



Australian Government

Commonwealth Environmental Water Office

Commonwealth Environmental Water

Portfolio Management Plan

Border Rivers

2018–19



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Dumaresq River, Photo by Commonwealth Environmental Water Office.

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Upper Dumaresq River, Photo by Commonwealth Environmental Water Office.

Acknowledgement of the traditional owners of the Murray-Darling Basin

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Commonwealth environmental water portfolio management planning

Commonwealth Environmental Water Holder

The Commonwealth Environmental Water Holder is a statutory position established under the *Water Act 2007* and is responsible for managing the Commonwealth's environmental water holdings. This water must be managed to protect and restore the rivers, wetlands and floodplains (and the native animals and plants they support) of the Murray–Darling Basin. Ms Jody Swirepik is the current Commonwealth Environmental Water Holder. Ms Swirepik is supported by staff of the Commonwealth Environmental Water Office. The Office employs six local engagement officers who live and work in regional centres across the Murray–Darling Basin.

Commonwealth environmental water

Commonwealth environmental water holdings are water entitlements that have been acquired by the Australian Government through investments in water-saving infrastructure and purchases on the water market. The holdings are a mix of entitlement types held across 19 catchments. The rules governing the entitlements vary across states and across catchments. Commonwealth environmental water entitlements are subject to the same fees, allocations, carryover and other rules as equivalent entitlements held by other water users.

There are broadly three options for managing Commonwealth environmental water:

- delivering water to a river or wetland to meet an identified environmental demand
- leaving water in storage and carrying it over for use in the next water year (referred to as 'carryover')
- trading water, that is, selling water and using the proceeds to buy water in another catchment or in a future year, or investing in complementary 'environmental activities'.

Purpose of the document

This document sets out the plans for managing the Commonwealth environmental water portfolio in the Border Rivers for 2018–19. Efficient and effective management of Commonwealth environmental water requires the utilisation of all portfolio management options. By taking a multi-year approach to planning, portfolio management tools such as use, carryover and trade can be managed for maximising environmental outcomes.

The portfolio management plans support transparent, coordinated and adaptive management of Commonwealth environmental water, consistent with the Basin-wide environmental watering strategy and having regard to the Basin annual environmental watering priorities.

To learn more about the planning approach see *Portfolio Management Planning: Approach to planning for the use, carryover and trade of Commonwealth environmental water, 2018–19* (available at: <http://www.environment.gov.au/water/cewo/publications> under 'Planning approach').

Delivery partners

Commonwealth environmental water is managed in conjunction with and delivered by a range of partners. This portfolio management plan has been developed in consultation with our delivery partners, including the Department of Natural Resources, Mines and Energy (DNRME); Department of Agriculture and Fisheries (DAF); Department of Environment and Science (DES); and the Queensland Murray–Darling Committee Inc. (QMDC). In NSW they include the Office of Environment and Heritage (OEH); Department of Primary Industries – Fisheries (DPI Fisheries); Department of Industry – Water (DOI Water); WaterNSW and Local Land Services (LLS) groups. Advice on the use of Commonwealth environmental water in the Border Rivers is also provided by individual landholders; Border Rivers Environmental Water Network (BREWN) and Border Rivers Food and Fibre (BRFF).

Your input

The management of Commonwealth environmental water relies on considerable advice and assistance from local organisations, state governments and others. Individuals and groups within the Murray–Darling Basin community are encouraged to submit suggestions for the management of Commonwealth environmental water. Please contact the Office via: ewater@environment.gov.au.

Table of contents

Commonwealth environmental water portfolio management planning	1
Commonwealth Environmental Water Holder	1
Commonwealth environmental water	1
Purpose of the document	1
Delivery partners	1
Your input	2
Table of contents	3
1. Environmental watering in the Border Rivers catchment	4
1.1. The Border Rivers catchment	4
1.2. Environmental objectives in the Border Rivers catchment	6
1.3. Environmental flow requirements	7
1.4. Monitoring and adaptive management	8
2. Portfolio management in 2018–19	10
2.1. Antecedent and current catchment conditions and the demand for environmental water in 2018–19	10
2.2. Water availability in 2018–19	12
2.3. Overall purpose of managing environmental water based on supply and demand	13
2.4. Water Delivery in 2018–19	14
2.5. Trading water in 2018–19	16
2.6. Carrying over water for use in 2019–20	16
2.7. Identifying investment opportunities	17
3. Next steps	24
3.1. From planning to decision making	24
3.2. Further information	24
Bibliography	25
Attachment A – Expected outcomes from the Basin-wide environmental watering strategy	28
Attachment B – Operational details for watering	30
Operational considerations in the Border Rivers catchment	30
Potential watering actions under different levels of water resource availability	32
Potential watering actions – standard operating arrangements	35
Attachment C – Long-term water availability	41
Commonwealth environmental water holdings	41
Other sources of environmental water	41
Planned environmental water	41

1. Environmental watering in the Border Rivers catchment

1.1. The Border Rivers catchment

The Border Rivers catchment covers around 49 500 km² in southern Queensland (QLD) and north eastern New South Wales (NSW), with roughly an equal area in each state. The system is based around the Macintyre and Dumaresq rivers, which merge upstream of Boggabilla and continue as the Macintyre River (Figure 1). The Dumaresq River, Macintyre River and the part of the Barwon River downstream of the junction of the Weir River to Mungindi (the end of the Border Rivers system) forms the border between NSW and Queensland for approximately 470 kilometres. The Weir River, wholly in Queensland, is the only significant tributary in the lower Macintyre River.

The headwaters of the Macintyre River are in the Great Dividing Range near Inverell from where it flows in a north-westerly direction. Its main tributary, the NSW Severn River, on which Pindari Dam is located, rises in the elevated region north of Glen Innes. Otleys Creek is the last significant tributary before the Macintyre and Dumaresq rivers merge. To the north east, the Severn River and Pike Creek in Queensland and Tenterfield Creek and the Mole River in NSW join to form the Dumaresq River. The main tributaries of the Dumaresq below this are the Beardy River in NSW and Macintyre Brook in Queensland (Figure 1).

Rainfall in the Border Rivers catchment is summer-dominant and highly variable, resulting in high variable stream flows (refer section 2.1) and timing and pattern of flow events between years.

The major public storages are Pindari Dam on the Severn River in NSW (312 GL), Glenlyon Dam on Pike Creek in Queensland (254 GL), and Coolmunda Dam on Macintyre Brook in Queensland (69 GL). The volume of on-farm storage is comparable to public storage, reflecting the importance of unregulated flows (opportunistic diversion of river and overland flows) to irrigation supplies in the catchment. On a long term average basis unregulated entitlement (supplementary water licences in NSW and unsupplemented water allocations in Queensland) and diversions in the Border Rivers catchment exceed regulated water entitlements and use.

Environmental assets

The many streams of the Border Rivers system provide diverse habitat for aquatic organisms including the river channel itself, in-stream features such as bars, benches, riparian areas and low level wetlands (SKM 2009). The streams in the catchment support a relatively rich native fish fauna. Sixteen native species have been documented, including a number of threatened species or populations either listed under the *Environment Protection and Biodiversity Conservation Act 1999* or identified by NSW DPI Fisheries as an important population in the Border Rivers. These include: Murray cod; silver perch; purple-spotted gudgeon; olive perchlet and freshwater catfish (NSW DPI 2015a). Assessments by NSW DPI (NSW DPI 2015c; NSW DPI and QLD DAF 2017) and the second Sustainable Rivers Audit (Davies et al. 2012) concluded that overall the Border Rivers fish community is in moderate health, ranking it among the best catchments in the Basin for fish.

Environmentally significant river reaches that can potentially be targeted with Commonwealth environmental water include:

- The **Dumaresq River** is one of the few areas in the QLD Murray-Darling Basin where dense aggregations of aquatic macrophytes occur. Reaches near Bonshaw and between the Yellowbank and Bengalla reserves support diverse native fish communities and high quality in-stream habitat (Butcher 2007). Observed species include olive perchlet and purple-spotted gudgeons with Murray cod and freshwater catfish, including evidence of breeding, observed at Bonshaw (NSW DPI 2015a; QLD DNRM 2015).
- The **Macintyre River** from Mungindi to the Severn River is a key movement corridor, has high fish biodiversity including threatened species, and provides hydrodynamic diversity and dry period refuge (MDBA 2014a).
- The **NSW Severn River** below Pindari Dam sustains high fish diversity and provides good refuge conditions for native fish. Wetlands upstream of Ashford power station and within Kwiambal National Park are important ecological features that rely on natural flow variability and freshes to

maintain health and diversity (NSW DWE 2009b). The reach also supports a small platypus community.

- The **lower Macintyre River** between Goondiwindi and Boomi supports low lying floodplain lagoons that are likely to be important for breeding and recruitment of native species including olive perchlet and spangled perch. The reach is also a key fish movement corridor supporting high biodiversity and threatened species including silver perch and Murray cod (NSW DPI 2015a).
- The **Queensland Severn River in Sundown National Park** is in near natural condition and sustains high fish diversity, including threatened species such as silver perch and provides significant dry period refuge conditions for native fish (QLD DNR 2015; MDBA 2014a)

In the lower catchment multiple effluent creeks and anabranches break off the main channel of the Macintyre River (DWE 2009a). These break outs, which include Callandoon and Dingo creeks and the Little Weir River in QLD, and Whalan Creek and the Boomi River in NSW, flow away from the trunk stream only when certain river levels are reached and meander across the floodplain forming a network of billabongs and wetlands. Hydrological connectivity of this floodplain area relies on overbank flows and when flooded it provides large amounts of dissolved organic carbon to the river ecosystem, driving food webs (MDBA 2012). Intermittent connection of anabranches, which occurs at flows below overbank level, also stimulates nutrient and carbon cycling and is significant contributor to overall inputs (Thoms et al. 2005; McGinness and Arthur 2011; Reid et al. 2012).

Semi-permanent and intermittent billabongs and lagoons bordering the main channel and on prior river channels are a key feature of the floodplain from Yetman on the Macintyre River and Texas on the Dumaresq River to around Boomi. When flooded, billabongs and wetlands in the lower Macintyre have supported breeding for a range of nationally and internationally important birds such as brolgas, black-necked storks, and magpie geese (MDBA 2012; Brandis and Bino 2016) and provide a wide range of aquatic habitats and drought refugia (NSW OEH 2014). The Morella Watercourse/Boobera Lagoon/Pungbougul Lagoon complex, located on the floodplain just south-west of Goondiwindi, is listed in the *Directory of Important Wetlands in Australia* (Environment Australia 2001). Boobera Lagoon is considered to be one of the most important Aboriginal sites in south-eastern Australia. The local Aboriginal people, the Gamilaraay, believe that Boobera Lagoon is the resting place of the rainbow serpent, Garriya.

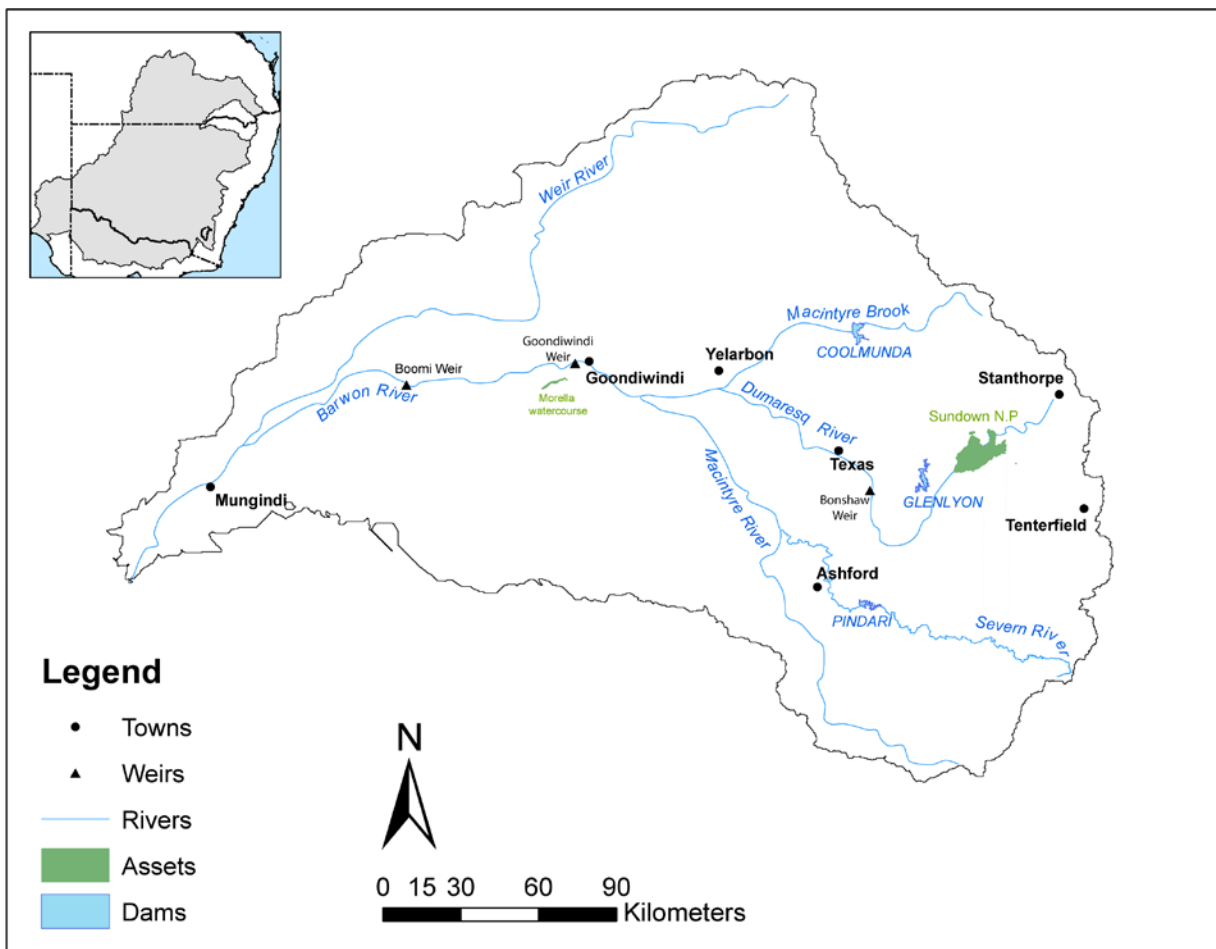


Figure 1: Map of the Border Rivers catchment

1.2. Environmental objectives in the Border Rivers catchment

The long-term environmental objectives for the Murray-Darling Basin are described in the Basin Plan's environmental watering plan and the Basin-wide environmental watering strategy, which includes 'quantified environmental expected outcomes' at both a Basin-scale and for each catchment. The expected outcomes relevant for the Border Rivers are described in [Attachment A](#).

Basin state governments are also developing long-term watering plans for each catchment. These plans will identify the priority environmental assets and ecosystem functions in the catchment, the objectives and targets for these assets and functions, and their watering requirements. Once developed, these plans will provide the key information on the long-term environmental water demands in the catchment. Prior to the development of long-term watering plans, the Office will continue to draw on existing documentation on environmental water demands developed by state governments, local natural resource management agencies and the Murray-Darling Basin Authority.

Based on these strategies and plans, and in response to best available knowledge drawing on the results of environmental watering monitoring programs, the objectives for environmental watering in the Border Rivers are summarised in Table 1 below. The objectives for water-dependent ecosystems will continue to be revised as part of the Commonwealth Environmental Water Office's commitment to adaptive management.

Table 1: Summary of objectives being targeted by environmental watering in the Border Rivers

BASIN-WIDE MATTERS (Matters in red link to the Basin-wide Environmental Watering Strategy)	ENVIRONMENTAL OBJECTIVES FOR BORDER RIVERS ASSETS		
	IN-CHANNEL ASSETS	OFF-CHANNEL ASSETS	
	Severn (NSW and QLD), Dumaresq, Macintyre and Barwon Rivers	Wetlands, lagoons and billabongs	Anabranches and effluent creeks
VEGETATION	Maintain riparian and in-channel vegetation condition, growth and survival	Maintain and improve wetland vegetation condition, growth and survival in targeted sites. Maintain floodplain vegetation (with use of unregulated holdings and flows).	
WATERBIRDS		Maintain foraging, roosting and breeding habitats at targeted sites on the floodplain to support waterbirds.	
FISH	Provide flows that improve habitat conditions and support different life stages (migration, spawning, recruitment, refuge)	Support natural flow variability and connectivity between the river channel, wetlands anabranches and floodplains	
INVERTEBRATES	Provide habitat (e.g. pools and riffles) and conditions (low flows, freshes, scouring flows) to maintain /improve micro and macroinvertebrate condition and diversity.		
OTHER VERTEBRATES	Provide habitat and conditions to support survival and recruitment of native aquatic fauna (e.g. platypus, native water rat, frogs, turtles)		
CONNECTIVITY	Support longitudinal connectivity in the major streams of the Border, including end of system flows to the Barwon River	Support lateral and longitudinal (anabranches) connectivity between the river and wetlands and floodplains	
PROCESSES	Support primary production, nutrient and carbon cycling and biotic dispersal and movement		
WATER QUALITY	Maintain water quality within channels and pools	Support more natural water temperature, flow regimes and connectivity to support nutrient cycling and water quality benefits	
RESILIENCE	Provide refuge habitat for fish and other aquatic fauna		

Information sourced from: Australian Wetlands (2009), CEWO (2014), Davie and Mitrovic (2014), Kingsford (1999), McGinness and Arthur (2011), MDBA (2012), NSW DPI (2018), NSW DWE (2009a, b), Reid et al. (2015), SKM (2009, 2012), Thoms et al. (2005).

1.3. Environmental flow requirements

Not all environmental demands can and will be met through the use of held environmental water. Some demands are met by regulated water deliveries for consumptive purposes, while others are met by large unregulated/natural flows events or are beyond what can be delivered within operational constraints. Figure 2 shows the broad environmental demands that are in scope for Commonwealth environmental water. Importantly, these are broad, indicative demands and individual watering events may contribute to particular opportunities, such as using infrastructure to deliver water to individual wetlands that would otherwise not be possible due to constraints. Also, there may be opportunities for Basin State governments to remove or modify constraints, which will improve the efficiency and/or effectiveness of environmental watering. Further information on delivery constraints are described in [Attachment B](#).

Border Rivers – Regulated

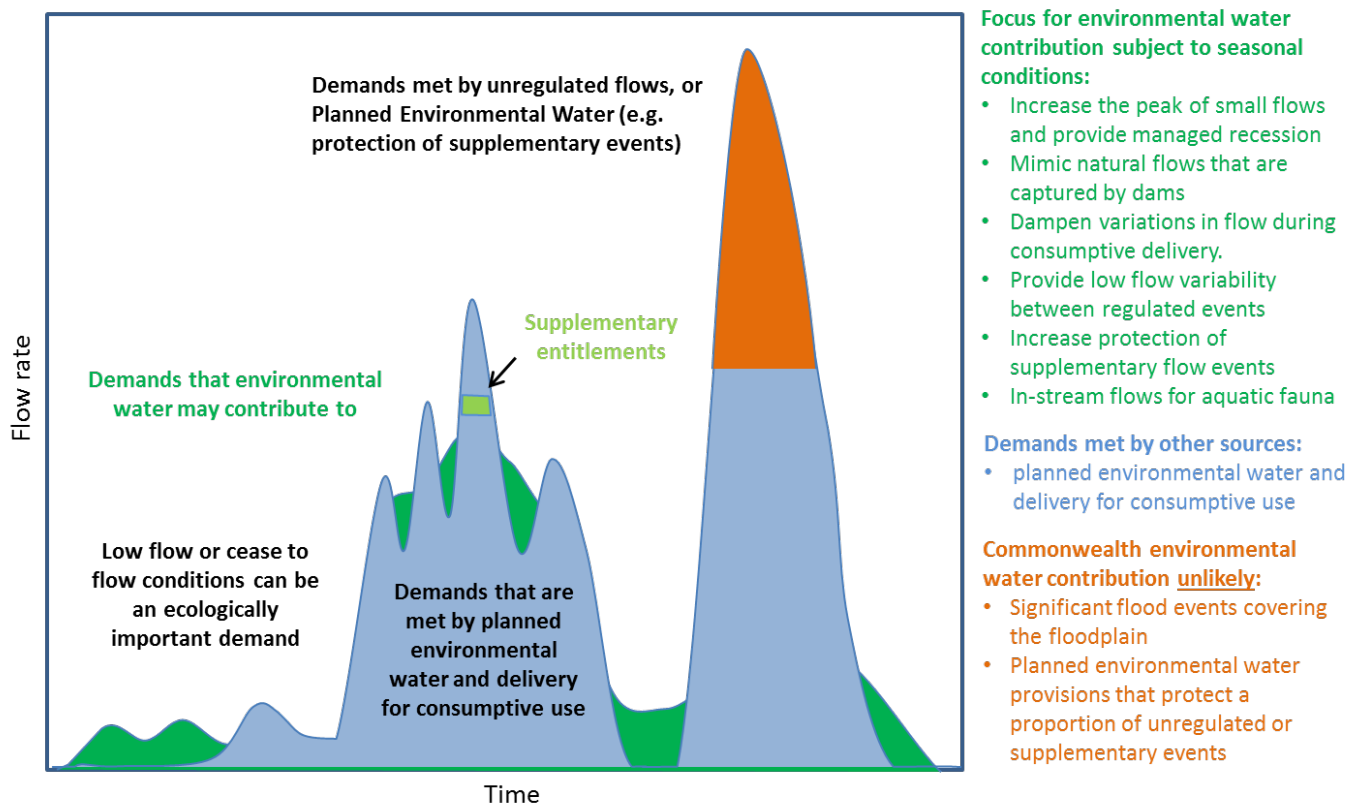


Figure 2: Scope of demands that environmental water may contribute to in the Border Rivers catchment

Based on the above objectives and delivery constraints, specific watering requirements (flow magnitude, duration, timing and frequency) have been identified as being in scope for Commonwealth environmental water. These water requirements are described in Table 3. As with the objectives, the environmental water requirements will continue to be reviewed and revised in response to new knowledge.

1.4. Monitoring and adaptive management

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

In the Border Rivers catchment, monitoring and research activities have been undertaken in collaboration with QLD and NSW agencies and the Office. Details include:

- Short-term intervention monitoring of native fish in the upper Border Rivers catchment (Dumaresq, NSW Severn and Macintyre reaches) is funded by the Office. Fish monitoring is being undertaken by a cross-jurisdictional project team, led by NSW DPI including scientists from QLD DAF, and has been designed to understand the environmental responses to different watering actions, with respect to targeted objectives and expected outcomes. This project commenced in 2016-17 and is expected to be completed by 2019.
- Dumaresq River Habitat Mapping project has been funded by the Office and was completed in 2017-18. This project was undertaken by NSW DPI (Aquatic Habitat Rehabilitation unit), who recorded key in stream features used by aquatic fauna along 193 km of the Dumaresq River, from Pike Creek Junction downstream to its confluence with the Macintyre River, targeting habitat needed by native fish during breeding and recruitment. Results determined volumes

required for inundation of habitat (such as large woody habitat, rootballs, bank overhangs, in-channel benches, and entry points to connected wetland). This information was used to identify relationships between river flow height and habitat availability of the Dumaresq River, and specify environmental water requirements for native fish, focusing on important or threatened populations occurring in the area.

Key findings and recommendations from projects undertaken in 2017-18 include:

- A moderately healthy and diverse native fish population exists in upper Border Rivers (Dumaresq, Macintyre and NSW Severn river reaches) and is comprised of all Basin Wide Strategy (BWS) listed species, including the threatened Murray cod and silver perch.
- Evidence of successful Murray cod recruitment in the Dumaresq and Macintyre rivers in 2016/17, possibly due to the medium to large flows in Spring 2016 that initially provided opportunities to spawn and recruit, which were then followed with maintenance and conditioning flows pre-winter.
- A distinct fish population occurs in the NSW Severn River reach compared to the Dumaresq and Macintyre rivers. Key differences were the exclusion of small bodied fish while silver perch were only caught in this reach, suggesting that some flow conditions are favouring flow dependent species but hindering stable flow dependent species.
- Evidence of limited recruitment of Murray cod in the NSW Severn River reach, with the last possible recruitment estimated to have occurred in 2013, which was also same season that the NSW stimulus flow provided a priming pulse to the system.
- Preliminary fish monitoring results from November 2017 (immediately post delivery) and April 2018 (outside peak spawning timeframes for all species) have suggested watering actions in spring 2017 achieved targeted ecological outcomes. For the Dumaresq River, there was evidence that the growth and survival of younger native fish from 2016-17 and Murray cod recruitment in 2017-18. For the NSW Severn River, there was evidence of the first Murray cod recruitment since 2013.
- Other monitoring observations include spawning aggregation of silver perch in the NSW Severn River, however, no evidence of successful recruitment. As this could be a naturally occurring population of this endangered species, determining possible factors limiting recruitment requires further investigation.
- Spring watering actions occurred in conjunction with natural inflows and suggests that the use of planned environmental water to enhance natural flows in the upper Border Rivers improves ecological outcomes.
- Undertaking fish monitoring before the start of watering year, as well as using on-ground observations to assess key risks, enables the development and implementation of targeted and adaptive watering actions that can maximise ecological outcomes.

The outcomes from these activities are used to inform portfolio management planning and adaptive management decision-making as outlined in Section 2.

Monitoring and research projects can also include observations of environmental outcomes, including by state partners. For example, the NSW Fisheries are undertaking other monitoring projects in the Border Rivers (cod spawning, MDBA fish monitoring). Also both states are currently completing their Long-term plans for the Border Rivers and an extensive amount of information has been gathered. The outcomes from these monitoring activities, and any other available relevant data, are used in adaptive management to inform portfolio planning and decision-making.

2. Portfolio management in 2018–19

In planning for the management of Commonwealth environmental water, the Office aims to maximise the outcomes achieved from the available water. This includes consideration of the urgency of demands (based on targeted objectives and watering requirements, watering history and asset condition) and the available supply under different resource scenarios. Plans for water delivery, trade and carryover are then made in a multi-year context, with an assessment also undertaken of need for water in future years.

In the Border Rivers, the Commonwealth holds both regulated and unregulated entitlements (Table 2). Commonwealth unregulated entitlements in the Border Rivers (excluding NSW supplementary water holdings) provide environmental benefits by restoring flows that were formerly extracted and improving flow variability.

This planning process is outlined in full in Table 3 below and summarised in the sections below.

2.1. Antecedent and current catchment conditions and the demand for environmental water in 2018–19

In 2017-18, the Border Rivers catchment only experienced periodic rainfall, most of it localised, resulting in a few small to moderate flow events that generally helped maintain low flow conditions for the watering year. The first rainfall event occurred in early July and resulted in a series of small freshes, predominately confined to the NSW Severn and lower Macintyre river reaches, and contributed to small end of system flows at Mungindi throughout the month. However, flows in the Border Rivers quickly receded to low and very low flow conditions throughout August until a series of rainfall events across the Macintyre sub-catchment in early to mid-October provided small to moderate freshes. These freshes were the largest flow events for the year and occurred throughout most of the Border Rivers system, including the Weir River, and resulted a moderate end of system flow event at Mungindi. Into 2018, periodic rainfall events in the upper Border Rivers in January contributed to another small fresh through the lower Macintyre River. Localised rainfall across the Weir River sub-catchment in March resulted in moderate flows breaking the cease to flow conditions.

Between these small to moderate flows in 2017-18, Commonwealth and planned environmental water was delivered to support important environmental assets, mainly threatened and BWS listed fish species in the upper Border Rivers reaches. Deliveries in early Spring 2017 supported reproduction success in the NSW Severn and Dumaresq river reaches. Deliveries in late April 2018, as part of the Barwon-Darling connectivity event, not only provided end of system flows to Mungindi, but also maintenance and conditioning flows for native populations in the Dumaresq River reach.

Environmental water delivery in 2017-18 protected native fish species in the upper Border Rivers but the catchment as a whole is still recovering from prolonged periods of restricted flows over the last 14 years. Prior to the very high flows in 2010–11, high flows in 2011–12 and moderate flows 2012–13, the region had not experienced widespread connection with the lower Macintyre River floodplain since 2004. During these years of low to very low flows, small freshes from local rainfall are the only events able to fully, or partially, meet some of the demands of environmental assets. These freshes are not able to achieve widespread connection to wetlands, anabranches and floodplains, but can result in continuous end of system flows. Although these freshes do, in part, help protect some assets, including some breeding of the threatened Murray cod and freshwater catfish, the majority asset demands need further protection in 2017–18.

Environmental water demands for environmental assets in the Border Rivers catchment in 2018–19 are represented in Table 3 and are summarised below:

River channel: High demand for replenishment flows in the Dumaresq, NSW Severn and lower Macintyre river reaches to maintain in-stream habitat during low to no flow conditions. Low / Moderate to high demand for a large pulse in the lower Macintyre River to provide access for juvenile fish to a range of habitats, including connectivity to low level wetlands to bring nutrients and carbon into the main river channel. There is a moderate demand for a medium to large pulse in late winter–early spring in the Dumaresq River to stimulate fish movement and breeding that would strengthen the resilience of these threatened populations after prolonged periods of low flows. This large pulse would also scour the riverbed to provide a stimulus to food

webs. If this priming flow occurs, there is a moderate demand in the Dumaresq River for a long stable low flow in spring to early summer to support the completion of breeding and dispersal of large fish and to provide breeding and recruitment opportunities for small fish that spawn in low flows. This demand is moderate / high in the NSW Severn River as populations of the threatened silver perch and small fish to support resilience. Meeting most of these demands requires other flows in the system. The higher flow demands in the Dumaresq and Macintyre will only be met if there are suitable unregulated flows as there is insufficient regulated environmental water to drive these. Demand in the lower Macintyre are high as the required frequency for a large in channel pulse (biennial) has not occurred for over five years.

Anabranches: Moderate / high to high demand. Anabranch connection would support floodplain vegetation and to improve wetland health and exchange of nutrients and carbon to support productivity in the system. Lower Macintyre River anabranches have had limited connection since 2013 due to flows in the main river being limited to low magnitude, short duration events. However, there is unlikely to be sufficient environmental water to uniformly support anabranches through river channel flows, and there is uncertainty about required frequency and protection of in-stream flows through these watercourses. Therefore, should it be possible to contribute to these demands in 2018–19, watering is likely to be limited to infrastructure assisted delivery to targeted anabranch(es) with known high demand where multiple environmental benefits, such as fish and riparian/wetland vegetation, can be achieved.

Wetlands: Low to high demand. High for wetlands that are isolated from natural flows as a result of resource development, such as certain Morella watercourse lagoons south of Goondiwindi. These demands have become critical as not met in 2017-18. Requirements could potentially be met through targeted infrastructure assisted delivery in 2018–19. Moderate for other wetlands between Goondiwindi and Boomi, as these areas have been inundated after three years without in-flows. Some wetlands require filling and reconnection with the main river on a regular basis to support wetland health and resilience, exchange of nutrients, carbon and biota (particularly lateral movement of fish) and wetland vegetation. Low to moderate demand is also likely for near channel wetlands on the lower Dumaresq River, given that demands were partially met with Commonwealth environmental water delivery in autumn 2018. A contribution to meet demands in the lower Macintyre River is likely to require using available holdings and temporary water to increase the protection of a flow event in the target reach of the river.

Wetlands in the NSW Severn River have low demand as these have been watered for the last five years through unregulated flows, irrigation deliveries and stimulus flows.

Barwon-Darling: There is a growing awareness of the importance of connecting flows across the northern Basin, to support habitat, water quality, native fish and other aquatic species in the Barwon-Darling and its tributary systems, including the Border Rivers. Subject to antecedent conditions, water availability, and urgency of environmental demands, there may be opportunities to coordinate releases across multiple rivers in the northern Basin to meet broader environmental demands. The environmental demands in the Barwon-Darling are described in the *Commonwealth Environmental Water Portfolio Management Plan: Barwon-Darling 2018–19*.

Murray–Darling Basin Plan environmental watering priorities and the Murray–Darling Basin-wide environmental watering strategy

The Murray–Darling Basin Authority publish the *Basin annual environmental watering* priorities each year and in 2017–18 also published multi-year priorities. Commonwealth environmental water in the Border Rivers will contribute to the following multi-year environmental watering priorities and the 2018–19 Basin annual environmental watering priorities.

Rolling, multi-year priorities

- Support lateral and longitudinal connectivity;
- Support viable populations of threatened native fish, maximise opportunities for range expansion and establish new populations;
- Maintain and improve the condition and promote recruitment of forests and woodlands;
- Improve the condition and extent of lignum shrublands;
- Improve the abundance and maintain the diversity of the Basin's waterbird population;

- Improve flow regimes and connectivity to maximise the ecological function of the Barwon-Darling river system for native fish;
- Support viable populations of threatened native fish, maximise opportunities for range expansion and establish new populations.

2018-19 Annual Priorities

- Support opportunities for lateral connectivity between the river and adjacent low-lying floodplains and wetlands to reinstate natural nutrient and carbon cycling processes;
- Coordinate replenishment flows across multiple tributaries to maintain habitat condition and regulate water quality, carbon and nutrients in refuges along the Barwon-Darling watercourse;
- Improve flow regimes and connectivity to maximise the ecological function of the Barwon-Darling river system for native fish;
- Support viable populations of threatened native fish, maximise opportunities for range expansion and establish new populations.

The Commonwealth Environmental Water Holder will not inundate private land without prior approval from land holders while contributing to the Basin annual environmental watering priorities.

In contributing to these demands, the Commonwealth Environmental Water Office will also be aiming to contribute to the expected outcomes in the Basin-wide environmental watering strategy (see [Attachment A](#)).

2.2. Water availability in 2018–19

Forecasts of Commonwealth water allocations

Water resource availability, in the context of contributing to environmental demands, comprises total allocations (including carryover) against entitlements held by the Commonwealth in the major dams as well as water that becomes available to unregulated entitlements in the main river channel during natural flow events. Natural inflows can be infrequent and unpredictable in the Border Rivers, therefore unregulated environmental water volumes are dependent on the characteristics of the trigger flow event and cannot be described in advance. However, in terms of average annual yield, the Commonwealth's unregulated entitlements in the Border River currently exceed its regulated water holdings.

Ongoing allocations against regulated water entitlements in the Border Rivers are determined by the QLD and NSW governments based on dam inflows and criteria in the respective water resource plans. The following forecasts of total regulated water (Table 2) are based on the best available information including State forecasts and historical inflow scenarios.

The volume of Commonwealth environmental water likely to be carried over in the Border Rivers for use in 2018–19 is estimated to be approximately 6.5 GL.

Table 2: Forecasts of Commonwealth water allocations (including carryover) in 2018–19 in the Border Rivers as at 22 May 2018.

Entitlement type	Forecasts of Commonwealth water allocations (including carryover) in 2018–19 (GL)					
	Very dry ← → Very wet					
	95 percentile	90 percentile	75 percentile	50 percentile	25 percentile	10 Percentile
Supplemented (QLD) – medium	7	8	9	11	13	13
General Security (NSW)	1.0	1.0	1.2	1.5	1.8	2.3
Total – Border Rivers	8	9	10	13	15	15
Unsupplemented (QLD)	Up to 26 GL	Up to 26 GL	Up to 26 GL	Up to 26 GL	Up to 26 GL	Up to 26 GL
Supplementary(NSW)	Up to 1.4 GL	Up to 1.4 GL	Up to 1.4 GL	Up to 1.4 GL	Up to 1.4 GL	Up to 1.4 GL

Information on allocations to Commonwealth environmental water holdings can be found at <http://www.environment.gov.au/water/cewo/portfolio-mgt/holdings-catchment> and is updated monthly.

Water resource availability scenarios

Commonwealth environmental water is managed in conjunction with other water in the system. When considering the available resource to meet environmental demands, it is necessary to also factor in the resources managed by other entities and available to contribute to environmental objectives. While neither the QLD nor NSW government has any held environmental water in the Border Rivers, other relevant resources include planned environmental water, natural and unregulated flows, conveyance water and consumptive water. Further detail on sources of environmental water in Border Rivers is provided in [Attachment C](#).

By combining the forecasts of water held by the Commonwealth with streamflow forecasts, as well as taking into account operational considerations, water resource availability scenarios can be developed ranging from very low to very high. Based on available information very low to high resource availability scenarios are in scope for 2018–19. However, very low resource availability would require a significant deterioration (drying) in conditions, while high availability is only possible with significant new inflows and unregulated flows.

The resource availability for the start of 2018–19 is low to moderate. This resource availability scenario takes into account relatively low public dam storage levels and the limited overall volume in accounts in the NSW and QLD schemes – as at May 2018 around 25 per cent of entitlement volume was held in medium security accounts in the QLD system and around 40 per cent overall in NSW general security accounts. Overall allocations, which were not already approved for use by the CEWH, to QLD medium security entitlements were 25 per cent in 2017–18 (to May 2017) and 15 per cent for NSW general security. It is important to note that while Commonwealth regulated account volumes are reasonable in the historical context, carryover from previous years contributes significantly to this position.

2.3. Overall purpose of managing environmental water based on supply and demand

Environmental water needs (demand) and water availability (supply) both influence the overall purpose of Commonwealth environmental water management. Under different combinations, the management purpose can range from ‘avoiding damage’ to the environment to ‘improving’ ecological health. This in turn informs the mix of portfolio management options that are suitable for maximising outcomes.

Figure 3 shows how current demands and forecasted supply are considered together.

The overall 'purpose' for managing the Commonwealth's water portfolio in the Border Rivers for 2018–19 is to **protect** the health and resilience of near channel wetlands and ecological processes in the lower Macintyre River, and fish habitat and life cycles in the Dumaresq River. If resource availability becomes very high there may be scope to **improve** the health of these assets. A secondary aim is to maintain the health and resilience of selected key wetlands and anabranches.

Demand for environmental water					
Overall environmental water resource availability	Critical – water predominantly needed urgently	High – water predominantly needed this year	Moderate – water predominantly needed this year and/or next	Low – water predominantly not needed this year	Very low - water predominantly not needed this year and next
Very low	Avoid damage to environmental assets		Protect and ensure ecological capacity for recovery		
Low					
Moderate					
High					
Very high	Improve the health and resilience of aquatic ecosystems / build future capacity to support ecological health and resilience				
				Maintain ecological health and resilience	

Figure 3: Determining a broad purpose for portfolio management in the Border Rivers for 2018–19. Note: grey lines represent potential range in demand and resource availability.

Further detail on how the overall purpose for portfolio management changes under different supply and demand scenarios is provided in *Portfolio Management Planning: Approach to planning for the use, carryover and trade of Commonwealth environmental water, 2018–19* (available at: <http://www.environment.gov.au/water/cewo/publications>).

2.4. Water Delivery in 2018–19

The overall focus for use of Commonwealth environmental water in the Border Rivers (focusing on the main channels of the Dumaresq and Macintyre rivers, and the NSW Severn River) for 2018–19 is to maintain in-channel habitat by providing either baseflows or a connectivity event should unregulated flows not materialise, and the river dries significantly and system connectivity is lost (see also Table 3 for supporting information regarding the basis for determining these watering intentions). These connecting flows support populations of native fish and aquatic fauna in the Border Rivers, as well as in the Barwon-Darling. Importantly flows provide hydrological connections that link a diversity of aquatic environments for feeding, breeding, dispersal, migration and re-colonisation, which is essential for the survival of native fish populations and other aquatic fauna. This importance will be taken into consideration when using Commonwealth environmental water for fish outcomes.

Commonwealth environmental water could also be used to support spawning and recruitment of listed threatened native species in the upper Border Rivers, subject to triggers, identification and mitigation of risks and operational arrangements. Commonwealth environmental water could also be used to maintain the

health of some key off-channel assets (that are isolated from natural flows as a result of resource development), such as small volumes delivered to specific wetlands and/or anabranches in the lower Macintyre floodplain using public and private irrigation infrastructure, if key information is addressed.

Going into 2018–19, the following options are priorities based on higher water resource availability scenarios and antecedent conditions:

- A watering action to replenish refuge pools and improve water quality to the end of the system.
- A peak priming pulse in the NSW Severn River to support reproduction opportunities for silver perch.
- Stable flows in the Dumaresq and Severn rivers to support reproduction, conditioning and movement opportunities for other native fish communities, including Murray cod, freshwater catfish, purple-spotted gudgeon and olive perchlet.
- Anabranch connectivity to improve inflows into key anabranches to protect environmental assets and functions in these watercourses and the benefits of anabranch connectivity to the main river system (nutrient and carbon transfer, movement, spawning and reproduction of fish and other aquatic species).

In the event that conditions become much wetter with improved resource availability, larger unregulated flow events in the system could provide opportunity to support additional outcomes:

- Contribute to a large in-channel pulse through to the end of the system to improve the health and resilience of in and near channel flora and fauna. The flow would aim to improve availability of habitat for fish and other aquatic organisms, initiate significant transfer of nutrients and carbon and provide movement, spawning and recruitment opportunities for fish.
- Contribute to a large in-channel pulse to improve the health and resilience of riparian and near channel wetlands and in-stream processes in the Dumaresq River. The flow would connect to and support vegetation and primary productivity in these areas. In the channel, flows would scour algae and reset biofilm processes to stimulate the aquatic food chain and provide movement, spawning and recruitment cues to native fish.

Stakeholder Feedback

Feedback on environmental demands and proposed watering in the Border Rivers was sought from the Queensland Departments of Natural Resources, Mines and Energy and Agriculture and Fisheries, the NSW OEH, NSW Department of Primary Industries – Water and Fisheries, WaterNSW, Border Rivers Environmental Water Network (BREWN), Border Rivers Food and Fibre (BRFF), and the Queensland Murray-Darling Committee Inc (QMDC). There was general agreement among stakeholders for the proposed watering actions in the Dumaresq and Severn rivers to support fish outcomes in moderate to higher water resource availability scenarios, considering that watering actions in 2017–18 have improved population resilience of native fish. It was noted that replenishment flows will be critical under low to no flow conditions to maintain these populations and the watering of assets in 2018–19 be prioritised based on flow conditions during important periods (namely reproduction, conditioning and maintenance), water resource availability and urgency of the environmental demand. For fish outcomes, the most urgent environmental demand in 2018–19 will be for reproduction of threatened perch species, particularly silver perch in the NSW Severn. However, it was suggested that key risks to spawning aggregation be investigated to ensure ecological outcomes can be achieved.

There was general agreement that the range of monitoring and research activities currently being undertaken in the lower Macintyre River could also provide some key information needed on the environmental values of some anabranches of the Macintyre River, as well as the wetlands of the lower floodplains (including Morella watercourse lagoons). However, there may still be some knowledge gaps that still need to be addressed to adequately determine urgency of watering and the need for environmental water in 2018–19.

Overall, there was support for practical watering actions to be undertaken in 2018-19.

2.5. Trading water in 2018–19

Planning on water trade considers supply and demand within the catchment and across the Basin. As part of the planning process, the Commonwealth Environmental Water Office undertakes a Basin-wide analysis to identify opportunities to use allocation trade to better match differing demands across catchments.

As highlighted in Table 2, the Commonwealth has a low volume of regulated and unregulated water in the Border Rivers catchment. The capacity of the regulated and unregulated entitlements to provide water for environmental watering actions is limited due to the volume of the Commonwealth environmental water holdings. The Commonwealth Environmental Water Holder may seek to increase the holdings of regulated and unregulated entitlements in the catchment to meet long term environmental watering requirements.

Further information will be provided to the market ahead of any trade of Commonwealth environmental water at: <http://www.environment.gov.au/water/cewo/trade/current-trading-actions>.

For more information on the rules and procedures governing the trade of Commonwealth environmental water, see the *Commonwealth environmental water Trading Framework* available at: <http://www.environment.gov.au/water/cewo/publications/water-trading-framework-nov2016>.

2.6. Carrying over water for use in 2019–20

Regulated entitlements in all Border Rivers water supply schemes are managed on a continuous accounting (and continuous sharing in Queensland schemes) basis. Any unused water held in accounts can be carried over to the following year. However, account limits apply that limit carryover and use.

- For the QLD (Glenlyon) scheme, where the majority of Commonwealth regulated entitlement is held, a maximum of 85 per cent of entitlement volume can be held in accounts at any point in time and a maximum of 100 per cent can be distributed to accounts in any year.
- For NSW general security entitlements the instantaneous account limit is 100 per cent of entitlement volume.
- The QLD Macintyre Brook scheme allows for more than 200 per cent of entitlement volume to accrue in accounts over time.
- The annual usage limit in all three schemes is 100 per cent of the entitlement volume.

The volume of water carried over for use in 2019–20 will depend upon resource availability and demand throughout the year. Commonwealth environmental water in the Border Rivers may be carried over to 2019–20 if it is not required for priority in-channel actions in 2018–19 in the Dumaresq and lower Macintyre rivers, or if trigger conditions (primarily the presence of other flows) for these actions are not met.

As documented in Table 3 below, potential demands in 2019–20 include:

- late winter or spring flows for fish conditioning and/or breeding purposes in the upper Border Rivers
- flows into anabranches to protect their environmental values until reconnection to the main channel
- flows to connect with riparian areas and near channel wetlands in the lower Dumaresq and lower Macintyre rivers
- wetlands with high commence to fill levels in the lower Macintyre that have not received inflows for more than seven years
- flows < 2 000 ML (150 ML to 300 ML over 5–7 days) to top up refuge pools and improve water quality through to the end of the system, if prolonged dry conditions prevail in the later part of 2018–19.

Carryover volumes will be adjusted throughout the year as the season unfolds in response to both current and future demands and the water available to meet these demands. Carrying water over for maintaining drought refuges will be considered. These decisions will be based upon best information available at the time.

More information on how the Commonwealth makes decisions on carryover is here: <http://www.environment.gov.au/water/cewo/portfolio-mgt/carryover>

2.7. Identifying investment opportunities

Under the Water Act the Commonwealth Environmental Water Holder (CEWH) has the flexibility to use the proceeds from the sale of water allocations to fund environmental activities in the Basin. 'Environmental activities' should improve the capacity of the CEWH to meet the objectives of the Basin Plan environmental watering plan.

Environmental Activities must also be consistent with:

- the CEWH's obligation to exercise its functions to protect and restore environmental assets; and
- the requirement to use Special Account funds (including trade proceeds) to cover costs incurred in the performance of the CEWH's functions.

The CEWH is in the process of developing an Investment Framework to guide decisions on what types of environmental activities may be considered when investing the proceeds from the sale of environmental water allocations.

Table 3: Environmental demands, priority for watering in 2018–19 and outlook for coming year in the Border Rivers.










Environmental assets	Indicative demand (for <u>all sources of water</u> in the system)			Watering history (2012–2018)	2018–19		Implications for future demands
	Physical and process assets	Flow/Volume	Required frequency (maximum dry interval)	(from all sources of water)	Environmental demands for water	Potential Commonwealth environmental water contribution?	Likely urgency of demand in 2019–20 if watering occurred as planned in 2018–19
Border Rivers main channels: Dumaresq, Severn (NSW), Macintyre, lower Macintyre to Mungindi (including Weir River) <ul style="list-style-type: none"> Native fish reproduction, conditioning and maintenance Instream aquatic ecosystem processes i.e. scouring habitat inundation 	Fish resilience, maintain in-channel habitat during low flows, water quality and longitudinal connectivity	Base flow, flow variability and connectivity in Dumaresq and/or Macintyre Rivers ^{1,2}	As required in extreme dry conditions or to provide variability. (potential trigger: extended no flow periods impacting on persistence of larger waterholes in the Dumaresq ¹⁸)	<u>Dumaresq River</u> Demand has been met annually since 2012 due to a combination of irrigation / environmental water deliveries and /or natural flows. However, these flows are required annually to maintain in-stream habitat, and will be required again in 2018–19.	High	A high priority for Commonwealth environmental water contribution under all water resource availability scenarios. Need to consider timing of potential contribution, in line with replenishment flows and potential risks to refugial quality of identified waterholes.	Critical
		<u>Dumaresq River</u> 100 ML/day at Glenarbon. Duration / volumes depend on required outcomes ¹⁸ <u>NSW Severn / Macintyre rivers</u> 50 ML/day at Ducca Marrin. Duration / volumes depend on required outcomes ¹⁸	As required in extreme dry conditions or to provide variability. (potential trigger: extended no flow periods impacting on in-stream habitat)	<u>NSW Severn / Macintyre rivers</u> Demand has been met annually since 2012 due to a combination of irrigation / environmental water deliveries and/or natural flows. However, these flows are required annually to maintain instream habitat, and will be required again in 2018–19.	High	A high priority for Commonwealth environmental water contribution under all water resource availability scenarios. Need to consider timing of potential contribution, in line with replenishment flows.	Critical
		<u>Lower Macintyre River</u> 400 ML/day at Mungindi for end of system connectivity. Duration / volumes depend on required outcomes, with optimal volumes up to 5 000 ML at Goondiwindi ¹⁴	As required in extreme dry conditions or to provide variability. (trigger: flow <10 ML/day for more than 12 weeks at Mungindi)	<u>Lower Macintyre River</u> Demand has been met annually since 2012, with exception of 2014–15, due to a combination of irrigation / environmental water deliveries and/or natural flows. However, these flows are required annually to maintain instream habitat, and will be required again in 2018–19.	High	A high priority for Commonwealth environmental water contribution under all water resource availability scenarios. Need to consider timing of potential contribution, in line with replenishment flows.	Critical
	Fish spawning / recruitment flow targeting – long lived BWS listed species that are in-channel specialists (i.e. freshwater catfish, Murray cod)	Small in-channel pulse for 14 – 34 days ¹⁸ <u>Dumaresq River</u> Spawning – 515 to 1 040 ML/day at Roseneath for minimum 14 days ¹⁸ Recruitment – 340 to 600 ML/day at Roseneath for minimum 20 days <u>NSW Severn / Macintyre rivers</u> Priming pulse – initial peak of 2 000 ML/day @ Ducca Marrin followed by recession (duration variable)	8 in 10 years ^{15,16} (Frequency aligned with BWS) July–Aug (Priming pulse before spawning and recruitment) Aug–Oct (Peak recruitment season for Murray cod and freshwater catfish)	<u>Dumaresq River</u> After an extended dry period (2012–2015), this demand has been met for last three years with natural events in 2015–16 and 2016–17, and environmental water delivery in 2017–18. There has also been evidence of recent recruitment and healthy population status ¹⁹ . Demand for water is not urgent in 2018–19 but an opportunity to spawn and recruit would benefit population resilience in line with BWS objectives and has been assessed as moderate.	Moderate	A low priority for Commonwealth environmental water contribution under low water resource availability scenarios. Potential for contribution of reduced flow targets under higher water resource availability scenarios.	Moderate to High

Environmental assets	Indicative demand (for <u>all sources of water</u> in the system)			Watering history (2012–2018)	2018–19		Implications for future demands
	Physical and process assets	Flow/Volume	Required frequency (maximum dry interval)	(from all sources of water)	Environmental demands for water	Potential Commonwealth environmental water contribution?	Likely urgency of demand in 2019–20 if watering occurred as planned in 2018–19
		Spawning and recruitment - Flow height, duration and volume unknown		<u>NSW Severn / Macintyre rivers</u> After an extended dry period (2012–2015), this demand has been met for last three years with natural events in 2015–16 and 2016–17, and planned watering in 2017–18 which included a priming pulse. As Murray cod have only recently recruited ¹⁹ this environmental demand has been assessed as moderate.	Moderate	A low priority for Commonwealth environmental water contribution under low water resource availability scenarios. Potential for contribution of reduced flow targets under higher water resource availability scenarios.	Moderate to High
		<u>Lower Macintyre River</u> Large scale spawning and recruitment aligned with large unregulated pulse in the Weir River post winter (at least 2m rise and water temp > 23c) ²¹		<u>Lower Macintyre River</u> Demand has been met for last two years with natural events in 2015–16 and 2016–17, and evidence of large spawning of golden perch in 2016–17 ²² . However due to required frequency, environmental demand has been assessed as moderate.	Moderate	Possible for Commonwealth unregulated entitlements to contribute unregulated flows, if triggered. However, unable to receive planned Commonwealth environmental water from storages due to constraints.	Moderate to High
	Fish spawning / recruitment flow targeting – long lived BWS listed species that are flow dependent specialists (i.e. <i>golden perch</i> , <i>silver perch</i>)	Small to medium in-channel pulse for at least 3 days ¹⁸	8 in10 years ^{15,16} (Frequency aligned with BWS) Oct–April ¹⁸ (Recruitment season for silver and golden perch)	<u>Dumaresq River</u> After an extended dry period (2012–2015), there has been medium flows for last three years -natural events in 2015–16 and 2016–17, and environmental water delivery in 2017–18. However, there is no evidence that native silver and golden perch populations occur in this reach ¹⁹ . Demand for water is not urgent in 2018–19 but an opportunity to support stocked populations is in with BWS objectives and has been assessed as moderate.	Moderate	A low priority for Commonwealth environmental water contribution under low water resource availability scenarios. Potential for contribution under higher water resource availability scenarios.	Moderate to High
		<u>Dumaresq River / NSW Severn / Macintyre rivers</u> Flow height with at least a 2m rise and water temp > 23c) ²¹ Duration and volume unknown		<u>NSW Severn / Macintyre rivers</u> After an extended dry period (2012–2015), this demand has been met for last three years with natural events in 2015–16 and 2016–17, and environmental water delivery in 2017–18. However, monitoring has indicated mixed recruitment success between key species ¹⁹ and environmental demand has been assessed as moderate to high.	Moderate to High	A low priority for Commonwealth environmental water contribution under low water resource availability scenarios. Potential for contribution under higher water resource availability scenarios and impacts to recruitment success identified and mitigated.	High
		<u>Lower Macintyre River</u> Large scale spawning and recruitment aligned with large unregulated pulse in the Weir River post winter (at least 2m rise and water temp > 23c) ²¹		<u>Lower Macintyre River</u> Demand has been recently met with natural events in 2015–16 and 2016–17, and evidence of large spawning of golden perch in 2016–17 ²² . However due to required frequency, environmental	Moderate	Possible for Commonwealth unregulated entitlements to contribute unregulated flows, if triggered. However, unable to receive Commonwealth environmental water from storages due to constraints.	Moderate to High
		Consideration to contribute is higher if optimal pre-spawning conditions – first post-winter pulse ²²					

Environmental assets	Indicative demand (for <u>all sources of water</u> in the system)			Watering history (2012–2018)	2018–19		Implications for future demands
	Physical and process assets	Flow/Volume	Required frequency (maximum dry interval)	(from all sources of water)	Environmental demands for water	Potential Commonwealth environmental water contribution?	Likely urgency of demand in 2019–20 if watering occurred as planned in 2018–19
				demand has been assessed as moderate.			
	Fish condition and maintenance flow targeting – long lived BWS listed species covering in-channel specialists and flow-dependent fish guilds (i.e. <i>freshwater catfish</i> , <i>golden perch</i> , <i>Murray cod</i> , <i>silver perch</i>)	Large in-channel pulse for minimum 5 days ¹⁸ <u>Dumaresq River</u> Up to 2 300 – 6 250 ML/day at Roseneath ¹⁸ <u>NSW Severn / Macintyre rivers</u> Peak up to 2 000 ML/day at Ducca Murrin <u>Lower Macintyre River</u> Natural inflows in the lower Macintyre reach, including Weir river. Optimal flow height, duration and volume unknown.	1 in 1 to 2 years ¹³ (Maximum dry interval unknown) June–July (Pre-spawning conditioning) March–May (Pre-winter maintenance)	<u>Dumaresq River</u> With evidence of a healthy population status for species naturally occurring ¹⁹ , environmental demand is not urgently required in 2018–19. However due to required frequency, it has been assessed as low to moderate.	Low to Moderate	A low priority for Commonwealth environmental water contribution under low water resource availability scenarios. Potential for contribution of reduced flow targets under higher water resource availability scenarios and evidence of recruitment in 2018–19.	Moderate
				<u>NSW Severn / Macintyre rivers</u> Large in-channel pulses have occurred over the last 3 years, with pre-spawning conditioning flow provided in 2017 with the stimulus flow. Monitoring suggested that this flow could have assisted Murray cod spawning and silver perch spawning aggregation. Due to required frequency, environmental demand is still assessed as low to moderate.	Low to Moderate	A low priority for Commonwealth environmental water contribution under low water resource availability scenarios. Potential for contribution under higher water resource availability scenarios and evidence of recruitment in 2018–19.	Moderate
				<u>Lower Macintyre River</u> The last pulse within the Lower Macintyre River was April 2017. Due to required frequency, environmental demand has been assessed as moderate.	Moderate	Unable to receive Commonwealth environmental water due to constraints.	Moderate to High
		Stable low flow for 7–60 days (spawning* / reproduction / recruitment) ¹⁴ * A minimum stable low flow 7–21 days needed for spawning <u>Dumaresq River</u> Up to 100 ML/day at Roseneath ²⁰ <u>NSW Severn and Macintyre rivers</u> 50 ML/day at Ducca Marrin	1 in 1 to 2 years ¹³ (low uncertainty) Up to 3 years ¹³ (high uncertainty) Sept–Dec (Peak spawning season for olive perchlet, includes purple-spotted gudgeon)	<u>Dumaresq River</u> Natural events in 2015–16 and 2016–17 may have provided the required hydrological conditions (stable flows and warm temperatures) and there evidence from recent monitoring of some species occurring in the reach ¹⁹ . However, given the short life history of these BWS listed species, this environmental demand has been assessed as moderate to high.	Moderate	A low priority for Commonwealth environmental water contribution under low water resource availability scenarios. Potential for contribution under higher resource availability scenarios, when no flows conditions occur during peak spawning period and risks of cold water pollution are mitigated.	High

Environmental assets	Indicative demand (for <u>all sources of water</u> in the system)			Watering history (2012–2018)	2018–19		Implications for future demands
	Physical and process assets	Flow/Volume	Required frequency (maximum dry interval)	(from all sources of water)	Environmental demands for water	Potential Commonwealth environmental water contribution?	Likely urgency of demand in 2019–20 if watering occurred as planned in 2018–19
	<i>purple-spotted gudgeon</i>			<u>NSW Severn and Macintyre rivers</u> Irrigation deliveries usually disrupt stable flows throughout peak spawning season. As recent monitoring has not found any individuals in the Severn reach, this environmental demand is assessed as high.	High	A low priority for Commonwealth environmental water contribution in 2018–19 due uncertainty of population status in this reach. Needs further investigation to identify potential risks.	High
	Scouring, inundate inter-connected riparian areas and improved longitudinal connectivity for fish movement, (including maintenance and conditioning) of all native species	Large in-channel pulse (Aug–Dec ⁵) <u>Dumaresq River</u> Peak between 6 250–19 000 ML/day at Roseneath ¹⁸ <u>NSW Severn and Macintyre rivers:</u> Flows > 2 000 ML/day ^{3,4} to change periphyton species 4 000–16 000 ML	<u>All reaches</u> Up to 3 years for scouring ^{6,9,15} (Maximum dry interval unknown) Anytime (only if naturally occurring)	<u>Dumaresq River</u> Large pulses, or short duration, have occurred annually since 2013. Consequently the demand for water in 2018–19 is low.	Low	A low priority for Commonwealth environmental water contribution under low water resource availability scenarios, however Commonwealth unregulated entitlements could contribute unregulated flows, if triggered.	Moderate
				<u>NSW Severn and Macintyre rivers</u> Natural events in 2015–16 and 2016–17, and priming pulse from stimulus flow in 2017–18, have met hydrological demands in three consecutive years. Consequently the demand for water in 2018–19 is low.	Low	A low priority for Commonwealth environmental water contribution under low water resource availability scenarios, however Commonwealth unregulated entitlements could contribute unregulated flows, if triggered.	Moderate
	Inundate key habitat (large woody debris), support key ecosystem functions (nutrient, sediment and carbon cycling) and support recruitment opportunities for a range of native aquatic species (fish, frogs, turtles and invertebrates)	Large in-channel pulse 4 000 ML/day at Mungindi (end of system) for a minimum 5–11 days ⁶	1 in 3 to 4 years ⁶ (Maximum dry interval of 7-14 years ¹⁶) Oct –Dec (inundate habitat) 1 in 2 to 3 years ⁶ (Maximum dry interval of 6-8 years ¹⁶) Oct – Mar (support key ecosystem functions)	Last met during large pulses in late 2016, after a dry spell of three years. Therefore the environmental demand has been assessed as moderate to high.	Moderate to High	Unable to receive Commonwealth environmental water due to constraints	High
			Occur twice a year every 1 in 3 to 4 years ⁶ (maximum dry interval unknown) Oct –Dec (needs of threatened native fish)	Last met during the large floods in 2012–13. With maximum interval unknown, this environmental demand has been assessed as high	High		High

Environmental assets	Indicative demand (for <u>all sources of water</u> in the system)			Watering history (2012–2018)	2018–19		Implications for future demands
	Physical and process assets	Flow/Volume	Required frequency (maximum dry interval)	(from all sources of water)	Environmental demands for water	Potential Commonwealth environmental water contribution?	Likely urgency of demand in 2019–20 if watering occurred as planned in 2018–19
Anabranes downstream of Yetman/Texas <ul style="list-style-type: none"> Nutrient and carbon cycling, enhanced primary production. Support fish movement and condition. 	Infrastructure assisted watering to provide connection to disconnected anabranes	1 500–4 000 ML per action (infrastructure assisted) to target anabranes(es) with long-term flow deficit	Unknown. Frequency and maximum interval depends on pre-development regime.	Last met fully for all anabranes in 2010–11 and partially met in early 2013 and late 2016. As required frequency is known, environmental demand has been assessed as high.	High	Possible for environmental water contribution, if additional information supports a watering action.	High
	Unregulated flows that provide connection to anabranes	7 500 ⁷ –10 000 ⁸ ML/day at Goondiwindi for 7 days ⁷ (connect 4 main anabranes: Callandoon, Dingo, Whalan, Boomi)	1 in every 2 to 3 yrs for fish outcomes ^{6,9} (Maximum dry interval unknown)	Partially met annually since 2014. However, as both flow requirements and current condition of anabranes is unknown, demand for water has been assessed as moderate to high.	Moderate to High	Unable to receive Commonwealth environmental water due to constraints.	High
Wetlands, lagoons and billabongs <ul style="list-style-type: none"> Support movement, spawning and recruitment of aquatic species. Riparian vegetation health. Nutrient and carbon cycling Maintain refuge for aquatic biota, fish and riparian vegetation health, nutrient/ carbon cycling 	Infrastructure assisted watering to maintain refuge habitat E.g. Morella watercourse lagoons	1 500–4 000 ML per action (infrastructure assisted) to target specific wetlands with long-term flow deficit	Maximum: up to 10 years between filling (Morella watercourse)	Lagoons with low to no connectivity have had partial to no inflow for over 8 years. With current conditions unknown, environmental demand has been assessed high.	High	Additional information needed before supporting a watering action.	High
	Connection to lower Dumaresq wetlands / NSW Severn wetlands	<u>Dumaresq River</u> Large pulse to connect >30% of wetlands in the Dumaresq reach ¹⁸ > 1 040 ML/day @ Roseneath	1 in 3 to 4 years for wetland vegetation ¹⁵	<u>Dumaresq River</u> A series of large pulses in late 2017 recently provided connection >80% of wetlands, expected to have met demands. However, environmental demands have not been met within the required frequency between 2012 and 2017 and has been assessed as low to moderate.	Low to Moderate	A low priority for Commonwealth environmental water contribution under low to moderate water resource availability scenarios. Potential for contribution under a high water resource availability scenarios and in conjunction with similar flow requirements for fish outcomes	Moderate to High
		<u>NSW Severn and Macintyre rivers:</u> 1 200 ML/day ⁴ to connect upper reach wetlands	1 in 2 to 3 years for fish outcomes ^{6,9,15}	<u>NSW Severn and Macintyre rivers</u> Met annually since 2012. Environmental demand has been assessed as low.	Low	A low priority for Commonwealth environmental water contribution under low water resource availability scenarios, however Commonwealth unregulated entitlements could contribute unregulated flows, if triggered.	Low to Moderate

Environmental assets	Indicative demand (for <u>all sources of water</u> in the system)			Watering history (2012–2018)	2018–19		Implications for future demands
	Physical and process assets	Flow/Volume	Required frequency (maximum dry interval)	(from all sources of water)	Environmental demands for water	Potential Commonwealth environmental water contribution?	Likely urgency of demand in 2019–20 if watering occurred as planned in 2018–19
<ul style="list-style-type: none"> Lateral and longitudinal connectivity and nutrient and carbon cycling. Support movement, spawning and recruitment of aquatic species. Maintain riparian habitat for other species i.e. water birds 	Connection to lower Macintyre River wetlands	<p>>20 000 ML/day (low connectivity) to >60 000 ML/day (high connectivity) at Goondiwindi - 7 days¹⁰ (connect wetlands and anabranches - Goondiwindi to Mungindi)</p> <p>10 000–15 000 ML/day at Goondiwindi and 4 000–6 000 ML/day at Terrewah – 4–8 days Oct to Mar¹⁷ (low level wetland connection in Lower Macintyre)</p>	<p>1 in 3 to 4 years for wetland vegetation¹⁵</p> <p>1 in 2 to 3 years for native fish outcomes^{6,9,15}</p> <p>Every 3 years for small fish outcomes¹³</p>	A high connectivity event, meeting duration requirements, has not occurred since 2012–13. Therefore the environmental demand has been assessed as high	High	<p>Unable to receive Commonwealth environmental water due to constraints. (Unregulated entitlements could contribute to flows at Goondiwindi if there are in-range announced flows)</p>	High
<p>Environmental watering requirements</p> <p>¹ SKM (2009)</p> <p>⁴ Davie and Mitrovic (2014); pers comm DPI Water (2012)</p> <p>⁷ SKM (2012); McGinness and Thoms (2002); Lowes et al (2008)</p> <p>¹⁰ Reid (2006) cited in CSIRO (2007); Reid et al (2015)</p> <p>¹⁵ NSW DPI Fisheries (2015a)</p> <p>¹⁸ NSW DPI Fisheries (2018)</p> <p>Gauging stations</p> <p>¹¹ NSW Real Time Water Data http://realtimedata.water.nsw.gov.au/water.stm?ppbm=DAILY</p> <p>¹² QLD DNRME Water monitoring portal https://water-monitoring.information.qld.gov.au/</p> <p>Additional scientific input</p> <p>¹³ Kerr et al (2017) days)</p> <p>¹⁹ NSW DPI Fisheries and QLD DAF (2017)</p> <p>²² CPS Environmental (Unpublished)</p> <p>² NSW DWE (2009a)</p> <p>⁵ NSW DWE (2009b)</p> <p>⁸ SKM (2009)</p> <p>¹⁶ MDBA (2014b)</p> <p>¹⁴ in-house estimates (i.e. maintain 50-100 ML/d at Mungindi or in the Dumaresq for 50 days)</p> <p>²⁰ CEWO (unpublished)</p> <p>²³ Kerr and Prior (2018)</p> <p>³ NSW Office of Water (2011)</p> <p>⁶ MDBA (2012)</p> <p>⁹ Reid et al (2012)</p> <p>¹⁷ Hutchison et al (2008)</p> <p>²¹ Marshall et al (2016)</p>					<p>Carryover potential</p>	<p>Available allocations to be carried into 2018–19 will be identified in Border Rivers environmental water holdings at https://www.environment.gov.au/water/cewo/about/water-holdings.</p>	<p>Low proportion of available allocations anticipated to be carried into 2019–20, subject to Commonwealth Environmental Water Holdings at 30 June 2019, water resource availability and environmental watering actions undertaken in 2018-19.</p>
<p>Key - potential watering in 2018–19</p> <p> High priority for Commonwealth environmental watering (likely to receive water even under low water resource availability)</p> <p> Secondary priority for Commonwealth environmental watering (watering to occur only if natural trigger is met, or under moderate – high water resource availability); or water demand likely to be met via other means</p> <p> Low priority for Commonwealth environmental watering (under high – very high water resource availability)</p> <p> Unable to provide Commonwealth water due to constraints</p> <p>Key - urgency of environmental demands</p> <p> critical demand i.e. urgent need for water in that particular year to manage risk of irretrievable loss or damage</p> <p> high demand for water i.e. needed in that particular year</p> <p> moderate demand for water i.e. water needed that particular year and/or next</p> <p> low demand for water i.e. water generally not needed that particular year</p> <p> very low demand for water i.e. water generally not needed that particular year or the following year</p> <p>Note that demand is considered at a generalised scale; there may be specific requirements that are more or less urgent within the flow regime</p>					<p>Trade potential</p>	<p>Potential for the commercial trade of Commonwealth water allocation will be reviewed throughout the water year. The Commonwealth Environmental Water Holder will inform the market of any intention to acquire allocation if the conditions precedent for a purchase are met.</p>	<p>As highlighted in Table 2, the Commonwealth has a low volume of regulated and unregulated water in the Border Rivers catchment and the capacity of these holdings to meet urgent environmental demands can be further limited by other factors like carry over potential, catchment conditions and operational considerations. The Commonwealth Environmental Water Holder may seek to increase the holdings of regulated and unregulated entitlements in the catchment to meet long term environmental watering requirements.</p>

Note: Contributions to meet Barwon-Darling environmental requirements may be considered subject to water availability, antecedent conditions, and environmental demands. Refer to *Commonwealth Environmental Water Portfolio Management Plan: Barwon-Darling 2018–19*.

3. Next steps

3.1. From planning to decision making

It is important to distinguish between planning and operational decision making. As shown in Figure 4, planning allows the Office to manage the environmental water portfolio in a holistic manner and is an exercise in developing a broad approach or intention, based on the key drivers (demand and supply).

Decision making throughout each year builds on the intention by considering in more detail the specific prevailing factors and additional factors such as costs, risks, and constraints to water delivery and market conditions.

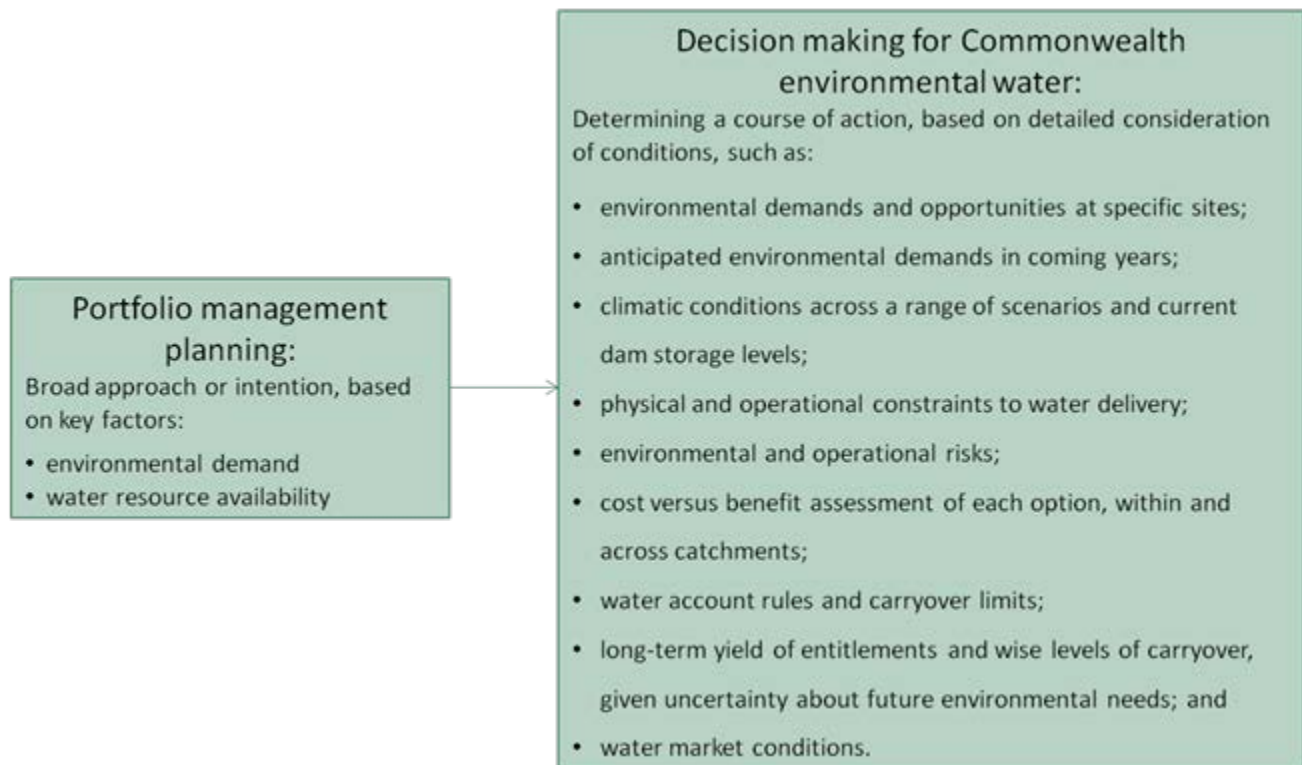


Figure 4: Planning and decision making for Commonwealth environmental water use

3.2. Further information

For further information on how the Office plans for water use, carryover and trade, please visit our web site: <http://www.environment.gov.au/water/cewo>

Or the sites below:

- Water use: www.environment.gov.au/topics/water/commonwealth-environmental-water-office/assessment-framework
- Carryover: <http://www.environment.gov.au/topics/water/commonwealth-environmental-water-office/portfolio-management/carryover>
- Trade: <http://www.environment.gov.au/water/cewo/trade/trading-framework>

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Attachment A – Expected outcomes from the Basin-wide environmental watering strategy

Expected outcomes from the Basin-wide environmental watering strategy (MDBA 2014a) that are relevant to the Border Rivers catchment are described below.

RIVER FLOWS AND CONNECTIVITY

Baseflows are at least 60 per cent of the natural level

Contribute to a 10 per cent overall increase in flows in the Barwon-Darling

A 10–20 per cent increase in the frequency of freshes and bankfull flows

VEGETATION

Maintain the current extent of forest and woodland vegetation and non woody vegetation

No decline in the condition of black box, river red gum and coolibah

Improved condition of lignum shrublands by 2024

Improved recruitment of trees within black box, river red gum and coolibah communities

Vegetation extent

Area of river red gum (ha)*	Area of black box (ha)*	Area of coolibah (ha)*	Shrublands	Non-woody water dependent vegetation
10 700	3 800	35 200	Lignum in the lower Border rivers region	Closely fringing or occurring within the within the Barwon, Dumaresq, Macintyre rivers and Macintyre Brook

* Area (ha) is based on: Cunningham, S.C., White, M., Griffioen, P., Newell, G. and MacNally, R. (2013). *Mapping vegetation types across the Murray-Darling Basin*. Murray-Darling Basin Authority, Canberra

WATERBIRDS

Maintain current species diversity

Increase Basin-wide abundance of waterbirds by 20–25 per cent by 2024

A 30–40 per cent increase in nests and broods (Basin-wide) for other waterbirds

Up to 50 per cent more breeding events (Basin-wide) for colonial nesting waterbird species

FISH

No loss of native species

Improved population structure of key species through regular recruitment, including

- Short-lived species with distribution and abundance at pre-2007 levels and breeding success every 1–2 years
- Moderate to long-lived with a spread of age classes and annual recruitment in at least 80 per cent of years

Increased movements of key species

Expanded distribution of key species and populations

Key native fish species for the Border Rivers catchment include:

Species	Longevity / Recruitment Frequency	Specific outcomes	In-scope for Commonwealth water in the Border Rivers?
Freshwater catfish (<i>Tandanus tandanus</i>)	Moderate to long-lived / 8 years in 10	Expand core range of 3–5 existing populations (Border Rivers is a candidate site)	Yes
Olive perchlet (<i>Ambassis agassizii</i>)	Short-lived / Annual	Expand range (or core range) of at least 3 existing populations (Border Rivers is a candidate site)	Yes. This species could be supported by connection and reconnection between low lying wetlands and the river channel in the lower Macintyre and low stable flows in the spawning season in the Dumaresq.
Southern purple-spotted gudgeon (<i>Mogurnda adspersa</i>)	Short-lived / Biennial	Expand the range (or core range) of at least 3 existing populations Establish or improve the core range of 2-5 additional populations (priority catchments include the Border Rivers/Gwydir)	Yes. Stable low flows in the spawning season could support this species in the Dumaresq.
River blackfish (<i>Gadopsis marmoratus</i>)	Moderate to long-lived / 8 years in 10	Expand the range of at least two current populations Establish 1-3 additional populations (candidate sites include upland portion of the Border Rivers)	No. Populations occur upstream of regulated water storages and/or in unregulated reaches where there are no Commonwealth holdings
Silver perch (<i>Bidyanus bidyanus</i>)	Moderate to long-lived / 8 years in 10	Expand the core range of at least two existing populations in the Northern Basin#	Yes, seasonally appropriate flows for conditioning and habitat availability. High peak flows to target spawning and recruitment are not in scope
Murray cod# (<i>Maccullochella peelii</i>)	Moderate to long-lived / 8 years in 10	A 10–15 per cent increase of mature fish in key populations	Yes. Stable low flows following a spawning trigger could support this species (Dumaresq)
Golden perch# (<i>Macquaria ambigua</i>)	Moderate to long-lived / 8 years in 10	A 10–15 per cent increase of mature fish in key populations	Yes, in conjunction with unregulated flows (Border Rivers main stem)

Not identified in the Basin-wide environmental watering strategy (MDBA 2014a) as a key species or outcome for the Border Rivers catchment, but included based on advice from NSW DPI Fisheries.

Important environmental assets for native fish in the Border Rivers

Environmental asset	Key movement corridors	High Biodiversity	Site of other Significance	Key site of hydrodynamic diversity	Threatened species	Dry period / drought	In-scope for C'th e-water
Macintyre River – floodplain lagoons Goondiwindi to Boomi	*	*	*		*	*	Yes, in combination with unregulated flows
Macintyre River – Mungindi to Severn in NSW	*	*		*	*	*	Yes (unregulated holdings or secondary benefits of regulated deliveries)
Severn River within Sundown National Park (QLD)		*		*	*	*	Yes (unregulated holdings)

Attachment B – Operational details for watering

Operational considerations in the Border Rivers catchment

The delivery of environmental water from regulated entitlements in the Border Rivers is potentially constrained by release capacities from storages and some re-regulating structures, travel time for deliveries, access conditions for unregulated licence holders, and standard river operation procedures. Channel constraints are unlikely to be triggered by flows that could be targeted for environmental purposes in the Dumaresq or Macintyre rivers, given the relatively large channel capacities of these rivers.

Large flows are required for full lateral connectivity across the floodplain. The volumes of environmental water available would make very little difference under these conditions. Therefore contributing to large overbank flow across the floodplain is out of scope for the provision of regulated Commonwealth environmental water at this stage in the water recovery process.

With use of unregulated entitlements activated at higher flows there is some potential to exceed channel constraints in the lower Macintyre River, leading to overbank flows and potential flooding of public or private lands. However, contributions from unregulated Commonwealth entitlements during flows of these magnitudes will comprise a small portion of the overall event and have a minimal effect on peak flows.

In Macintyre Brook use is constrained due to small environmental water holdings, to contributing to low flows. The volume of regulated environmental water available under any water resource scenario is also likely to limit capacity of overall holdings to contribute to larger in-stream and wetland connecting flows in the Dumaresq and Macintyre rivers and these demands will need to be met primarily through unregulated flows. Limited volume of environmental water also constrains the ability to undertake multiple actions in any given year targeting different environmental demands.

Watering actions will be developed in consideration of the following constraints:

- Ability to protect environmental releases from extraction through irrigation areas between Goondiwindi and Mungindi and along the Weir River during unregulated flow conditions.
- Outlet capacity of 5 000 ML/day at Pindari Dam, 3 540 ML/day at Glenlyon Dam and 390 ML/day at Coolmunda Dam (MDBA 2013).
- Storage capacity at Boggabilla weir (5.9 GL) and restricted draw down rate (0.5 m/day or 650–700 ML/day) could limit the ability to supply required volumes to meet in-stream flow targets in the lower Macintyre River. The discharge capacity of the Boomi regulator (60–70 ML/day under low flow conditions and 120–130 ML/day when the weir is overtopping

(MDBA 2013)) could constrain delivery into the Boomi River including to Budelah Nature Reserve.

- Minor flood levels of 21 300 ML/day at Boggabilla, 12 100 ML/day at Goondiwindi and 8 800 ML/day at Mungindi (MDBA 2013).
- During unregulated flow conditions, loss of regulated deliveries and/or unregulated contributions from the Macintyre to the Weir River at the Newinga regulator at flows above 600–800 ML/day.
- Adherence to default operational procedures whereby regulated water orders are met from unregulated river flows in preference to releases from storage needs to be considered when developing and finalising the environmental watering plan with QLD DNRME and NSW DoI Water.
- The long travel times for water orders (e.g. 16 - 21 days for a release from Glenlyon or Pindari Dam ordered to Mungindi), and limited volumes of regulated holdings, mean that the use of Commonwealth environmental water is unlikely to enhance the environmental outcomes of larger natural flow events in the lower system.
- In-stream weirs and the long travel distances (and lag times for water orders) to target river reaches will also impact the ability to achieve and maintain a desired hydrograph in the Dumaresq River using releases from Glenlyon dam.
- Channel constraints could limit active use of unregulated entitlements, such as temporary water purchase, in high flow events due to the risk of contributing to overbank flows and flooding.

Protection of environmental water

Leaving environmental water in-stream carries the potential risk that the additional flows are extracted by downstream users in a particular event. MDBA (2013) considers this to be the primary constraint for delivery of environmental water to the lower Macintyre River including end of system flows. The primary effect of additional regulated and/or unregulated environmental water in the system is likely to be in extending the period of unregulated access (and hence potentially the volume extracted) by maintaining flows at key gauges above the cut-off thresholds for water harvesting/supplementary access for longer. As demand (water orders) in the system is excluded from assessment of the volume of unregulated flow available for take, regulated deliveries made during unregulated flow conditions should not increase the announced volume of access.

Unregulated environmental flows in the Weir River could also bring forward achievement of flow triggers and announcement of unregulated access by increasing flows at Mascot, as well as increasing the total volume authorised for extraction in the Border Rivers main stem.

In the NSW sections of the Dumaresq and Macintyre rivers, unregulated access is based on local river flow thresholds. Regulated deliveries and unregulated water left in-stream could bring forward and/or extend access periods. Impacts would be limited because daily extractive capacity in these reaches is small compared to below Goondiwindi and water cannot be stored on farm.

Flows that reach end of system (Mungindi) are not protected from extraction in the Barwon-Darling outside an embargo. As a result, environmental deliveries undertaken during regulated/low flow conditions could potentially trigger pumping access in the Barwon or Darling rivers. End of system flows into the Barwon River during unregulated flow conditions are also not protected and could lead to additional extraction and loss of environmental water if the enhanced flows led to triggers for the next access licence class in the Barwon-Darling being met and/or extended the period that triggers were exceeded.

The risk of extraction of Commonwealth environmental water from the QLD Severn River is moderate because unregulated access conditions of downstream users along the Dumaresq River allows the

extraction of some of the additional environmental water left in-stream. However, the Commonwealth contribution to unregulated flows here is small relative to other flows in the system.

There may also be a risk of extraction of environmental water provided actively to anabranches (pumping and use of private infrastructure) and lagoons along watercourses (could impact unregulated access conditions and stock and domestic use in these systems). This risk of extraction also extends to passive delivery of environmental water (via enhanced in-stream flows), either impacting unregulated access conditions or potentially regulated water use in the main anabranches (Callandoon and Yambocully creeks). Further investigation of this risk is needed.

The protection of environmental water during unregulated flow conditions currently relies on existing water resource management systems including the Murray-Darling Basin Cap on diversions (specified for each valley) and existing rules governing the access of other users to unregulated flows. Additional arrangements are also being investigated as by the NSW and Queensland governments.

Existing rules provide a high degree of protection of in-stream flows from Commonwealth's unregulated entitlements in Queensland (unsupplemented water allocations) within the Macintyre River. Access is based on flow triggers at Goondiwindi (or at sites further downstream on the Macintyre River and on the Weir River) that capture the major unregulated inflows into the system. Available unregulated flows are shared between all users in line with entitlement share, regardless of actual use. This protects the Commonwealth's share of the flow event from extraction by others, with no management action required. However, the extent to which additional environmental flows in the system may extend the duration of access and total volumes available (in the case of unregulated contributions) is unclear.

Potential watering actions under different levels of water resource availability

Under certain levels of water resource availability, watering actions may not be pursued for a variety of reasons, including that environmental demand may be met by unregulated flows and that constraints and/or risks may limit the ability to deliver environmental water. Table 4 identifies the range of potential watering actions in Border Rivers and the levels of water resource availability that relate to these actions.

Table 4: Summary of potential watering actions for the Border Rivers

Broad Asset	Indicative demand	Applicable level(s) of resource availability				
		Very Low	Low	Moderate	High	Very High
River channel (Macintyre, Severn (NSW), Dumaresq, Barwon River to Mungindi)	<ul style="list-style-type: none">• Baseflows (no flow conditions)• Stable low flow pulse to inundate breeding habitat (Aug–Dec)• Scouring flows above 2 000 ML/day in NSW Severn (Aug–Dec)• Medium (scouring) flow pulse in the Dumaresq• Large in-channel pulse over 4 000 ML/day at Mungindi for minimum of 5 days	1. <i>Refuge pools and water quality contingency:</i> Contribute flows to refresh drought refuges and mitigate degrading water quality and provide longitudinal connectivity to Mungindi				
			2. <i>Fish reproduction and recruitment flows:</i> low stable flow to provide breeding habitat and support completion of breeding and/or recruitment of native fish (subject to agreement on operational arrangements)			
				3. <i>Scouring and conditioning flows:</i> Contribute to flows to scour algae and reset biofilm processes, provide migration, spawning and dispersal cues for fish, connect with riparian areas		
				4. <i>Habitat availability and nutrient/carbon cycling:</i> Contribute to flows to increase access to in-stream habitats, support movement, spawning and recruitment opportunities of native aquatic species		
Anabranches	<ul style="list-style-type: none">• 1 500–4 000 ML per site• 7 500–10 000 ML/day at Goondiwindi for 7 days (November to February)		5. <i>Infrastructure assisted delivery:</i> Use irrigation infrastructure to deliver water to specific anabranches for localised connectivity, nutrient/carbon cycling and habitat benefits (subject to additional information to support an action)			
				6. <i>Anabranch connectivity:</i> Contribute to flows to support connectivity to and between anabranches and floodplain wetlands and river channel (subject to agreement on operational arrangements)		
Wetlands	<ul style="list-style-type: none">• 1 500–4 000 ML per site• 1 200 ML/day NSW Severn to connect upper reach wetlands		7. <i>Wetland connectivity:</i> Contribute to unregulated flows to support lateral connectivity, primary production, nutrient and carbon cycling, and biotic dispersal and movement			

Broad Asset	Indicative demand	Applicable level(s) of resource availability				
		Very Low	Low	Moderate	High	Very High
	<ul style="list-style-type: none"> • ~ 6 000 ML/day at Terrewah (Sept–Jan) to connect lower Macintyre wetlands i.e. Boobera 		5. <i>Infrastructure assisted delivery</i> : Use irrigation infrastructure to water specific wetlands for localised connectivity, nutrient and carbon cycling and to support riparian and wetland vegetation and any naturally triggered breeding events (subject to delivery and accounting arrangements being in place)			

Potential watering actions – standard operating arrangements

Table 4 identifies the range of potential watering actions in the Border Rivers in the Murray–Darling Basin that give effect to the long-term demands and flow regime identified as being in scope for the contribution of Commonwealth environmental water in any given year. The standard considerations associated with these actions are set out below.

1. River Channel – Refuge pools and water quality contingency:

Watering action: Contribute to/or provide base flows to refresh drought refuges, ensure the persistence of pools, and mitigate the risk of degrading water quality.

Standard operational considerations:

- Water would be delivered primarily from Glenlyon dam. A coordinated release of the small volumes held in Coolmunda and Pindari dams could also be considered.
- Triggered by an extended period of low/nil flow conditions (e.g. 8 weeks at Mungindi or suitable site in Dumaresq, threshold to be confirmed) and/or degrading water quality due to dry, hot conditions.
- Commonwealth water would be released if irrigation deliveries/stock and domestic replenishment flow (Pindari) are not expected to meet this demand, or to supplement these deliveries.
- Release pattern would be based on the flow rates and duration required to achieve a sustained end of system flow, and provide some low flow variability in the system.

Typical extent: Dumaresq and Macintyre (main stem) rivers to Mungindi. The action will also provide flows into the Barwon River.

Approvals: Consult with QLD DNRME, SunWater, NSW DoI Water, WaterNSW, QLD and NSW Fisheries, and NSW OEH before implementing this action. Also inform key stakeholders, including BREWN, BRFF, LLS groups and QMDC before implementing this action. Delivery of water from NSW entitlements can be linked to appropriate water supply works, including Mungindi weir. A similar delivery arrangement for Queensland entitlements may be required. Delivery of the full volume (5 000 ML) to Mungindi may need to be negotiated as it will potentially require additional conveyance water to standard operations.

2. River channel – Fish reproduction and recruitment flow:

Watering action: Maintain a long stable low flow to support the completion of breeding of larger bodied fish, primarily Murray cod and freshwater catfish. Alternatively, or in addition to, the flow could provide suitable breeding habitat (submerged macrophyte beds) and favourable conditions for completion of breeding and recruitment of stable low flow spawning fish in the Dumaresq River. Target species include purple-spotted gudgeon, olive perchlet, Western carp gudgeons and crimson rainbowfish.

Typical extent: Target reaches are the Dumaresq River below the Pike Creek inflow and the NSW Severn River below Pindari dam (separate actions).

Standard operational considerations:

- Commonwealth environmental water would be released from either Glenlyon dam (for the Dumaresq action) or Pindari dam (for the NSW Severn River action).

Flow to support Murray cod recruitment (NSW Severn or Dumaresq):

- The action would be considered if there had been preceding unregulated flow pulse in early winter that provided cues for movement and breeding, or there is evidence of breeding activity.
- Preferred timing is late August to early September following the main spawning period for cod.
- Release to achieve a low peak to inundate suitable cod habitat (approx. 200 ML/day in the Severn; 515-1040 ML/day in the Dumaresq) followed by a recession over 20 days.

- Commonwealth environmental water for the NSW Severn River would be delivered in conjunction with the NSW stimulus flow. Irrigation deliveries or translucency flows from Pindari dam could also provide some of the desired flow outcome.

Flow to support silver perch recruitment (NSW Severn or Dumaresq):

- The action would be considered if risks to spawning aggregation can be identified and mitigated.
- Preferred timing is late September to early October, during warmer flow conditions and before irrigation deliveries.
- Release to achieve a high peak to stimulate aggregation (approx. 2000 ML/day at Ducca Marrin for at least 3 days).
- Commonwealth environmental water for the NSW Severn River would be delivered in conjunction with the NSW stimulus flow. Irrigation deliveries or translucency flows from Pindari dam could also provide some of the desired flow outcome by providing a stable recession.

Flow to support breeding and recruitment of stable low flow spawning fish (Dumaresq)

- Preferred timing is October to December, the peak spawning season for the target threatened species.
- Releases from Glenlyon dam would aim to maintain a stable low flow (minimal fluctuation in stream height and flow velocity) at around water levels that inundates macrophyte beds and provide suitable breeding habitat to low flow spawning fish.
- Target flow rates will be based on aquatic habitat mapping by NSW DPI Fisheries (~50-100 ML/day at Glenarvon) and confirmation of macrophyte habitat availability, if a scouring flow has recently occurred.
- Commonwealth environmental water from Glenlyon dam could supplement irrigation deliveries and/or be released after a small unregulated flow pulse.
- The ability to maintain long duration low flows (up to 60 days to cover egg laying through development) will depend on whether larger unregulated flows occur and/or operational arrangements are in place.

Approvals: As for watering option 1.

3. River Channel – Scouring and conditioning flows:

Watering action: Medium to large in-channel pulse to scour algae and reset benthic periphyton (biofilm) processes to stimulate production through all levels of the aquatic food chain; provide migration, spawning, dispersal and recruitment cues to native fish (dependent on timing); and wet and interconnect riparian areas and, improve access to aquatic habitat.

Typical extent: The Severn River (NSW) below Pindari Dam or the Dumaresq River below Glenlyon Dam (separate actions). Use of Commonwealth environmental water would also seek to achieve continuing environmental benefits downstream in the Macintyre River.

Standard operational considerations:

NSW Severn River

- Target flow rates above 2 000 ML/day to reset periphyton species (NSW Office of Water 2011) subject to managing cold water pollution impacts.
- Commonwealth environmental would be delivered from Pindari dam in conjunction with the NSW stimulus flow, and only if the latter is available. Irrigation deliveries and translucency flows could also contribute to meeting demand in the target reach.
- Delivery arrangements to minimise losses (e.g. downstream ordering point, timing releases when there is low downstream demand etc) and safeguard Commonwealth environmental water from extraction below Frazers Creek and in the Macintyre River are a consideration for proceeding.
- Early release in the stimulus flow window (August to December) is preferred to reduce cold-water pollution impacts on fish.

Dumaresq River

- Commonwealth environmental water would be delivered from Glenlyon dam, triggered by a suitable unregulated tributary flow event (medium to large flow pulse).
- Action is contingent on confirming operational arrangements. Also, this action is only feasible under high resource availability and/or with increased water holdings, to enable enhanced flow rates of 2 300 to 6 250 ML/day at Roseneath, improved flow recession and to minimise cold water pollution impacts.
- Maximum release capacity from Glenlyon dam (3 540 ML/day) and cold water pollution impacts are potential constraints on delivery.
- A downstream ordering point and release pattern would be sought that achieves desired outcomes in the target reaches while providing continued benefits as far downstream as possible.

Approvals: For the NSW Severn Option, the timing, rate, volume and duration of the stimulus flow is determined by NSW DoI Water in consultation with NSW OEH. These agencies, WaterNSW and NSW Fisheries would be consulted prior to a contribution being made to the stimulus flow. For the Dumaresq option, consult with QLD DNRME, NSW DoI Water, SunWater, WaterNSW, NSW OEH, QLD and NSW Fisheries before implementation. Also inform relevant stakeholders; including BREWN, BRFF, LLS groups and QMDC, before implementing this action.

4. River Channel – Habitat availability and nutrient and carbon cycling:

Watering action: Contribute to a large in-channel pulse to increase access to in-stream habitat (benches, large woody debris, macrophyte beds); stimulate carbon and nutrient cycling; support movement, spawning and recruitment opportunities of native aquatic species; and provide longitudinal connectivity to Mungindi.

Standard operational considerations:

- Commonwealth environmental water would be delivered from Glenlyon and/or Pindari dams, triggered by a suitable large unregulated tributary flow event.
- Conjunctive use with the NSW stimulus flow could also be possible for an action based from Pindari. All available sources of water be sought to maximise event volumes and flow peaks.
- As an alternative, Commonwealth regulated holdings could be converted through trade and/or a swap process into additional supplementary (NSW)/water harvesting (QLD) access, to protect more of the unregulated flow event for targeted flow improvements in the lower Macintyre River.
- Commonwealth unregulated entitlements in the Dumaresq and Macintyre (in particular) would contribute to the action, contributing in-stream flows that are in addition the 25 per cent of unregulated flows protected under water resource plans.
- Target flow rates and timing will be dependent on the prevailing flow conditions, priority outcomes sought at that point in time and operational considerations.
- An upper target for increasing access fish habitat (woody debris) and stimulating nutrient and carbon inputs into the river is 4 000 ML/day at Mungindi for a minimum of 5 to 11 days (MDBA 2012).
- Where fish outcomes are targeted, the timing and duration of the flows would be considered (e.g. late winter-early spring to stimulate spawning and mitigate cold water pollution impacts).
- Action would be contingent on confirming operational arrangements to release Commonwealth environmental water from Glenlyon dam in conjunction with unregulated flows and/or obtaining additional unregulated access in the lower Macintyre. High flows in the lower Macintyre may only be feasible under high resource availability and/or with increased water holdings.

Typical extent: The Macintyre River to Mungindi and in the Dumaresq and/or NSW Severn Rivers depending on which dams are used to deliver Commonwealth environmental water. Extent of influence of environmental water may depend on antecedent conditions and water availability.

Approvals: Consult with QLD DNRME, NSW DoI Water, SunWater, WaterNSW, NSW OEH, NSW and QLD Fisheries before implementing this action. Inform relevant stakeholders; including BREWN, BRFF, LLS groups and QMDC before implementing this action. May require development and implementation of a process for swapping and/or purchase and sale of relevant allocations.

5. Anabranes and Wetlands– infrastructure assisted delivery

Watering action: Provide water to targeted wetlands and or anabranes to provide localised connectivity and access for aquatic biota, support riparian vegetation, persistence of waterholes and terrestrial primary production.

Standard operational considerations:

- Action requires further investigation but may include diverting/pumping water from regulated or unregulated Commonwealth entitlements into channels, anabranes or offstream wetlands to restore ecological function to these areas.
- Likely to target areas with high environmental values and where multiple benefits can be achieved (wetlands or anabranes) and that have a long-term reduction in inflows due to water resource development and/or altered flow paths from floodplain structures and works.
- Delivery could also be used to meet short-term environmental requirements in discrete wetlands or channels, such as supporting completion of a naturally triggered waterbird breeding event or to consolidate benefits of previous flows.
- Delivery will include use of private irrigation infrastructure (channels, pumps, on farm storage).
- The Office will continue to investigate the feasibility of such options and will seek input from interested parties.

Typical extent: Wetlands and anabranes of the Macintyre floodplain (e.g. Boomi, Whalan and Morella watercourses), floodplain wetlands in the area around junction of Macintyre and Dumaresq rivers. Creek systems between the Macintyre and the Weir River may also be targeted.

Approvals: Access to infrastructure would need to be negotiated with landholders and/or relevant Water Boards and agreement for inundation of privately owned wetlands. Consultation with NSW OEH, QLD DNRME, WaterNSW, NSW DoI Water, NSW and QLD Fisheries, QMDC, BREWN and landholders would be undertaken before implementing this action.

6. Anabranch connectivity:

Watering action: Contribute to flows to support connectivity of anabranes to facilitate nutrient and carbon exchange and the movement of biota between anabranes, wetlands and the river channel. Flows could also support movement, spawning and condition of native fish and other aquatic species.

Standard operational considerations:

- Action requires further investigation. The release of Commonwealth environmental water from Glenlyon and/or Pindari dams could be triggered by suitable unregulated flows or large regulated flows (e.g. irrigation deliveries, stimulus flow, stock and domestic replenishment flow) to achieve/extend connection of anabranes to the river, or provide re-connection to build on previous environmental outcomes.
- Commonwealth unregulated entitlements will contribute if flows trigger unregulated access
- Target flow rates will depend on prevailing flow conditions, specific outcomes sought at the time and operational considerations. Indicative flows to connect the main Macintyre anabranes are 7 500 to 10 000 ML/day at Goondiwindi.
- If fish outcomes are sought, the timing and duration of the action may depend on the target species and life cycle stage (spawning, migration, conditioning etc).
- Action is subject to agreement on operational arrangements, if Commonwealth environmental water needs to be released within an unregulated flow event.
- Protection of in-stream flows (unregulated access conditions) in these watercourses and maintenance of water levels in levels in waterholes and wetlands (stock and domestic access) is a potential risk.

Typical extent: Anabranes of the Macintyre floodplain.

Approvals: This action may require close cooperation with river operators in both states and water and land holders in the target area(s). Any diversions to anabranches would occur in collaboration with relevant stakeholders.

7. Wetlands – Connectivity:

Watering action: Contribute to a medium to large flow pulse to support lateral and longitudinal connectivity to low lying floodplain wetlands to boost invertebrate production; trigger breeding activity in birds, fish and amphibians and subsequent recruitment and movement of those species; maintain wetland and riparian vegetation and provide opportunities for reproduction.

Standard operational considerations:

- Upper reach wetlands in the NSW Severn River would be targeted with Commonwealth environmental water from Pindari dam: flows 1 200 ML/day required (Davie and Mitrovic 2014).
- Releases from Pindari dam would be in conjunction with the NSW stimulus flow and/or irrigation deliveries.
- Wetlands in the lower Macintyre could be targeted with releases from both or either dam.
- For lower reach floodplain wetlands (Dumaresq and Macintyre) this action should be in conjunction with suitable medium to large unregulated flows and would need operational arrangements in place. Alternatively, trade could be used to obtain additional unregulated access in the target reach of the lower Macintyre.
- Commonwealth unregulated entitlements will contribute to connection of lower Macintyre wetlands if unregulated access is triggered.
- Target flow rates will be dependent on the prevailing flow conditions, estimated commence to flow levels for target wetlands, the range outcomes sought and operational considerations.
- Water could be used to maintain and increase inundation or assist re-connection of wetlands and anabranches to the river channel to improve exchange of nutrients and carbon and ensure biota can return to the river.
- Water could be used provide extended recession to enhance cues for biota to move back to the river. Serial connection of wetlands may be particularly important for dispersal of some native fish species.
- Contribution to connection events for wetlands in the lower Dumaresq and Macintyre rivers may be limited by the small holdings in the Border. Third party impacts are unlikely but still possible: minor flooding at Goondiwindi and Boggabilla occurs at flows of 12 100 and 21 300 ML/day, respectively.

Typical extent: upper reach wetlands on the Severn (NSW) River; low lying wetlands on the Macintyre (downstream of Yetman) and Dumaresq rivers (downstream from Texas) to Mungindi, including on Boomi River.

Approvals: This action would require close cooperation with river operators in Queensland and NSW and potentially the irrigation community.

Attachment C – Long-term water availability

Commonwealth environmental water holdings

The Commonwealth holds the following entitlements in the Border Rivers:

- Queensland medium security 'supplemented' water allocations in the Border Rivers Water Supply Scheme and a small parcel of similar allocations in the Macintyre Brook Water Supply Scheme.
- Queensland 'unsupplemented' water allocations in the Border River Water Management Area (Dumaresq, Macintyre and Barwon zones), the Stanthorpe Water Management Area (QLD Severn River) and in Macintyre Brook.
- New South Wales Border Rivers General B Security in Pindari dam.
- New South Wales 'supplementary' water allocation in the Border Rivers.

The full list of Commonwealth environmental water holdings can be found at www.environment.gov.au/topics/water/commonwealth-environmental-water-office/about-commonwealth-environmental-water/how-much and is updated monthly.

Other sources of environmental water

There are currently no other sources of held environmental water in the Border Rivers.

Planned environmental water

In addition to water entitlements held by environmental water holders, environmental demands may also be met via natural or unregulated flows and water provided for the environment under rules in state water plans (referred to as 'planned environmental water').

Key rules in the Border Rivers catchment protect some unregulated flows and inflows to dams:

- Low flows in river reaches below Coolmunda (Macintyre Brook) and Pindari (NSW Severn River) dams are protected by translucency rules that pass small inflows into the dams (in the range 50 to 200 ML/day) downstream. A rule in both state water plans protects natural low flows throughout the system in the warmer months (September to March) by requiring that unregulated inflows up to 100 ML/day at Mungindi are not used to supply regulated water orders.
- Take of water during unregulated flows is restricted to announced access periods (water harvesting in QLD and supplementary access in NSW), governed by river flow thresholds for the commencement and cessation of take. For large scale irrigators, access generally requires flows of at least 10 000 ML passing Goondiwindi over 2 days and ceases when two day flows fall below 3 650 ML. Site specific passing flow thresholds also apply to small scale irrigation enterprises on the Macintyre River in NSW and the QLD and NSW sides of the Dumaresq River.
- Flow-limited take periods are supported by a rule in both state water plans requiring that 25 per cent of all inflows to the system during announced unregulated events are protected from extraction to Mungindi.
- Overall these rules strive to achieve average end of system flows that are at least 61 per cent of pre-development levels. A rule in the NSW water sharing plan (applies to only 50 per cent of available unregulated flows) also allows for supplementary access to be restricted at times when these flows are needed in the Barwon–Darling River to provide for critical town water supplies or mitigate algal blooms.
- The NSW water sharing plan also reserves 4 000 ML per year for a stimulus flow release to mirror a natural fresh in the NSW Severn River (August to December). The release is triggered by an inflow into Pindari dam of over 1 200 ML (in one day) in the period April to August. Unused flows can be carried over to a maximum of 8 000 ML.



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