	BK1	>28,000 ML/d	Anytime	15 days minimum	5 in 10 years (50% of years)	4 years	
Overbank	OB1	>41,000 ML/d	Anytime	15 days minimum	2 to 4 years in 10 (30% of years)	5 years	Clustered events (i.e. multiple events over 2–3 years) will provide improved conditions for native vegetation recruitment. Multiple events in close proximity will also improve the condition of native veg communities.
	OB2	>51,000 ML/d	Anytime	15 days minimum	1 to 3 years in 10 (20% of years)	10 years	
	OB3	>120,000 ML/d	Anytime	15 days minimum	0.5 to 1 years in 10 (10% of years)	15 years	

PU13: Tilpa to Wilcannia

This planning unit includes the Darling River downstream of Tilpa Weir (Darling River Weir No.24) to Wilcannia and the adjacent floodplain. The Wilcannia weir is also in this planning unit. The morphology of the Darling River is less structurally (bedrock) controlled than the reach immediately upstream (Bourke to Tilpa) and is more similar to the channel upstream of Bourke with many in-channel benches (Thoms et al. 2016).

There are several anabranches on the floodplain, including Acres Billabong, Boat Hole Creek, Marra Billabong, Jamieson Creek, Coopara Creek, Lake Creek, Twenty Seven Mile Creek and Talyawalka Creek; and many deflation basin lakes, including large ones like Poopelloe and Wongalara. Other common wetland types are billabongs and wetlands associated with distributary channels.

Approximately half (53%) of all wetlands, lakes and anabranches commence to fill at flows of 29,000-35,000 ML/d, while 23% fill at lower flows of 8000-26,000 ML/d and the remaining 23% at higher flows above 37,000 ML/d (8% of these above 46,000 ML/d) (Brennan et al. 2002). The Paroo-Darling State Conservation Area is located on the floodplain and includes parts of Poopelloe and Wongalara lakes.

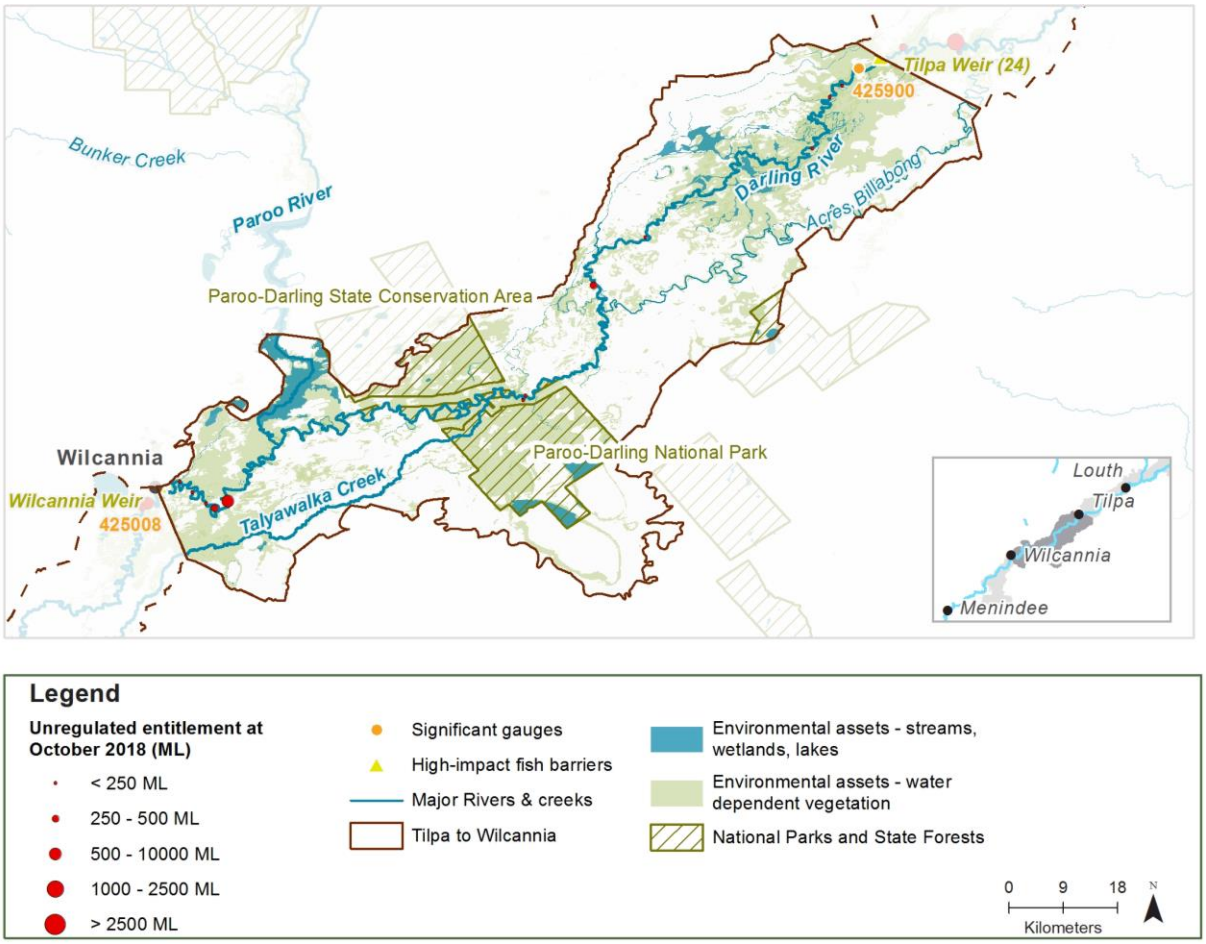


Figure 14 **Map of Tilpa to Wilcannia planning unit**
Area outside of planning unit has been faded. Significant gauge relevant to the planning unit is Darling River at Wilcannia (425008).

Key water-dependent values (CE = Critically Endangered, E = Endangered, V = Vulnerable, EP= Endangered Population in MDB, C = CAMBA, J = JAMBA, R = ROKAMBA, X = species recorded in this planning unit via catch records & or Australian Museum Records where they exist, Y = species expected to occur based on MaxEnt modelling)	
Native fish	• Carp gudgeon X+Y • Murray–Darling rainbowfish Y • Bony herring X+Y • Australian smelt X+Y • Spangled perch X+Y • Golden perch X+Y • Silver perch (V) X+Y • Murray cod (V) X+Y • Olive perchlet X+Y
Waterbirds	28 waterbird species recorded including freckled duck (V), brolga (V) & Australian gull-billed tern (C).
Native vegetation	• River red gum 3,277 ha • Black box 21,977 ha • Coolibah 54,308 ha • Floodplain 212,865 ha • Lignum 5,640 ha • Non-woody wetland 7,012 ha
Registered water-dependent cultural assets	• Aboriginal ceremony & dreaming • Aboriginal resource & gathering • Burials • Earth mounds • Stone quarry • Grinding grooves • Fish trap • Habitation structures • Hearths • Modified trees • Shells • Artefacts
	It is acknowledged that other Aboriginal values such as sites, objects, landscapes, resources & beliefs that are important to Aboriginal people as part of their continuing culture may be present but not registered.

Hydrology

Hydrological alteration	**River reach**	**CtF**	**Low flow & baseflow**	**Freshes**	**High & infrequent flows**		
					1.5ARI	**2.5ARI**	**5ARI**
See Table 1 for key	Louth to Menindee	H-	M-	M-	M-	L-	L-

Relevant rules from WSP

Current access rules: Users must cease-to-pump when the flow at the reference point is equal to or less than the flow rate specified below for each category of water access licence in the respective management zones.

Domestic & stock	0 ML/day	0 ML/day
A class	215 ML/day	123 ML/day
B class	1,010 ML/day	850 ML/day
C class	1,010 ML/day	12,000 ML/day
Reference point	Darling River at Tilpa (gauge 425900)	Darling River at Wilcannia Main Channel (gauge 425008)

There are 10 very small, 2 small and 1 medium water access licences distributed throughout the planning unit. The total volume of unregulated entitlements for the planning unit is 1929 ML.

There is one very small environmental water license and one 400ML local water utility license in this planning unit.

# WAL (share component)	Very small (<250 ML)	Small (250-500 ML)	Medium (500-1000 ML)	Large (1000-2500 ML)	Very large (>2500 ML)
A Class	9 and ***1 HEW (111 ML)***	-	-	-	-
B Class	1	2	1	-	-
C Class	-	-	-	-	-

Recommended management strategies

MS1: Reduce extraction pressure on in-channel flows

- **1a:** Review existing cease-to-pump thresholds based on identified ecological requirements
- **1b:** Review access (commence-to-pump) thresholds for each flow class based on identified ecological requirements
- **1c:** Consider flow sharing mechanisms that would enable limits to extraction on a daily or event basis

MS2: Ensure that floodplain harvesting is regulated within the SDL and LTAAEL of the WRP.

MS3: A resumption of flow rule which restricts access to flows following an identified cease-to-flow event.

MS4a: Protect HEW and EWA inflows from tributary catchments and through the Barwon-Darling

MS4b: Protect HEW held in Barwon-Darling

MS5: End-of-system flow requirements. **Applies from Border Rivers and Namoi WRPAs. Not applicable from Gwydir, Macquarie or Intersecting Streams (Paroo Rivers) WRPAs.**

MS6a: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending supplementary access. **Incorporated into NSW Border Rivers, Gwydir and Namoi WSPs.**

MS6b: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending B and C Class access. **Not statutory at the time of writing.**

MS7: Targeted purchase of water entitlements for the Barwon-Darling

MS8: Continue and refine temporary access restrictions such as through WMA s324 orders

Table 17 Environmental Water Requirements for the Tilpa to Wilcannia Planning Unit (Darling River at Wilcannia 425008)

Flow category and EWR code[22]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
Cease-to-flow	CtF	<1 ML/d	Can occur anytime of year, but more common October to March	Maximum duration: Typically, events should not persist for more than 20 days. In very dry years, events should not persist for more than 160 days	CtF events should occur in no more than 50% of years	NA	When managing water to restart flows, avoid harmful water quality impacts, such as de-oxygenation of refuge pools.
Very-low-flow	VLF	>30 ML/d	Anytime	In typical years, at least 340 days per year. In very dry years, at least 165 days per year.	Every year	In accordance with maximum duration of cease-to-flow events	Flows that provide replenishment volumes to refuge pools along the Barwon-Darling. Waterhole persistence can also be supported by groundwater.
Baseflows	BF1	>350 ML/d	Anytime	In typical years, at least 290 days per year. In very dry years, at least 120 days per year.	Every year	155 days	Aiming to provide a depth of 0.3 m to allow fish passage. Also to manage water quality, prevent destratification and reduce risk of blue-green algal blooms.
	BF2	>350 ML/d	September to March	In typical years, at least 185 days per year (within timing window). In very dry years, at least 60 days per year (within timing window).	Every year	200 days	Aiming to provide a depth of 0.3 m to allow fish passage.
Small fresh	SF1	>1,400 ML/d	Anytime – but ideally October to April	10 days minimum	Annual (100% of years)	1 year	Ideal timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod.

[22] Refer to Glossary for definitions of terms and explanatory text for EWRs

Flow category and EWR code[22]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
							Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish. Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form). Ideally shortly after LF2 for increased likelihood of successful recruitment of fish, productivity and dispersal.
	SF2	1,400-14,000 ML/d	September to April	14 days minimum	5–10 years in 10 (75% of years)	2 years	Timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod. Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish. Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form).
Large fresh	LF1	>14,000 ML/d	Anytime, but ideally July to September	15 days minimum	5–10 years in 10 (75% of years)	2 years	This flow in Jul to Sep will improve pre-spawning fish condition. Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form).
	LF2	>14,000 ML/d	October to April	15 days minimum	3–5 years in 10 (42% of years)	2 years	Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish.

Flow category and EWR code[22]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
							Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form). Temp preferably >17°C to maximise spawning outcomes. Ideally shortly before SF1.
Bankfull	BK1	>25,000 ML/d	Anytime	15 days minimum	5 in 10 years (50% of years)	4 years	
Overbank	OB1	>30,000 ML/d	Anytime	15 days minimum	2 to 4 years in 10 (30% of years)	5 years	Clustered events (i.e. multiple events over 2–3 years) will provide improved conditions for native vegetation recruitment. Multiple events in close proximity will also improve the condition of native veg communities.
	OB2	>31,000 ML/d	Anytime	15 days minimum	1 to 3 years in 10 (20% of years)	10 years	
	OB3	>43,000 ML/d	Anytime	15 days minimum	0.5 to 1 years in 10 (10% of years)	15 years	

PU14: Wilcannia to Upstream Lake Wetherell

This planning unit includes the Darling River from Wilcannia to the upstream extent of the Lake Wetherell weir pool, Talyawalka Creek (a major anabranch/floodrunner of the Darling River that re-enters the Darling River in the Murray-Lower Darling WRPA near Menindee), and associated floodplains. The floodplain is characterised by other smaller anabranches, distributary channels (and associated wetlands), billabong wetlands and deflation basin lakes and swamps (Brennan et al. 2002). The Darling River channel has fewer bedrock controls than the reach Bourke-Tilpa and more in-channel benches (Thoms et al. 1996).

The Talyawalka Creek below Wilcannia is traditionally included in the Murray-Lower Darling WRPA but has been included in the Barwon-Darling LTWP because it is directly influenced by flows in the Barwon-Darling River upstream of Menindee Lakes.

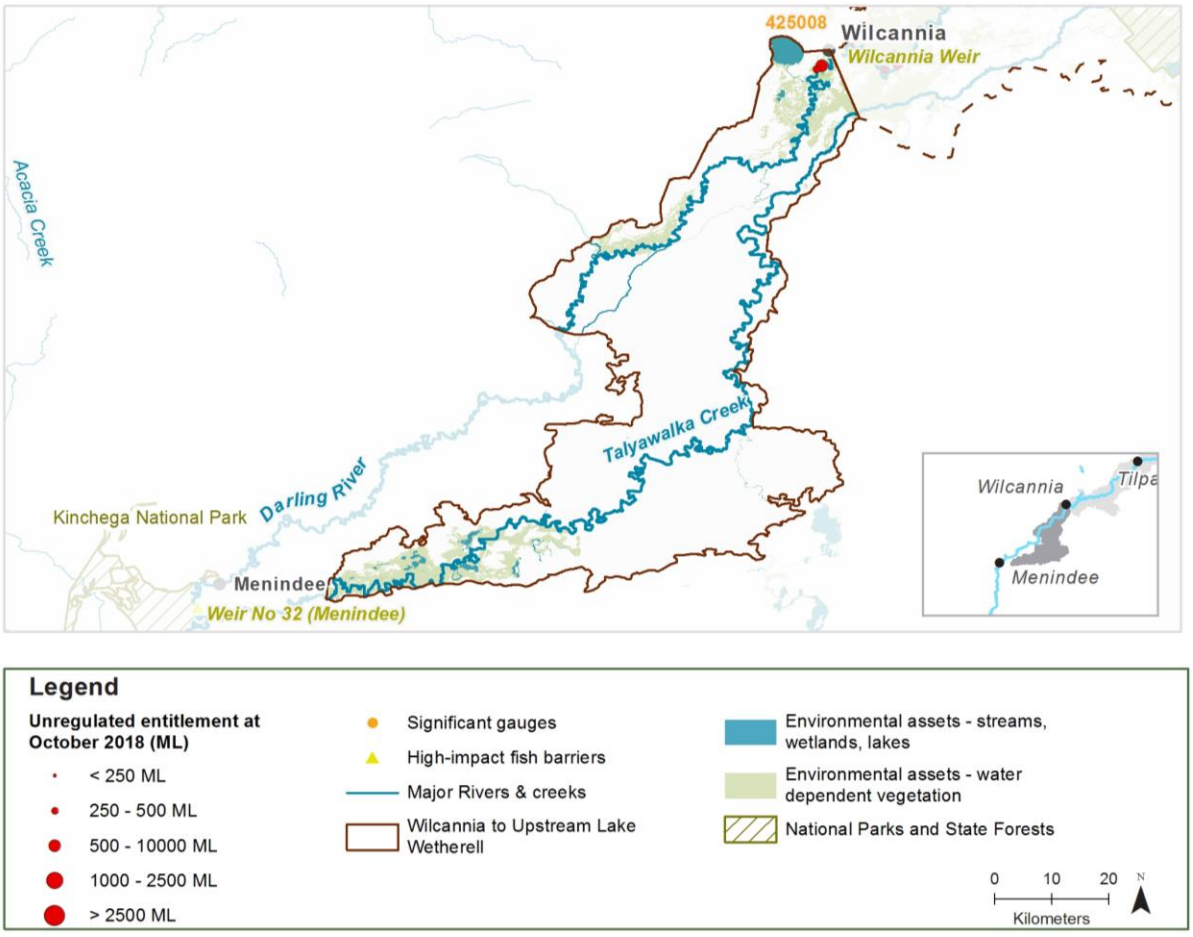


Figure 15 **Map of Wilcannia to Upstream Lake Wetherell planning unit**
Area outside of planning unit has been faded. Significant gauge relevant to the planning unit is Darling River at Wilcannia (425008).

Key water-dependent values (CE = Critically Endangered, E = Endangered, V = Vulnerable, EP= Endangered Population in MDB, C = CAMBA, J = JAMBA, R = ROKAMBA, X = species recorded in this planning unit via catch records & or Australian Museum Records where they exist, Y = species expected to occur based on MaxEnt modelling)	
Native fish	• Unspecked hardyhead [Y] • Carp gudgeon [X+Y] • Murray–Darling rainbowfish [X+Y] • Bony herring [X+Y] • Australian smelt [X+Y] • Spangled perch [X+Y] • Golden perch [X+Y] • Silver perch (V) [X+Y] • Murray cod (V) [X+Y] • Olive perchlet [Y]
Waterbirds	50 waterbird species recorded including Australian gull-billed tern (C), caspian tern (J), freckled duck (V) & Latham's snipe (JK).
Native vegetation	• River red gum 6825 ha • Black box 40,185 ha • Coolibah 1516 ha • Floodplain 68,979 ha • Lignum 749 ha • Non-woody wetland 1709 ha
Registered water-dependent cultural assets	• Ceremony & dreaming • Hearths • Burials • Shells • Modified trees • Fish traps
	It is acknowledged that other Aboriginal values such as sites, objects, landscapes, resources & beliefs that are important to Aboriginal people as part of their continuing culture may be present but not registered.

Hydrology

Hydrological alteration See Table 1 for key	**River reach**	**CtF**	**Low flow & baseflow**	**Freshes**	**High & infrequent flows**		
					1.5ARI	**2.5ARI**	**5ARI**
	Louth to Menindee	H^{-}	M^{-}	M^{-}	M^{-}	L^{-}	L^{-}

Relevant rules from WSP

Current access rules:

Users must cease-to-pump when the flow at the reference point is equal to or less than the flow rate specified below for each category of water access licence in the respective management zones.

Domestic & stock	0 ML/day
A class	123 ML/day
B class	850 ML/day
C class	12,000 ML/day
Reference point Barwon	Darling River at Wilcannia Main Channel (gauge 425008)

There are 1 small and 1 medium water access licences within the planning unit. The total volume of unregulated irrigation entitlements for the planning unit is 1072 ML. All of the entitlement is allocated for irrigation (rather than stock & domestic or town water supply).

# WAL (share component)	Very small (<250 ML)	Small (250-500 ML)	Medium (500-1000 ML)	Large (1000-2500 ML)	Very large (>2500 ML)
A Class	-	-	-	-	-
B Class	-	1	1	-	-
C Class	-	-	-	-	-

Recommended management strategies

MS1: Reduce extraction pressure on in-channel flows

1a: Review existing cease-to-pump thresholds based on identified ecological requirements

1b: Review access (commence-to-pump) thresholds for each flow class based on identified ecological requirements

1c: Consider flow sharing mechanisms that would enable limits to extraction on a daily or event basis

MS2: Ensure that floodplain harvesting is regulated within the SDL and LTAAEL of the WRP.

MS3: A resumption of flow rule which restricts access to flows following an identified cease-to-flow event.

MS4a: Protect HEW and EWA inflows from tributary catchments and through the Barwon-Darling

MS4b: Protect HEW held in Barwon-Darling

MS5: End-of-system flow requirements. **Applies from Border Rivers and Namoi WRPAs. Not applicable from Gwydir, Macquarie or Intersecting Streams WRPAs.**

MS6a: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending supplementary access. **Incorporated into NSW Border Rivers, Gwydir and Namoi WSPs.**

MS6b: Use of downstream environmental requirements as a trigger to manage upstream access. – suspending B and C Class access. **Not statutory at the time of writing.**

MS7: Targeted purchase of water entitlements for the Barwon-Darling

MS8: Continue and refine temporary access restrictions such as through WMA s324 orders

Table 18 Environmental Water Requirements for the Wilcannia to Lake Wetherell Planning Unit (Darling River at Wilcannia 425008)

Flow category and EWR code[23]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
Cease-to-flow	CtF	<1 ML/d	Can occur anytime of year, but more common October to March	Maximum duration: Typically, events should not persist for more than 20 days. In very dry years, events should not persist for more than 160 days	CtF events should occur in no more than 50% of years	NA	When managing water to restart flows, avoid harmful water quality impacts, such as de-oxygenation of refuge pools.
Very-low-flow	VLF	>30 ML/d	Anytime	In typical years, at least 340 days per year. In very dry years, at least 165 days per year.	Every year	In accordance with maximum duration of cease-to-flow events	Flows that provide replenishment volumes to refuge pools along the Barwon-Darling. Waterhole persistence can also be supported by groundwater.
Baseflows	BF1	>350 ML/d	Anytime	In typical years, at least 290 days per year. In very dry years, at least 120 days per year.	Every year	155 days	Aiming to provide a depth of 0.3 m to allow fish passage. Also to manage water quality, prevent destratification and reduce risk of blue-green algal blooms.
	BF2	>350 ML/d	September to March	In typical years, at least 185 days per year (within timing window). In very dry years, at least 60 days per year (within timing window).	Every year	200 days	Aiming to provide a depth of 0.3 m to allow fish passage.
Small fresh	SF1	>1,400 ML/d	Anytime – but ideally October to April	10 days minimum	Annual (100% of years)	1 year	Ideal timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod.

[23] Refer to Glossary for definitions of terms and explanatory text for EWRs

Flow category and EWR code[23]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
							Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish. Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form). Ideally shortly after LF2 for increased likelihood of successful recruitment of fish, productivity and dispersal.
	SF2	1,400-14,000 ML/d	September to April	14 days minimum	5–10 years in 10 (75% of years)	2 years	Timing is based on preferred temperature range for fish spawning - >20°C for most native fish and >18°C for Murray cod. Aiming to provide a depth of greater than 0.5 metres to allow movement of large fish. Flow velocity ideally up to 0.3 to 0.4 m/s (depending on channel form).
Large fresh	LF1	>14,000 ML/d	Anytime, but ideally July to September	15 days minimum	5–10 years in 10 (75% of years)	2 years	This flow in Jul to Sep will improve pre-spawning fish condition. Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish. Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form).
	LF2	>14,000 ML/d	October to April	15 days minimum	3–5 years in 10 (42% of years)	2 years	Aiming to provide a depth of 2 m to cover in-stream features and trigger response from fish.

Flow category and EWR code[23]		Flow rate	Timing	Duration	Frequency (LTA frequency)	Maximum inter-event period	Additional requirements and comments
							Flow velocity ideally 0.3 to 0.4 m/s (depending on channel form). Temp preferably >17°C to maximise spawning outcomes. Ideally shortly before SF1.
Bankfull	BK1	>25,000 ML/d	Anytime	15 days minimum	5 in 10 years (50% of years)	4 years	
Overbank	OB1	>30,000 ML/d	Anytime	15 days minimum	2 to 4 years in 10 (30% of years)	5 years	Clustered events (i.e. multiple events over 2–3 years) will provide improved conditions for native vegetation recruitment. Multiple events in close proximity will also improve the condition of native veg communities.
	OB2	>31,000 ML/d	Anytime	15 days minimum	1 to 3 years in 10 (20% of years)	10 years	
	OB3	>43,000 ML/d	Anytime	15 days minimum	0.5 to 1 years in 10 (10% of years)	15 years	

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