Valley report cards

Technical supplement to Basin-scale 2019–20 evaluation of Commonwealth environmental water: Hydrology

Commonwealth Environmental Water Office (CEWO): Monitoring, Evaluation and Research Program

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We take this opportunity to thank the many individuals and agencies who provided data to support this evaluation. This includes officers within the CEWO, Victorian Environmental Water Holder (VEWH), WaterNSW, Goulburn-Murray Water (GMW), South Australian Department for Environment and Water (DEW), NSW Department of Planning, Industry and Environment (DPIE), Mallee Catchment Management Authority (CMA), North-Central CMA, Goulburn Broken CMA, the Murray–Darling Basin Authority (MDBA) and Geoscience Australia. The authors would also like to thank Jim Foreman, Aftab Ahmad and Matt Gibbs for assistance with modelling and review. We would like to thank the CSIRO and University of Canberra teams for their efforts in report layout, editing, reviewing and formatting. Special mention to Susan Cuddy and Jackie O'Sullivan whose input, together with formatting specialist, Jill Sharkey, greatly improved the readability of the report.

Document submission history

2 July 2021	Final draft incorporating reviewer comments
3July 2021	Final draft with minor corrections
27 August 2021	Final

Cover photograph

Flooded creek in Yanga National Park, NSW
Photo credit: Tanya Doody

Overview of Flow-MER

Flow-MER is the Commonwealth Environmental Water Office's (CEWO) Monitoring, Evaluation and Research Program. Its objective is to monitor and evaluate the ecological responses to the delivery of Commonwealth environmental water in the Murray–Darling Basin. It provides the CEWO with evidence to inform our understanding of how water for the environment is helping maintain, protect, and restore the ecosystems and native species across the Basin. This work will support environmental water managers, demonstrate outcomes, inform adaptive management and fulfil the legislative requirements associated with managing Commonwealth-owned environmental water.

The Program runs from 2019 to 2022 and consists of 2 components: monitoring and research in 7 Selected Areas (Selected Area projects); and Basin-scale evaluation and research (the Basin-scale project) (Figure 1 The 7 Selected Areas and 25 valleys established for long-term monitoring of the effects of environmental watering under the LTIM Project and Flow-MER Program (2014–15 to present)Figure 1). The Basin-scale project is led by CSIRO in partnership with the University of Canberra, and collaborating with Charles Sturt University, Deakin University, University of New England, South Australian Research and Development Institute, Arthur Rylah Institute, NSW Department of Planning, Industry and Environment, Australian River Restoration Centre and Brooks Ecology & Technology.

It builds on work undertaken through the Long Term Intervention Monitoring (LTIM) (2015–2019) and Environmental Water Knowledge and Research (EWKR) (2014–2019) projects.

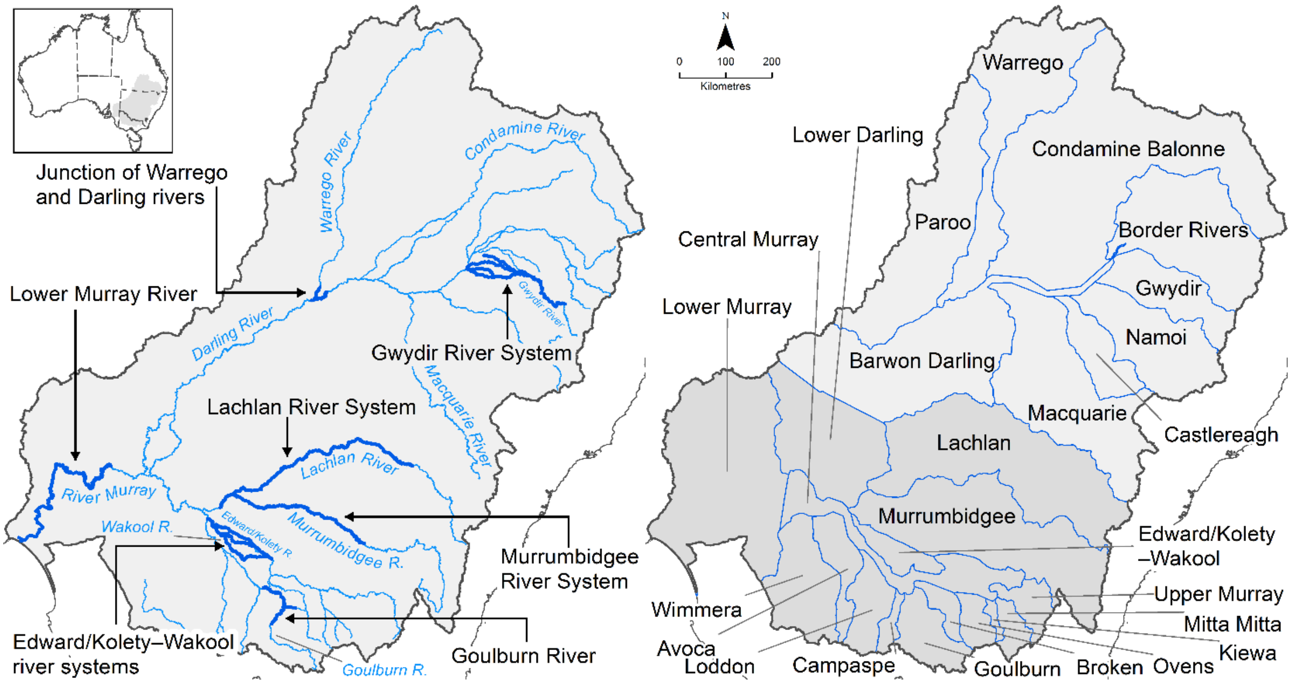


Figure 1 The 7 Selected Areas and 25 valleys established for long-term monitoring of the effects of environmental watering under the LTIM Project and Flow-MER Program (2014–15 to present)

The Flow-MER evaluation adopts an adaptive management framework to acknowledge the need for collectively building the information, networks, capacity and knowledge required to manage environmental water at Basin scale. While knowledge of ecological response to instream flow and inundation has advanced significantly in recent years, substantive challenges remain in understanding the similarities and differences in species' response across time and space, as well as the interaction between species at a community and ecosystem scale.

The Basin-scale evaluation is being undertaken across 6 Basin Themes (Figure 2) based on ecological indicators developed for the LTIM Project and described in the Environmental Water Outcomes Framework. It is undertaken in conjunction with the Selected Area projects, which provide data, research and knowledge for ecological outcomes within the 7 Selected Areas. The Basin-scale evaluation integrates across Selected Areas, themes, datasets, approaches and different types of knowledge.

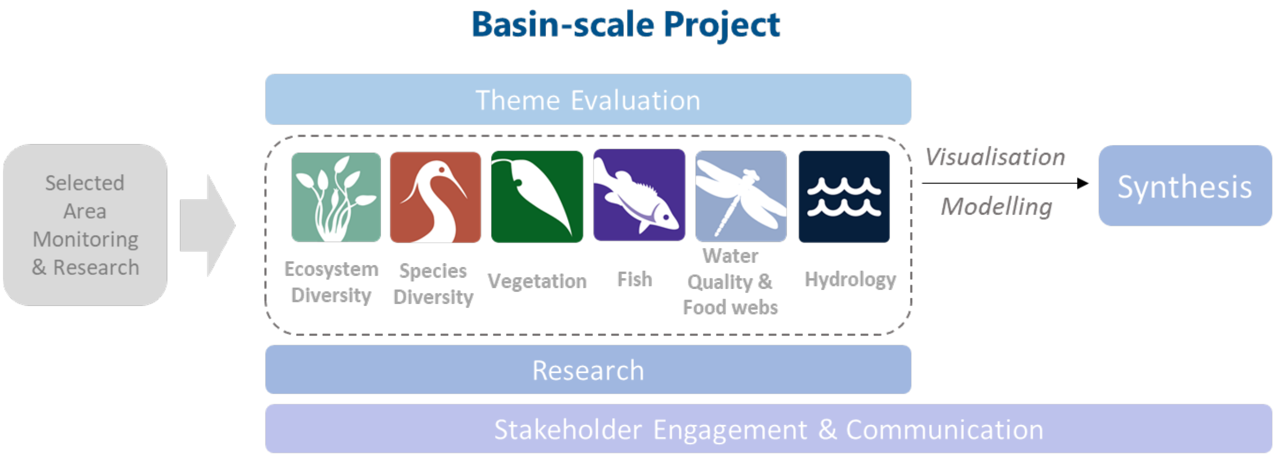


Figure 2 Basin-scale Project evaluation reports on Commonwealth environmental water outcomes for the 6 Basin Themes as well as a high-level Basin-scale synthesis
The evaluation is informed by Basin-scale research projects, stakeholder engagement and communication, including Indigenous engagement, visualisation and modelling, as well as the 7 Selected Area projects

About the Basin-scale evaluation

Water delivery and outcomes data provided by CEWO is used in conjunction with monitoring data provided by the 7 Selected Areas and other publicly available data to undertake the Basin-scale evaluation. The research and evaluation content is structured into 6 disciplinary themes. Technical reports for each of the 6 themes are available from the Commonwealth Environment Water Office's website.

The evaluation aims to address theme specific questions in relation to how Commonwealth environmental water contributed to, supported, or influenced environmental outcomes. Commonwealth environmental water is often delivered in conjunction with other environmental water holdings, and non-environmental water releases (such as for irrigation or during high-flow events). The evaluation consequently draws on available information to estimate (where possible) the specific contribution of Commonwealth environmental water to particular environmental outcomes. The way in which this contribution is assessed varies between the 6 themes depending on the data and tools currently available:

- modelling to estimate and compare outcomes both with and without Commonwealth environmental water (counterfactual modelling): hydrology (instream); fish (multi-year evaluation)
- identification of ecological response in locations that received Commonwealth environmental water (potentially in conjunction with other sources of environmental water or non-environmental water), and where feasible, comparison with areas that did not receive Commonwealth environmental water: ecosystem diversity, species diversity, vegetation
- use of flow and water quality metrics to infer likely outcomes: hydrology (inundation); food webs and water quality
- synthesis of findings across Selected Areas: fish (annual); vegetation; food webs and water quality.

This report

Of the 25 valleys in the Basin (19 reported herein), 17 received Commonwealth environmental water in the 2019–20 water year (Naomi and Lower Darling valleys not included). This report is a technical supplement to Guarino and Sengupta (2021) and presents detailed descriptions of the contributions of Commonwealth environmental water to these valleys. The structure and layout of this supplement is consistent with that developed for, and used in, the earlier LTIM project. As such, much of the text and the majority of figures and tables are the same as or have been adapted from Stewardson and Guarino (2020).

Contents

1 Gwydir Valley

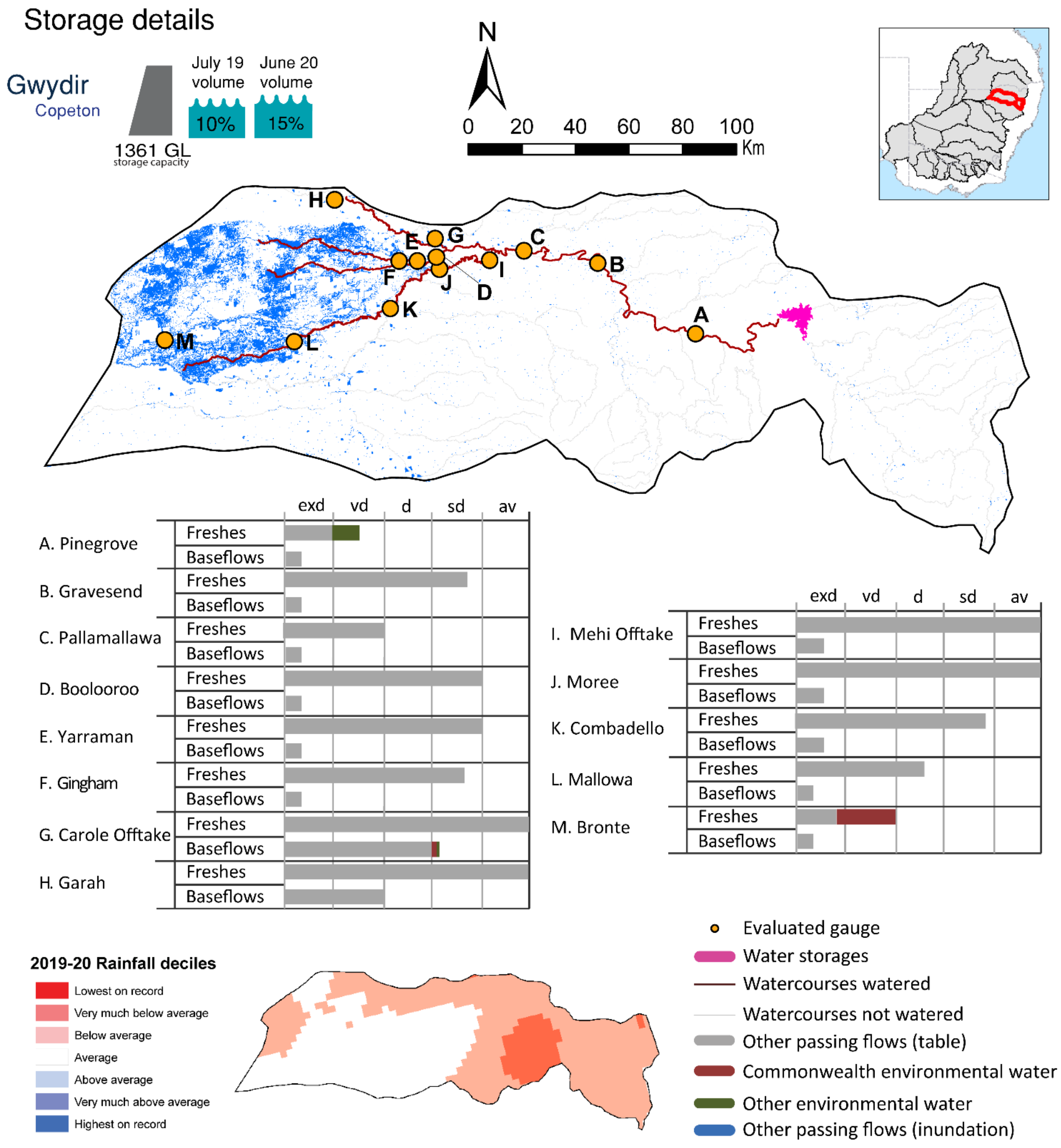


Figure GWY1: Watercourses influenced, areas inundated (where applicable) and gauge stations evaluated in the Gwydir valley during the 2019–20 water year. Inset bar graphs report the condition of annual flow regimes by showing the improvements in hydrological condition with the addition of environmental water as well as the hypothetical scenario in 'grey' (if no environmental flow had been delivered). Rainfall conditions (rainfall deciles) and trend in storage levels for the water year are also shown. The classified bands are: exd = extremely dry, vd=very dry, sd=somewhat dry and av=average.

1.1 Summary

The volume of environmental water delivery for the 2019–20 year in the Gwydir valley is quantified using data for 13 sites. This evaluation only considers the contribution of held environmental water, which is a primary focus for the Commonwealth. The contributions of planned environmental water (e.g. passing flows), unregulated tributary inflows, and use of irrigation flows for environmental benefits can all be very important but these are outside the scope of this report.

Environmental watering actions lasted on average 34 days over the course of the year. The volume of environmental water at these 13 sites was between 0% and 42% of the total streamflow. Commonwealth environmental water contributed on average 52% of this environmental water.

Ideally, baseflows should be maintained and long periods of excessively low flows avoided. In this valley, the baseflow regime was generally considered to be extremely dry relative to the pre-development flow regime. In our analysis, a low fresh refers to a period of increased flow, when the water level rises at least one eighth of the way up the river bank (above the low flow level). These low freshes are a regular part of the natural flow regime and support a range of natural processes. In terms of the occurrence and duration of low freshes, the year was assessed as being somewhat dry.

We define a medium fresh as being a period of increased flow, when the water level rises at least one quarter of the way up the river bank. These medium freshes are not as frequent as low freshes but are also a regular and important part of the natural flow regime. The occurrence of medium freshes for the year was assessed as being somewhat dry.

In our analysis, a high fresh refers to a period of increased flow, when the water level rises more than half way up the river. Whilst a high fresh may not occur every year, long periods without major freshes can have serious consequences for floodplains and their contribution to river ecosystem health. Delivering environmental flows with an overall high flow volume normally requires that all risks to riparian landholders and infrastructure have been resolved. In the Gwydir valley, in terms of the occurrence of high freshes, the year was assessed as being somewhat dry.

1.2 Water delivery context

During the 2019–20 water year, the Commonwealth Environmental Water Holder (CEWH) held water entitlements of up to 114,484 ML for environmental use in the Gwydir valley. Each year, water utilities allocate water entitlement holders a percentage of water based on their holding, licence type and carryover (the exact rules vary among Jurisdictions and licence type). In 2019–20, the Gwydir entitlements held by the CEWH were allocated 6,451 ML of water, representing 13% of the Long term average annual yield (LTAAY) for the Gwydir valley (47,932 ML). Information and data relating to the portfolio of held Commonwealth environmental water is shown in Table GWY1.

The 2019–20 water allocation (6,451 ML) together with the carryover volume of 11,589 ML of water meant the CEWH had 18,039 ML of water available for delivery. A total of 9,070 ML of Commonwealth environmental water was delivered in the Gwydir valley. A total of 12039 ML (67%) of available Commonwealth environmental water was carried over for environmental use into the 2020–21 water year.

1.3 Environmental conditions and resource availability

The water available for environmental delivery combined with the present and antecedent environmental conditions are key inputs used by environmental water managers in planning and implementing watering actions. *Post hoc*, this information provides important context when evaluating the effectiveness and appropriateness of environmental water use with respect to hydrological outputs.

The rainfall conditions in the Gwydir valley were classified as below average, based on rainfall percentile data for the entire record held by the Bureau of Meteorology for this valley. The water held in major storages in the Gwydir valley decreased over the water year, for example Copeton dam was 10.3% full at the beginning of the water year and 14.5% full by the end of the year (Figure GWY1).

The CEWO calculates resource availability scenarios (RAS) to guide the use and prioritisation of held environmental water. The RAS are progressively calculated over the year as part of the continual adaptive management planning processes. The RAS are based on the availability of held environmental water (including progressive licence acquisitions and allocations) as well as the potential for unregulated or planned environmental flows. The outcome is then used to determine the demand for environmental water across the Basin.

In 2019–20, the resource availability of held Commonwealth environmental water in the Gwydir was classified as very low to moderate, whilst the overall demand for environmental water was classified as critical to low. The physical conditions meant that the CEWO was managing to protect critical refuges for fish and vegetation in wetlands and river reaches, avoiding irreversible loss and ensuring their ecological capacity for recovery.

1.4 Watering actions

A total of 3 watering actions were delivered over the 2019–20 water year, the duration of these actions varied (range of individual actions: 1 - 100 days) and Commonwealth environmental water was delivered for a total of 103 days. The number of water actions commencing in each season included, summer (2), autumn (1), winter (0), spring (0). Similarly, the count of flow component types delivered in the Gwydir valley were; (1) baseflow, (0) baseflow-fresh, (0) baseflow-fresh-bankfull, (1) baseflow-fresh-overbank-wetland, (0) fresh, (0) fresh-wetland, (0) bankfull, (0) overbank, (0) wetland and (1) wetland-overbank.

In the Gwydir, watering actions were delivered for water quality, ecosystem processes and vegetation purposes, but water was also delivered for other purposes too. The percentage of watering actions delivered across the nine main themes included fish (0.0%), vegetation (50%), waterbirds (0.0%), frogs (0.0%), other biota (0.0%), connectivity (0.0%), process (25%), resilience (0.0%) and water quality (25%).

Table GWY1. Commonwealth environmental water accounting information for the Gwydir valley over 2019–20 water year (where LTAAY is the Long-term Average Annual Yield)

Total registered volume (ML)	Allocated volume (ML)	Carry over + allocated volume (ML)	Delivered (ML)	LTAAY (ML)	Carried over to 2020–21
114,484	6,451	18,039	9,070	47,932	12,039

1.5 Contribution of Commonwealth environmental water to flow regimes

1.5.1 Pinegrove

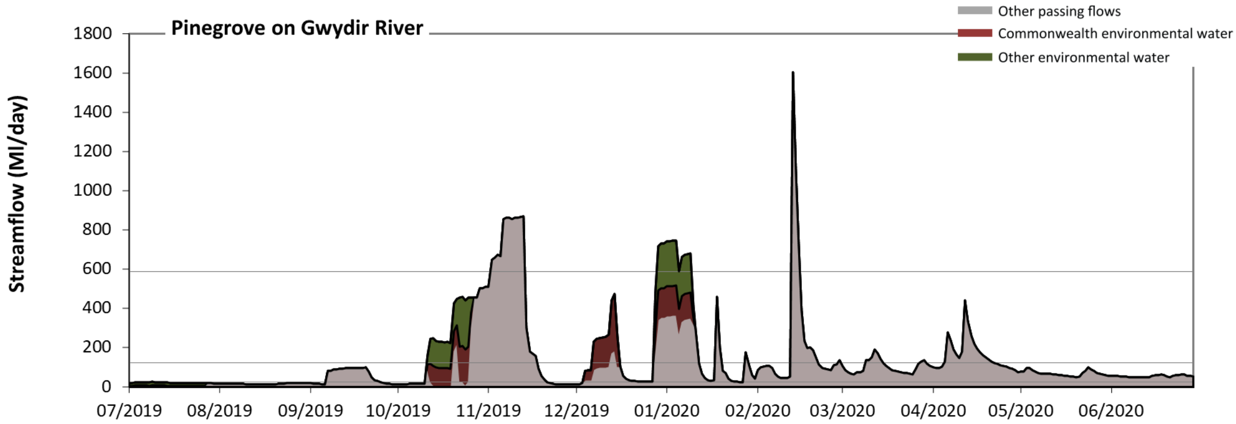


Figure GWY2: Contribution of environmental water delivery at Pinegrove. Horizontal lines indicate thresholds for very low flows, low flows and low freshes (from lowest to highest).

At Pinegrove on Gwydir River environmental water contributed 21% of the total streamflow volume (with approximately half contributed by Commonwealth environmental water). Environmental watering actions affected streamflows for 19% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 25 ML/day) in the periods July to September and October to December would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 30% to 27% of the year, with greatest influence in the period October to December. Similarly, without environmental water, the durations of low flows (i.e. < 120 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 78% to 73% of the year, with greatest influence in the period October to December. Commonwealth environmental water equally shared responsibility with other environmental water holders for these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 590 ML/day) in the periods October to December and January to March. Environmental water increased the duration of the longest low fresh during the period January to March (from 3 days to 9 days). Commonwealth environmental water made little or no contribution to these increased durations of low freshes. There were no medium or high freshes this year.

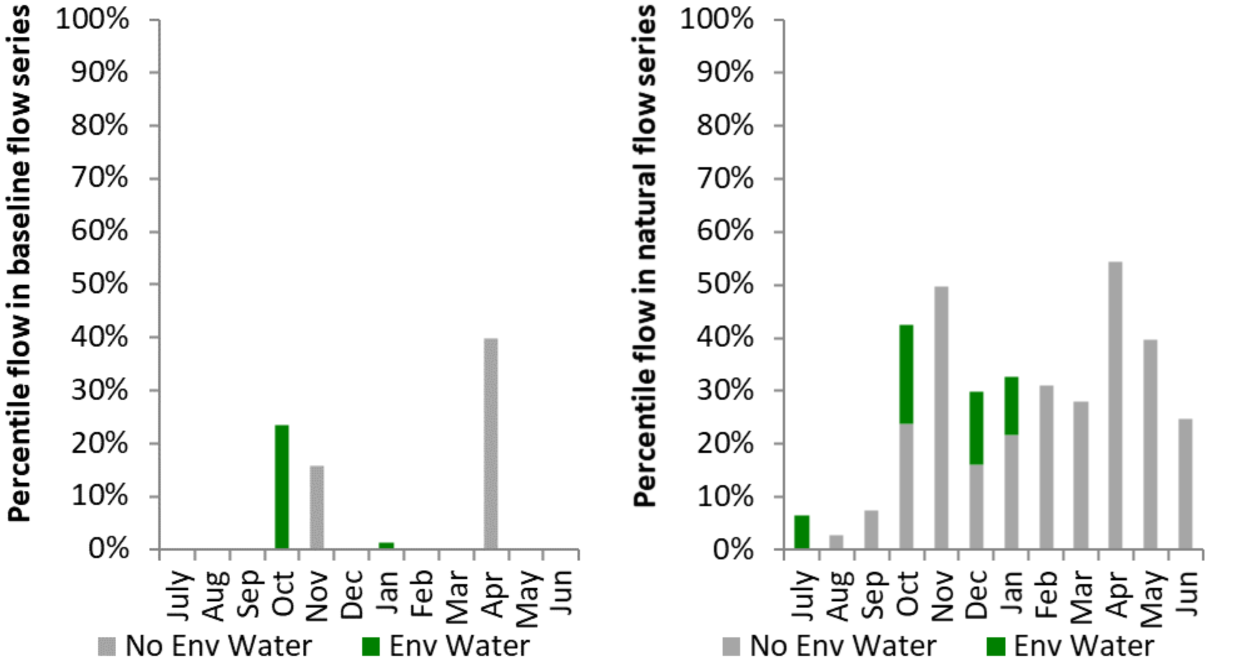


Figure GWY3: Contribution of environmental water delivery at Pinegrove as percentiles in the natural and baseline flow series.

1.5.2 Gravesend

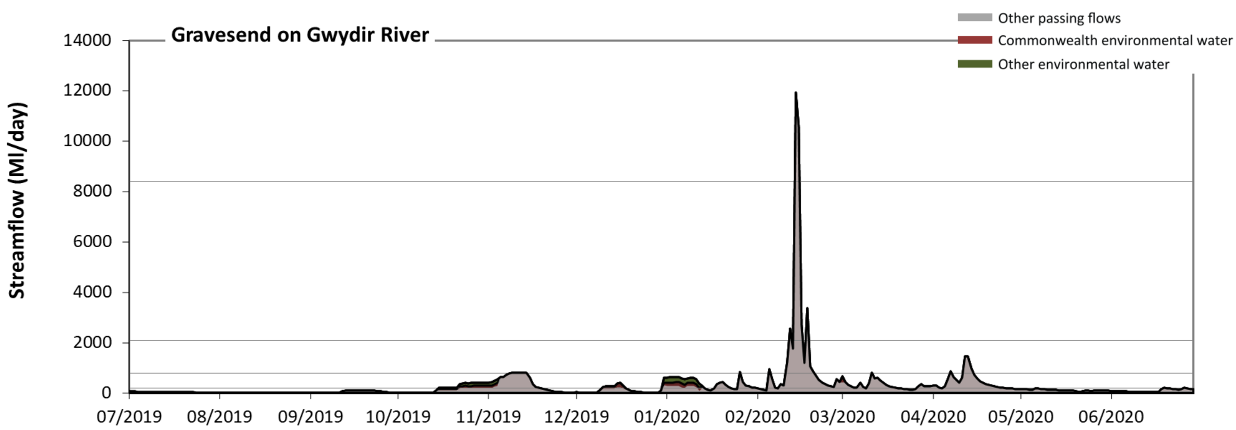


Figure GWY4: Contribution of environmental water delivery at Gravesend. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Gravesend on Gwydir River environmental water contributed 9% of the total streamflow volume (with approximately half contributed by Commonwealth environmental water). Environmental watering actions affected streamflows for 21% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 40 ML/day) in the periods July to September and October to December would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 31% to 29% of the year, with greatest influence in the period July to September. Similarly, without environmental water, the durations of low flows (i.e. < 200 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 70% to 63% of the year, with greatest influence in the period October to December. Commonwealth environmental water equally shared responsibility with other environmental water holders for these enhancements of environmental baseflows at this site. There was at least one low fresh (i.e. > 780 ML/day) in the periods October to December, January to March and April to June. Environmental water made no change to the duration of these low freshes. There was at least one medium fresh (i.e. > 2100 ML/day) in the period January to March. Environmental water made no change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the period January to March. Environmental water made no change to the duration of these high freshes.

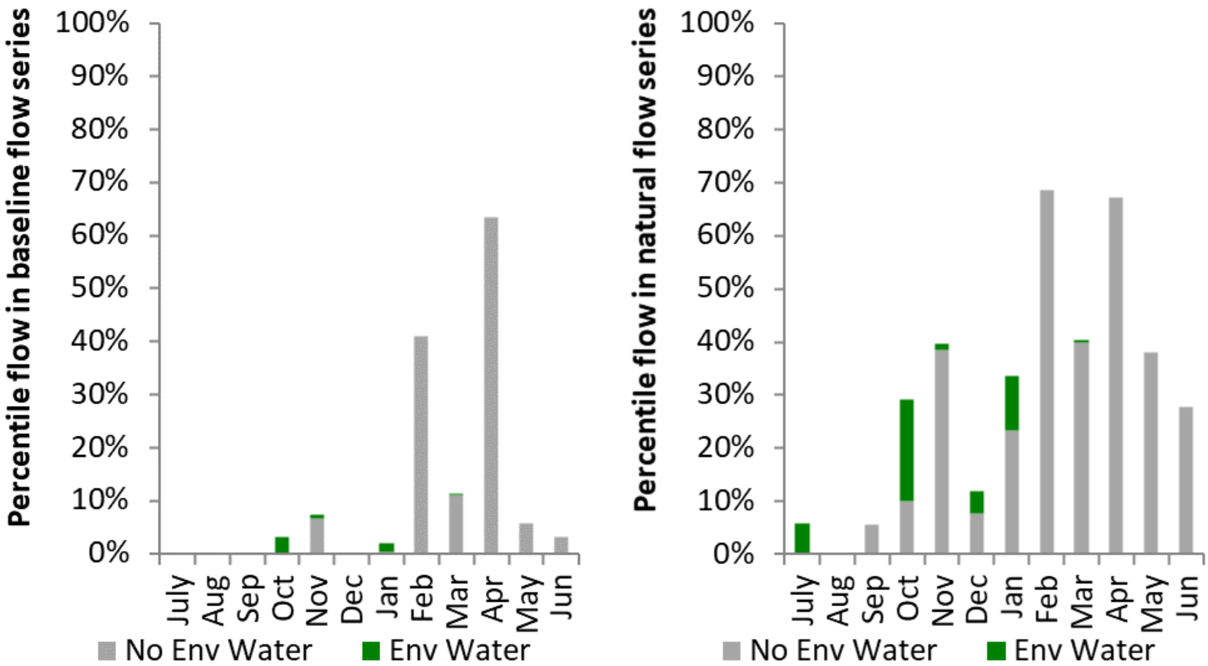


Figure GWY5: Contribution of environmental water delivery at Gravesend as percentiles in the natural and baseline flow series.

1.5.3 Pallamallawa

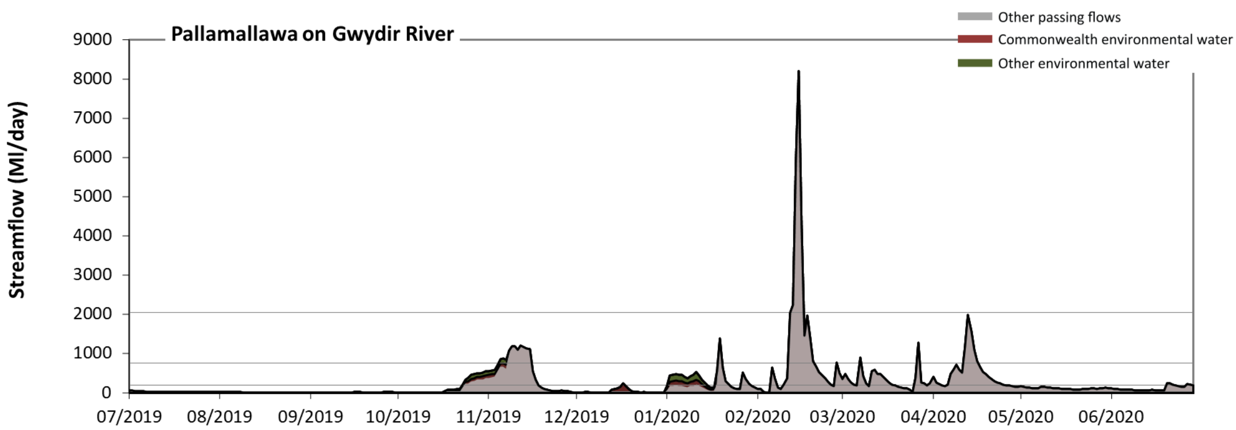


Figure GWY6: Contribution of environmental water delivery at Pallamallawa. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Pallamallawa on Gwydir River environmental water contributed 9% of the total streamflow volume (with approximately half contributed by Commonwealth environmental water). Environmental watering actions affected streamflows for 32% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 39 ML/day) in the periods July to September and October to

December would have substantially exceeded durations expected in an average year in the natural flow regime[1]. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 42% to 37% of the year, with greatest influence in the periods July to September and October to December. Similarly, without environmental water, the durations of low flows (i.e. < 200 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 72% to 68% of the year, with greatest influence in the period January to March. Commonwealth environmental water equally shared responsibility with other environmental water holders for these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 770 ML/day) in the periods October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the period October to December (from 8 days to 11 days). Commonwealth environmental water equally shared responsibility with other environmental water holders for these increased durations of low freshes. There was at least one medium fresh (i.e. > 2000 ML/day) in the period January to March. Environmental water made no change to the duration of these medium freshes. There was no high freshes (i.e. > 8400 ML/day) this year.

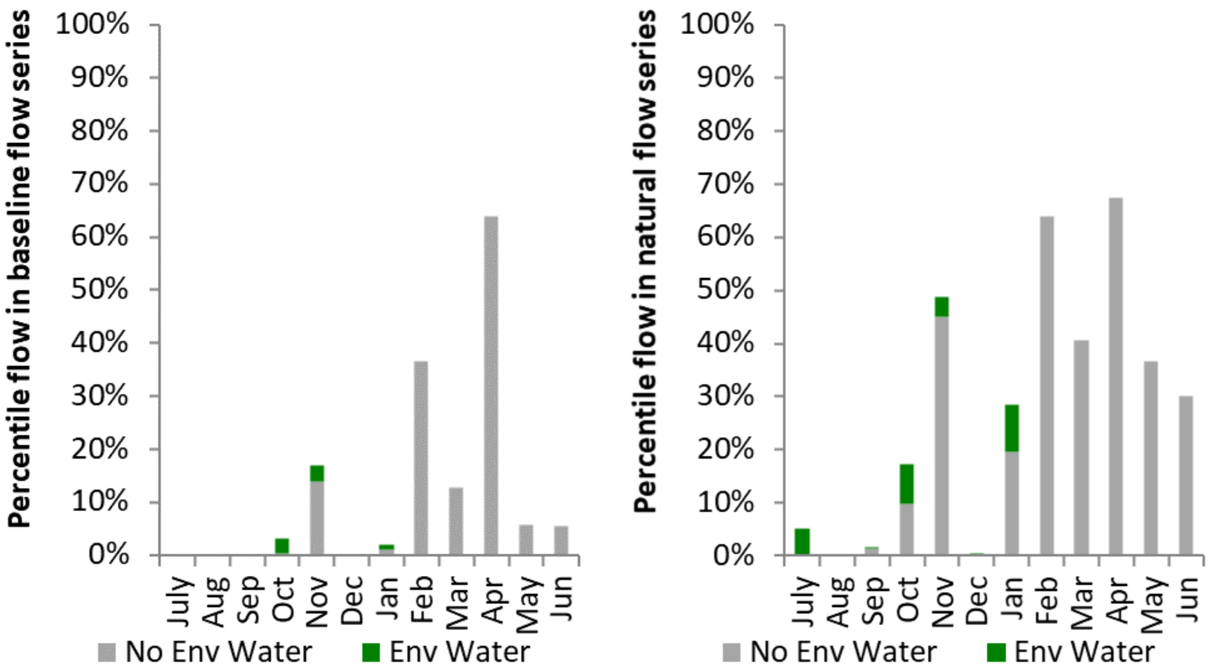


Figure GWY7: Contribution of environmental water delivery at Pallamallawa as percentiles in the natural and baseline flow series.

[1] The method to derive the reference set is described in the Methods chapter of Guarino and Sengupta 2021.

1.5.4 Mehi Offtake

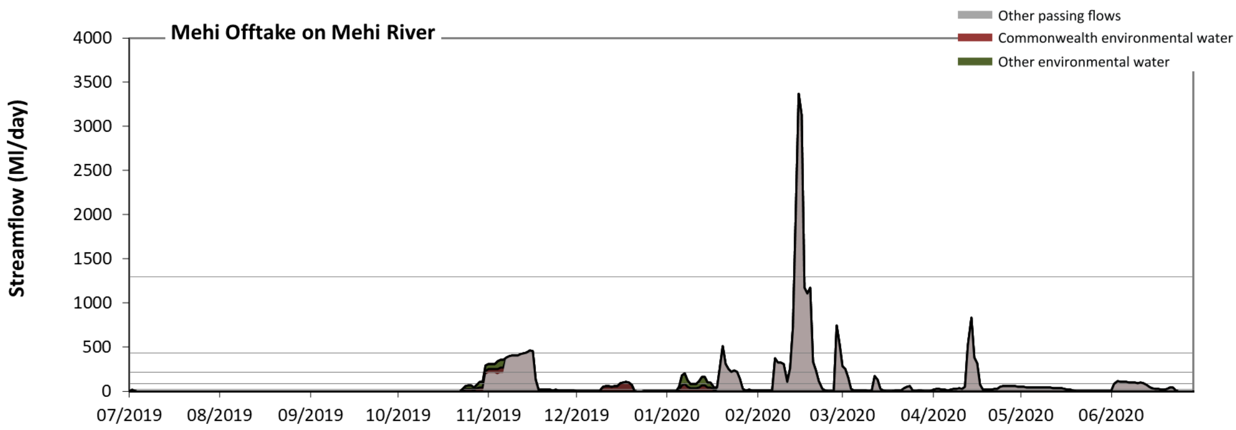


Figure GWY8: Contribution of environmental water delivery at Mehi Offtake. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Mehi Offtake on Mehi River environmental water contributed 11% of the total streamflow volume (with approximately half contributed by Commonwealth environmental water). Environmental watering actions affected streamflows for 11% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 18 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 66% to 57% of the year, with greatest influence in the periods October to December and January to March. Similarly, without environmental water, the durations of low flows (i.e. < 90 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 83% to 79% of the year, with greatest influence in the periods October to December and January to March. Commonwealth environmental water equally shared responsibility with other environmental water holders for these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 220 ML/day) in the periods October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the period October to December (from 10 days to 17 days). Commonwealth environmental water equally shared responsibility with other environmental water holders for these increased durations of low freshes. There was at least one medium fresh (i.e. > 440 ML/day) in the periods October to December, January to March and April to June. Environmental water made no change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the period January to March. Environmental water made no change to the duration of these high freshes.

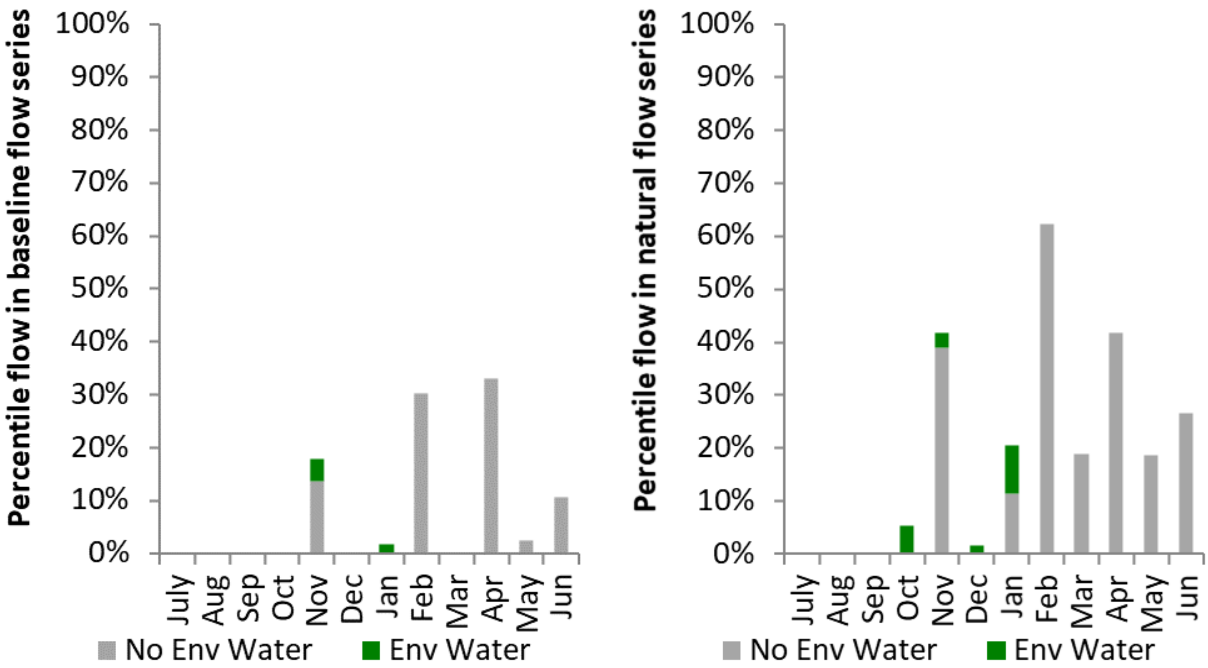


Figure GWY9: Contribution of environmental water delivery at Mehi Offtake as percentiles in the natural and baseline flow series.

1.5.5 Carole Offtake

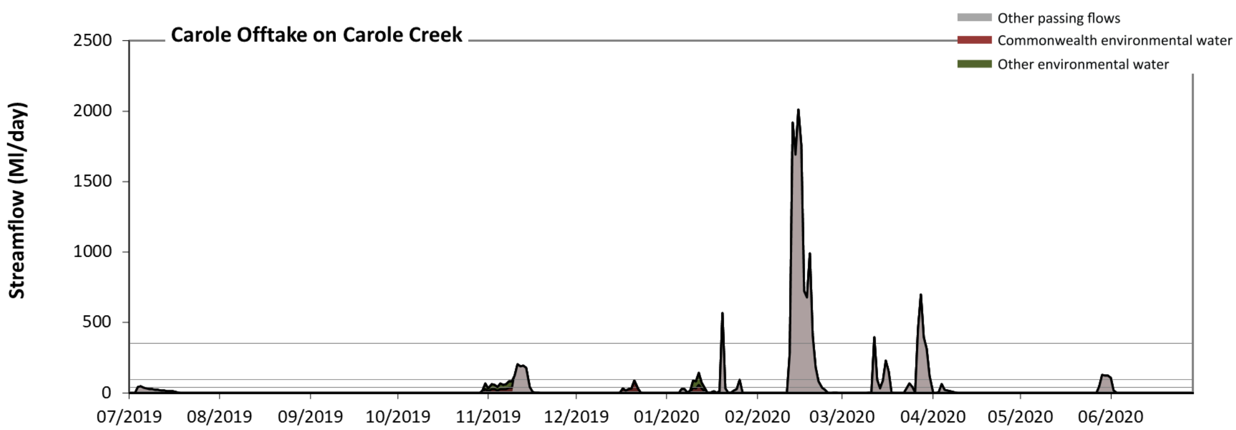


Figure GWY10: Contribution of environmental water delivery at Carole Offtake. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Carole Offtake on Carole Creek environmental water contributed 7% of the total streamflow volume (with approximately half contributed by Commonwealth environmental water). Environmental watering actions affected streamflows for 7% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 2.1 ML/day) in the periods July to September, October to December and April to June would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 80% to 74% of the year, with greatest influence in the periods October to December and January to March. Similarly, without environmental water, the durations of low flows (i.e. < 10 ML/day) in the periods July to September and October to December would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 82% to 76% of the year, with greatest influence in the periods October to December and January to March. Commonwealth environmental water equally shared responsibility with other environmental water holders for these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 36 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the period October to December (from 6 days to 14 days). Commonwealth environmental water made little or no contribution to these increased durations of low freshes. There was at least one medium fresh (i.e. > 92 ML/day) in the periods October to December, January to March and April to June. Environmental water made no change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the period January to March. Environmental water made no change to the duration of these high freshes.

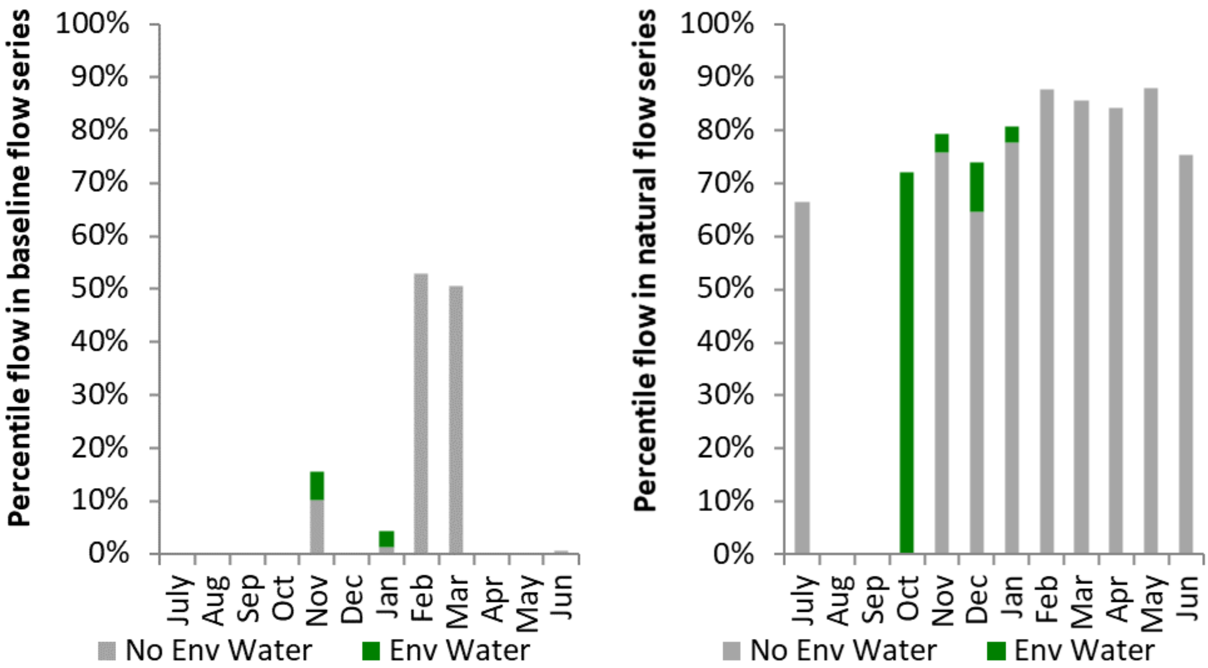


Figure GWY11: Contribution of environmental water delivery at Carole Offtake as percentiles in the natural and baseline flow series.

1.5.6 Boolooroo

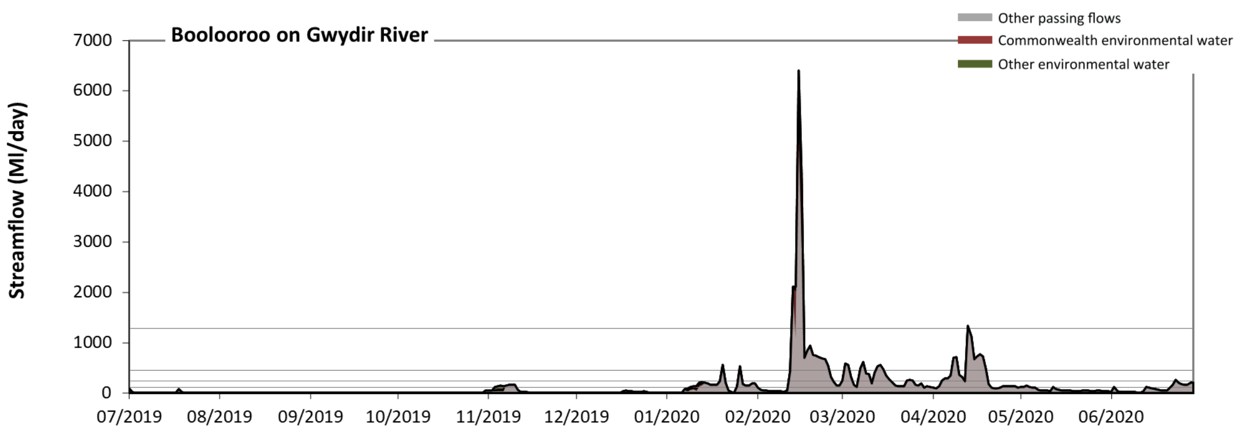


Figure GWY12: Contribution of environmental water delivery at Boolooroo. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Boolooroo on Gwydir River environmental water contributed 9% of the total streamflow volume (much of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 7% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 21 ML/day) in the periods July to September, October to December and January to March would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 53% to 49% of the year, with greatest influence in the period October to December. Similarly, without environmental water, the durations of low flows (i.e. < 100 ML/day) in the periods July to September, October to December and January to March would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 69% to 67% of the year, with greatest influence in the periods October to December and January to March. Commonwealth environmental water made the dominant contribution to these enhancements of environmental baseflows at this site. There was at least one low fresh (i.e. > 230 ML/day) in the periods January to March and April to June. Environmental water made no change to the duration of these low freshes. There was at least one medium fresh (i.e. > 450 ML/day) in the periods January to March and April to June. Environmental water made no change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the periods January to March and April to June. Environmental water increased the duration of the longest medium fresh during the period January to March (from 2 days to 4 days). Commonwealth environmental water was entirely responsible for these increased durations of high freshes.

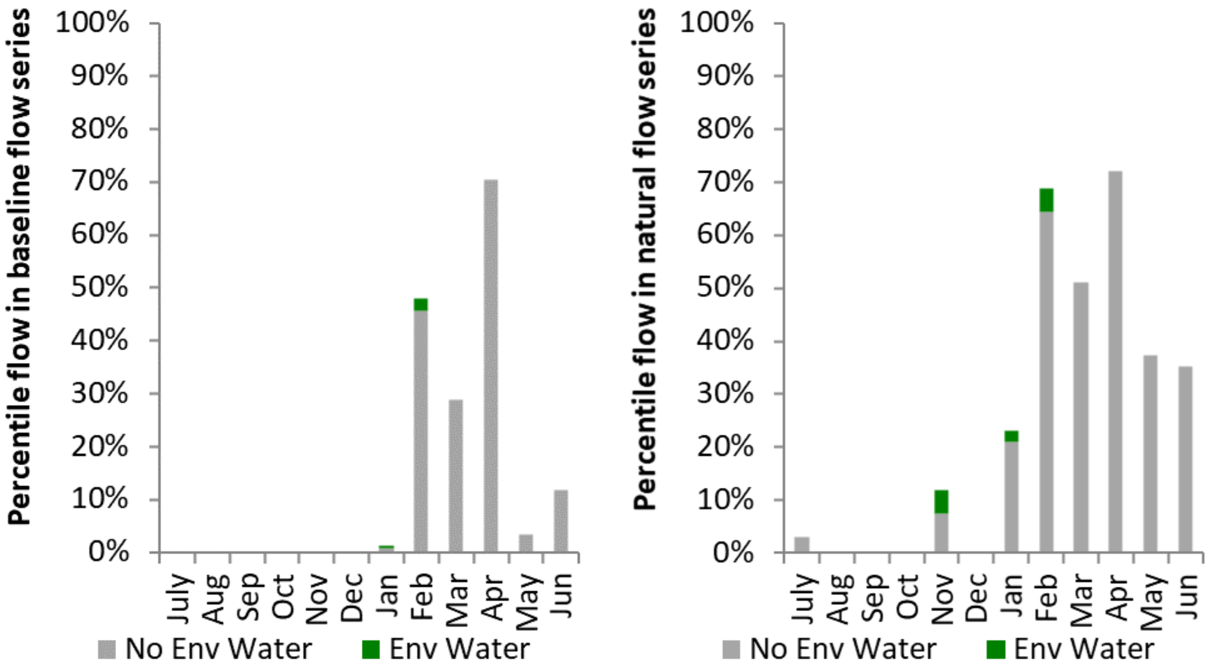


Figure GWY13: Contribution of environmental water delivery at Boolooroo as percentiles in the natural and baseline flow series.

1.5.7 Yarraman

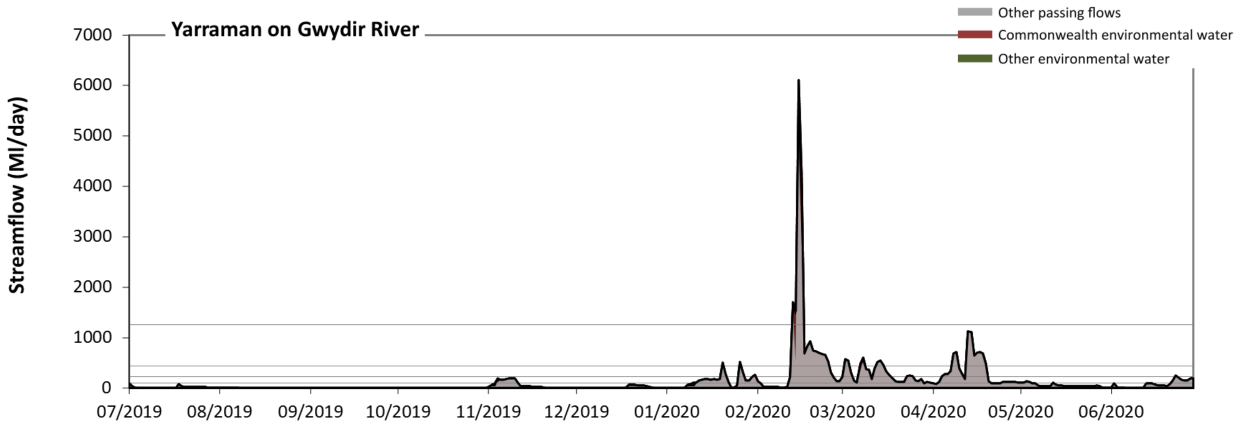


Figure GWY14: Contribution of environmental water delivery at Yarraman. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Yarraman on Gwydir River environmental water contributed 9% of the total streamflow volume (much of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 5% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 19 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 51% to 49% of the year, with greatest influence in the periods October to December and January to March. Similarly, without environmental water, the durations of low flows (i.e. < 94 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these low flows, which occurred for 68% of the year. There was at least one low fresh (i.e. > 220 ML/day) in the periods January to March and April to June. Environmental water made no change to the duration of these low freshes. There was at least one medium fresh (i.e. > 430 ML/day) in the periods January to March and April to June. Environmental water made no change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the period January to March. Environmental water increased the duration of the longest medium fresh during the period January to March (from 2 days to 4 days). Commonwealth environmental water was entirely responsible for these increased durations of high freshes.

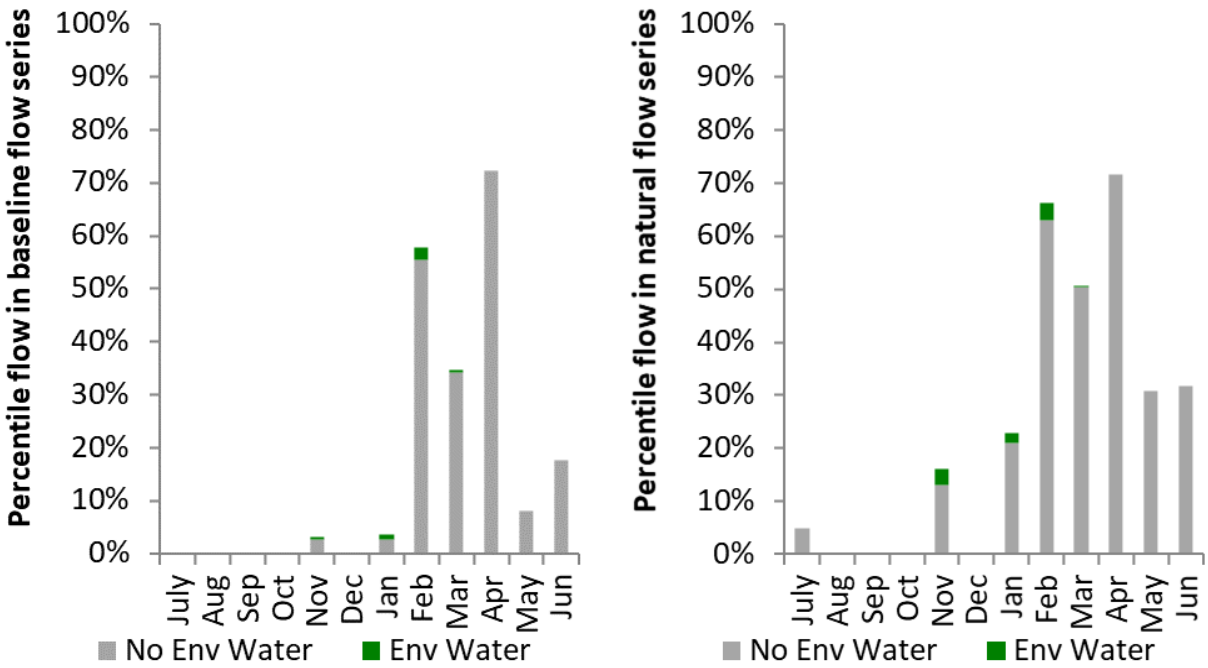


Figure GWY15: Contribution of environmental water delivery at Yarraman as percentiles in the natural and baseline flow series.

1.5.8 Gingham Diversion

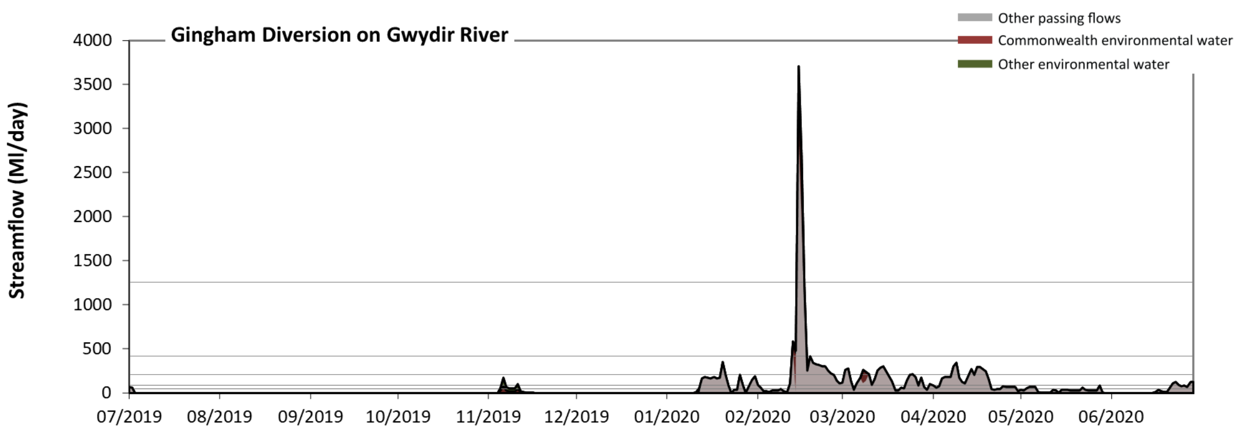


Figure GWY16: Contribution of environmental water delivery at Gingham Diversion. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Gingham Diversion on Gwydir River environmental water contributed 12% of the total streamflow volume (much of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 5% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 50 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 72% to 70% of the year, with greatest influence in the period October to December. Similarly, without environmental water, the durations of low flows (i.e. < 84 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 78% to 78% of the year, with greatest influence in the periods October to December and January to March. There was at least one low fresh (i.e. > 210 ML/day) in the periods January to March and April to June. Environmental water made little change to the duration of these low freshes. In the absence of environmental water there would have been at least one medium fresh (i.e. > 420 ML/day) in the period January to March. Environmental water increased the duration of the longest medium fresh during the period January to March (from 3 days to 5 days). Commonwealth environmental water was entirely responsible for these increased durations of medium freshes. In the absence of environmental water there would have been at least one high fresh in the period January to March. Environmental water made no change to the duration of these high freshes.

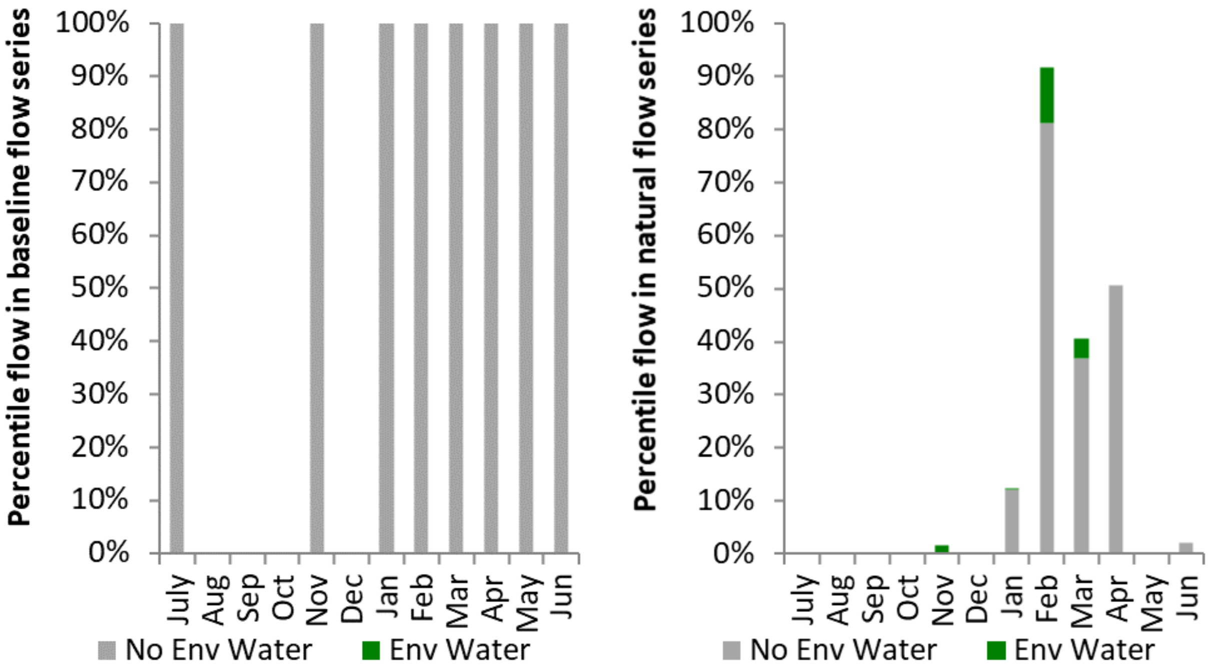


Figure GWY17: Contribution of environmental water delivery at Gingham Diversion as percentiles in the natural and baseline flow series.

1.5.9 Moree

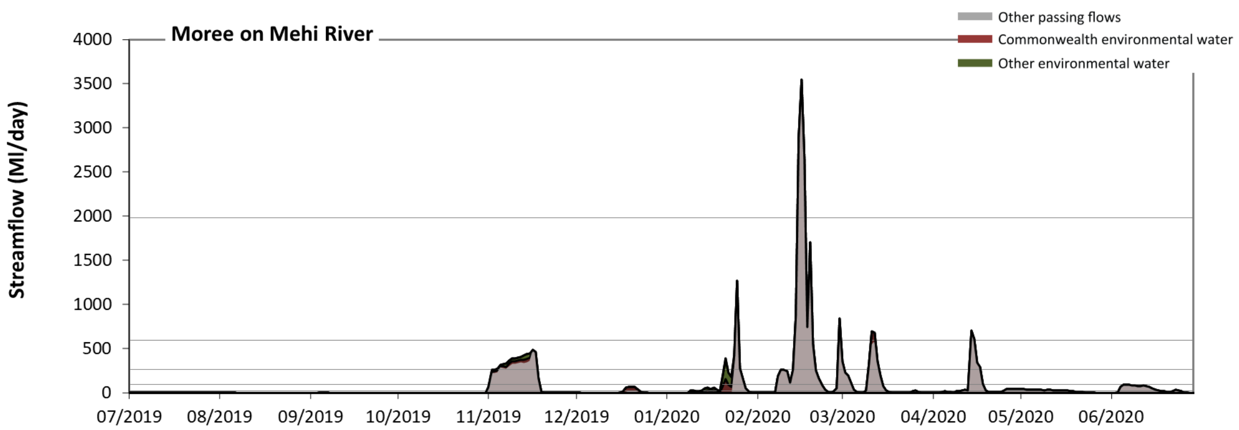


Figure GWY18: Contribution of environmental water delivery at Moree. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Moree on Mehi River environmental water contributed 8% of the total streamflow volume (with approximately half contributed by Commonwealth environmental water). Environmental watering actions affected streamflows for 11% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 19 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 70% to 65% of the year, with greatest influence in the period January to March. Similarly, without environmental water, the durations of low flows (i.e. < 95 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 86% to 85% of the year, with greatest influence in the period January to March. Commonwealth environmental water equally shared responsibility with other environmental water holders for these enhancements of environmental baseflows at this site. There was at least one low fresh (i.e. > 270 ML/day) in the periods October to December, January to March and April to June. Environmental water made no change to the duration of these low freshes. There was at least one medium fresh (i.e. > 590 ML/day) in the periods January to March and April to June. Environmental water made no change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the period January to March. Environmental water made no change to the duration of these high freshes.

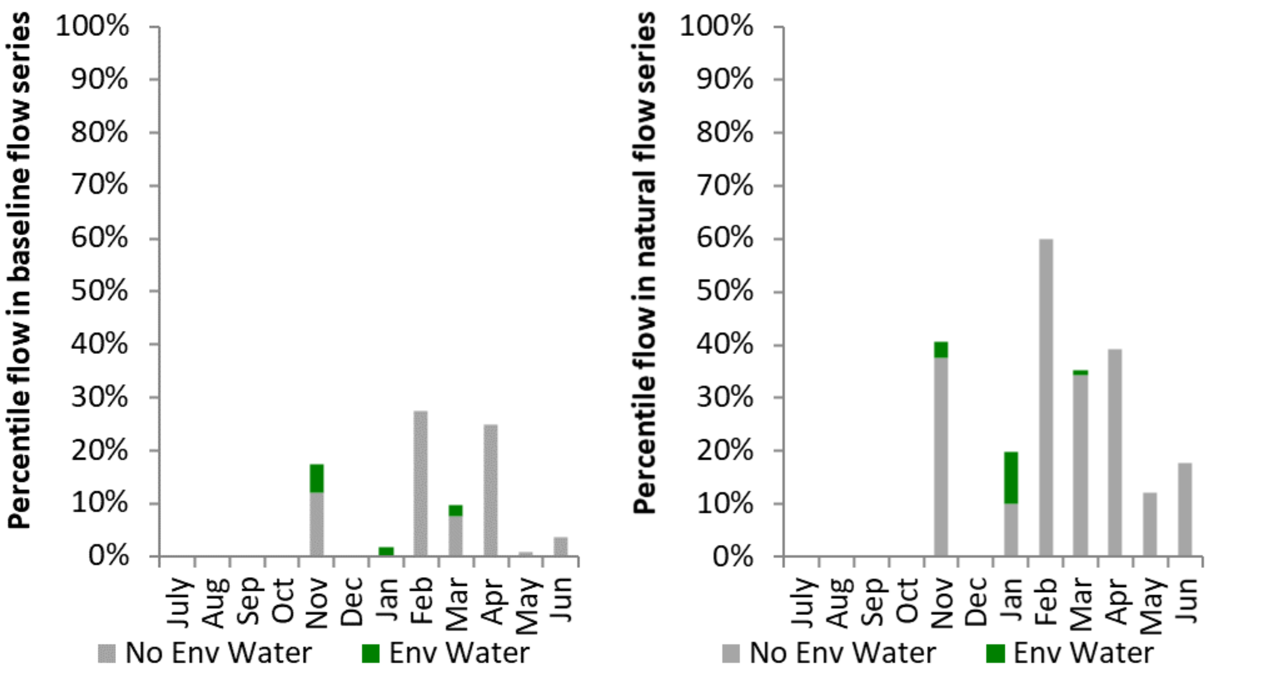


Figure GWY19: Contribution of environmental water delivery at Moree as percentiles in the natural and baseline flow series.

1.5.10 Combadello

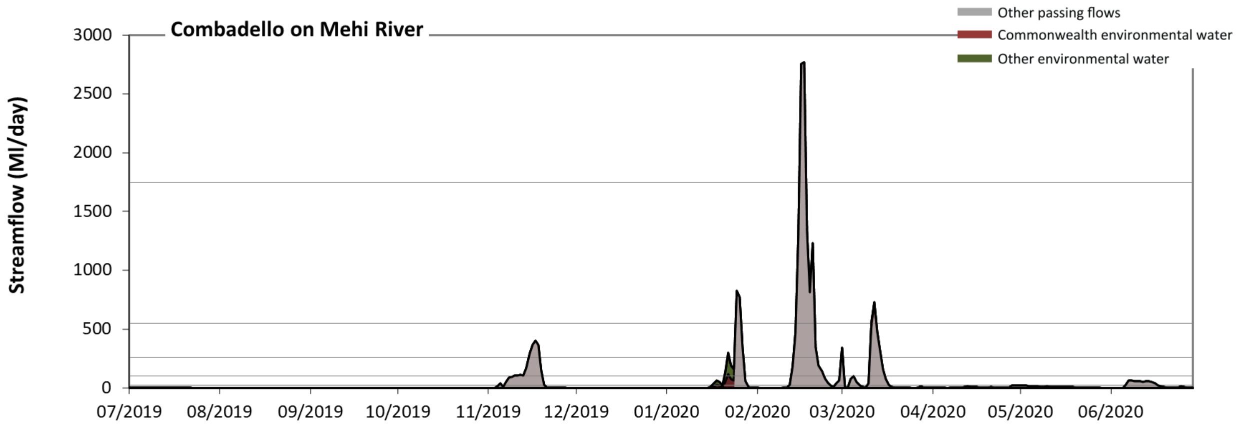


Figure GWY20: Contribution of environmental water delivery at Combadello. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Combadello on Mehi River environmental water contributed 6% of the total streamflow volume (with approximately half contributed by Commonwealth environmental water). Environmental watering actions affected streamflows for 3% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 20 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 82% to 80% of the year, with greatest influence in the period January to March. Similarly, without environmental water, the durations of low flows (i.e. < 99 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 92% to 91% of the year, with greatest influence in the period January to March. Commonwealth environmental water made a modest contribution to these enhancements of environmental baseflows at this site. There was at least one low fresh (i.e. > 260 ML/day) in the periods October to December and January to March. Environmental water made no change to the duration of these low freshes. There was at least one medium fresh (i.e. > 550 ML/day) in the period January to March. Environmental water made no change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the period January to March. Environmental water made no change to the duration of these high freshes.

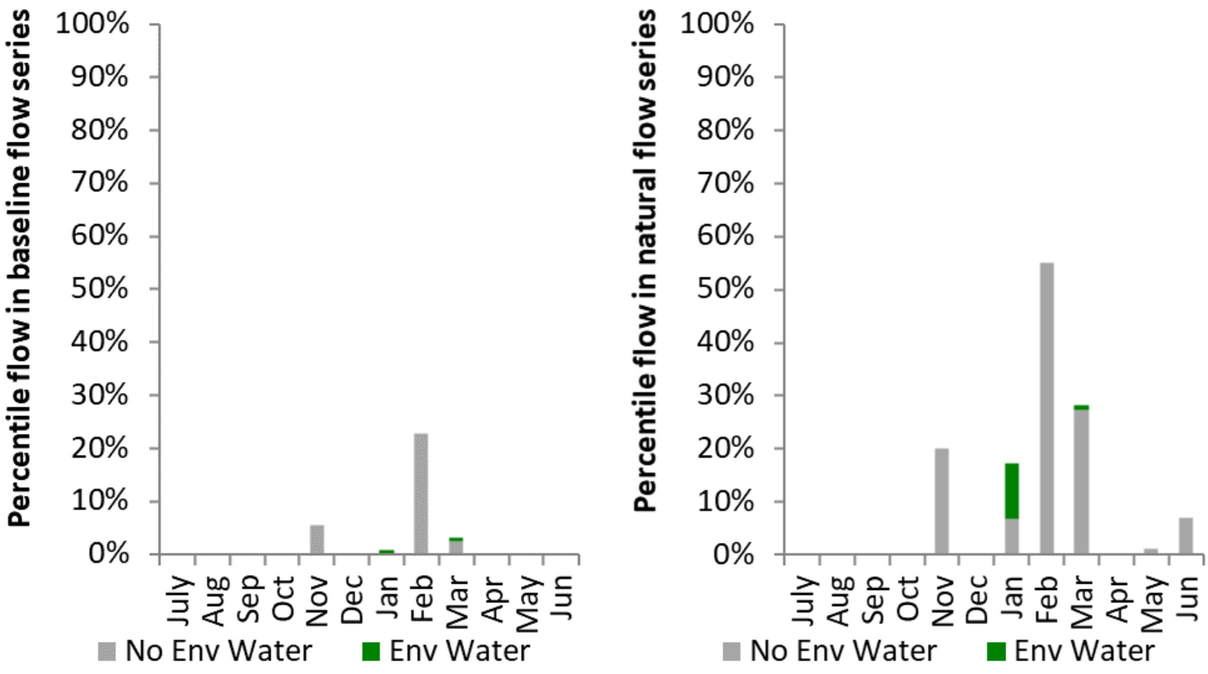


Figure GWY21: Contribution of environmental water delivery at Combadello as percentiles in the natural and baseline flow series.

1.5.11 Mallowa

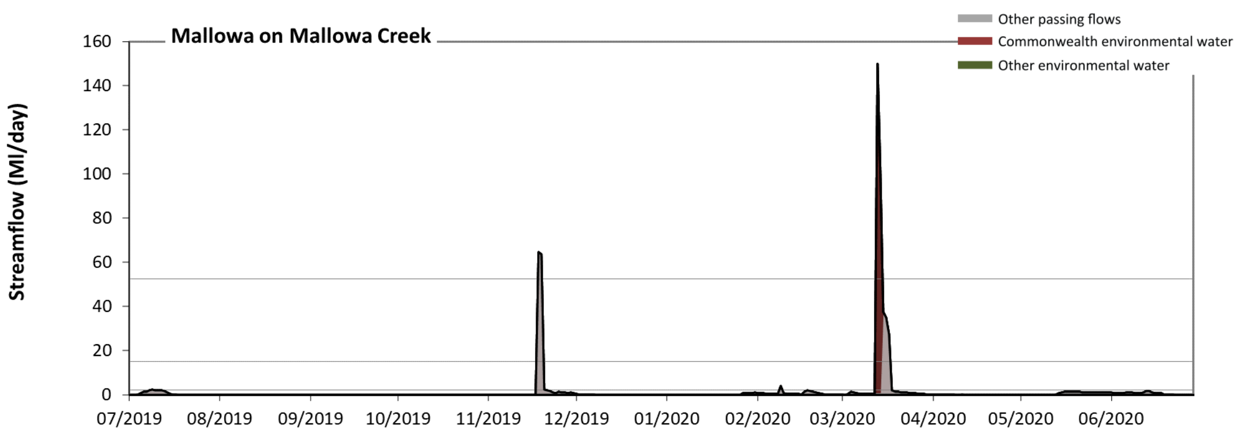


Figure GWY22: Contribution of environmental water delivery at Mallowa. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Mallowa on Mallowa Creek environmental water contributed 42% of the total streamflow volume (all of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 1% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 0.43 ML/day) in the periods July to September, October to December and January to March would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 73% to 72% of the year, with greatest influence in the period January to March. Similarly, without environmental water, the durations of low flows (i.e. < 2.1 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 98% to 97% of the year, with greatest influence in the period January to March. In the absence of environmental water there would have been at least one low fresh (i.e. > 15 ML/day) in the periods October to December and January to March. Environmental water increased the duration of the longest low fresh during the period January to March (from 3 days to 5 days). Commonwealth environmental water was entirely responsible for these increased durations of low freshes. In the absence of environmental water there would have been at least one medium fresh (i.e. > 52 ML/day) in the period October to December. Environmental water increased the duration of the longest medium fresh during the period January to March (from 0 days to 2 days). Commonwealth environmental water was entirely responsible for these increased durations of medium freshes. There was no high freshes (i.e. > 270 ML/day) this year.

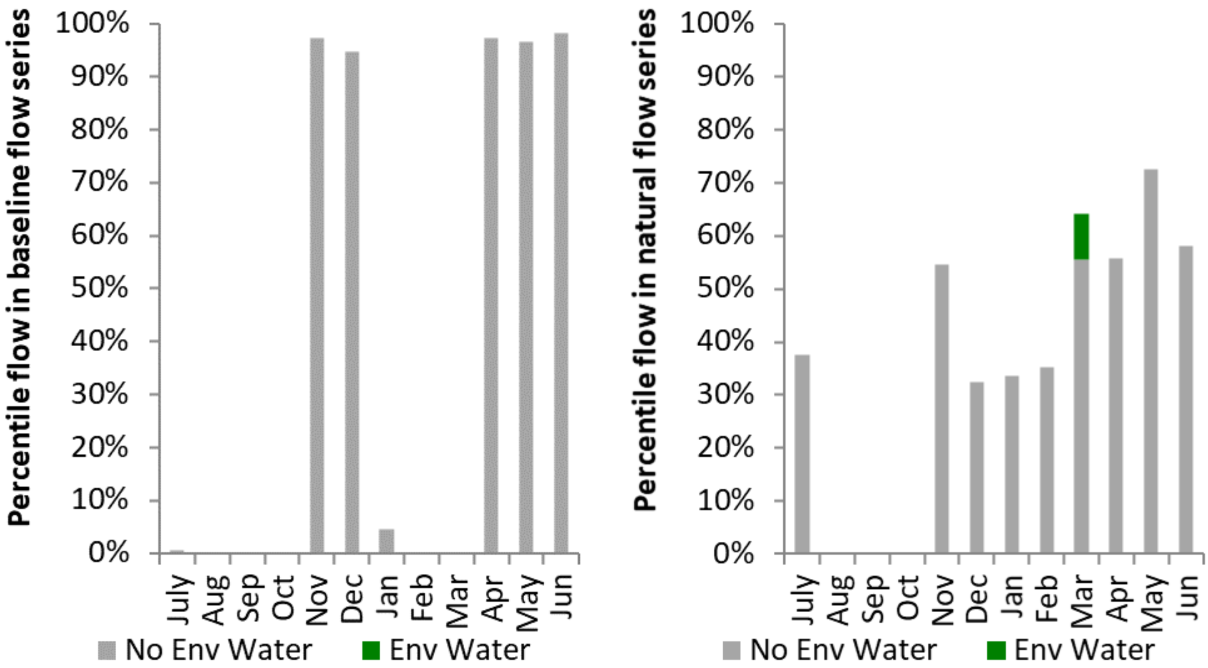


Figure GWY23: Contribution of environmental water delivery at Mallowa as percentiles in the natural and baseline flow series.

1.5.12 Garah

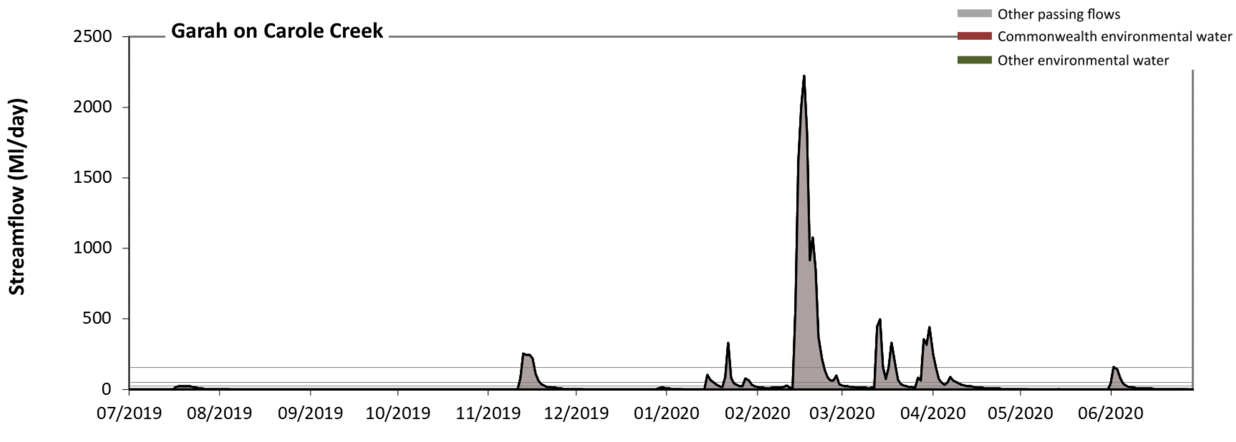


Figure GWY24: Contribution of environmental water delivery at Garah. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

There was no environmental water delivered at Garah on Carole Creek. Without environmental water, the durations of very low flows (i.e. < 1.7 ML/day) in the periods July to September and October to December was substantially in excess of durations expected in an average year in the natural flow regime. Similarly, without environmental water, the durations of low flows (i.e. < 8.3 ML/day) in the periods July to September and October to December was substantially in excess of durations expected in an average year in the natural flow regime. There was at least one low fresh (i.e. > 22 ML/day) in the periods July to September, October to December, January to March and April to June. There was at least one medium fresh (i.e. > 48 ML/day) in the periods October to December, January to March and April to June. In the absence of environmental water there was at least one high fresh in the periods October to December, January to March and April to June.

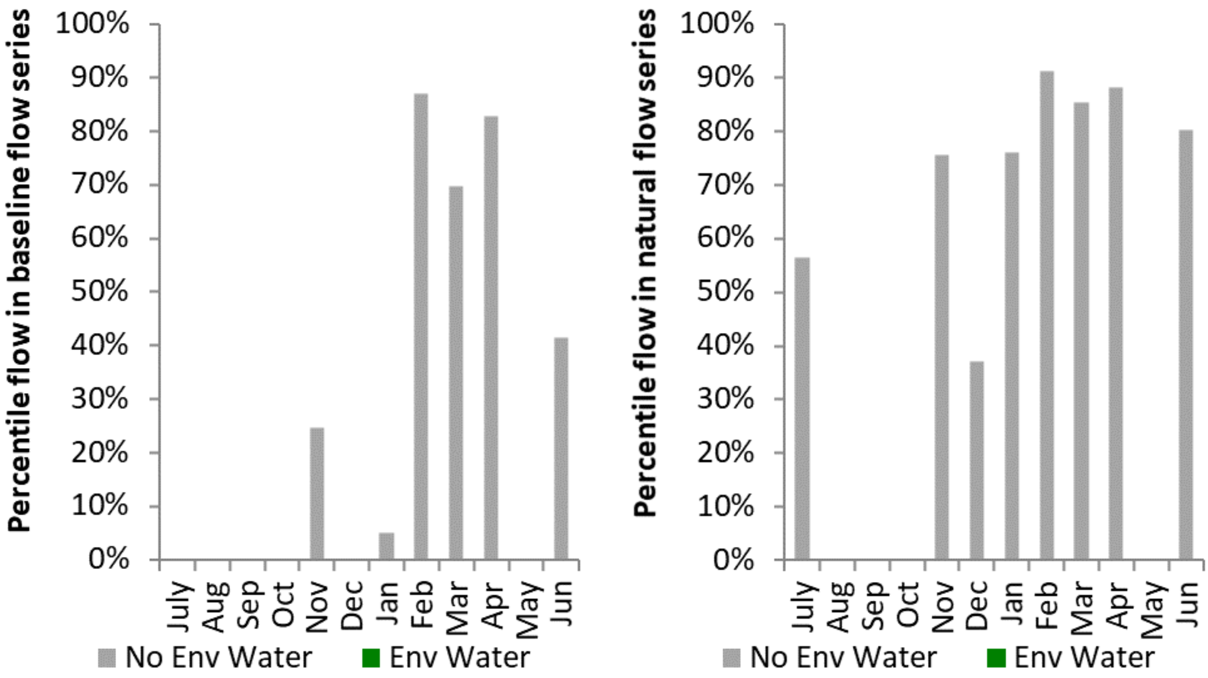


Figure GWY25: Contribution of environmental water delivery at Garah as percentiles in the natural and baseline flow series.

1.5.13 Bronte

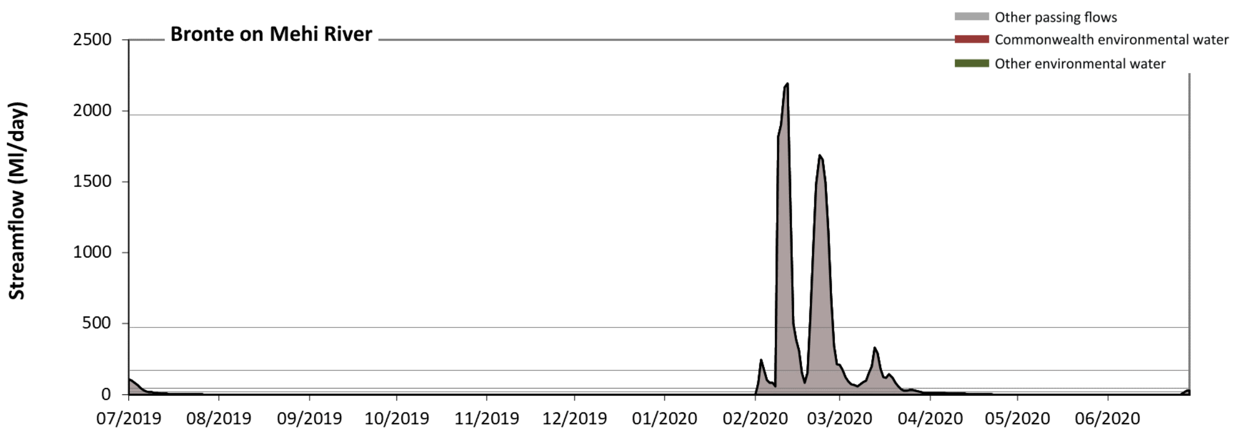


Figure GWY26: Contribution of environmental water delivery at Bronte. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

There was no environmental water delivered at Bronte on Mehi River. Without environmental water, the durations of very low flows (i.e. < 17 ML/day) in the periods July to September, October to December and April to June was substantially in excess of durations expected in an average year in the natural flow regime. Similarly, without environmental water, the durations of low flows (i.e. < 42 ML/day) in the periods July to September, October to December and April to June was substantially in excess of durations expected in an average year in the natural flow regime. There was at least one low fresh (i.e. > 170 ML/day) in the period January to March. There was at least one medium fresh (i.e. > 470 ML/day) in the period January to March. In the absence of environmental water there was at least one high fresh in the period January to March.

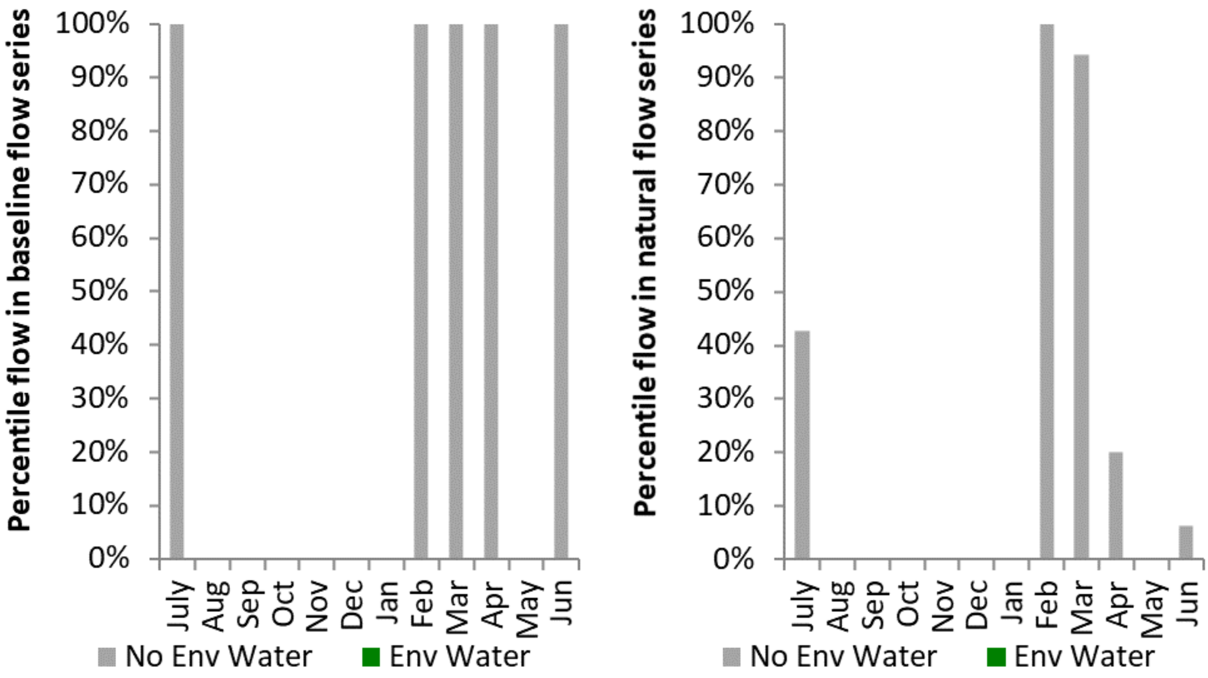


Figure GWY27: Contribution of environmental water delivery at Bronte as percentiles in the natural and baseline flow series

2 Namoi Valley

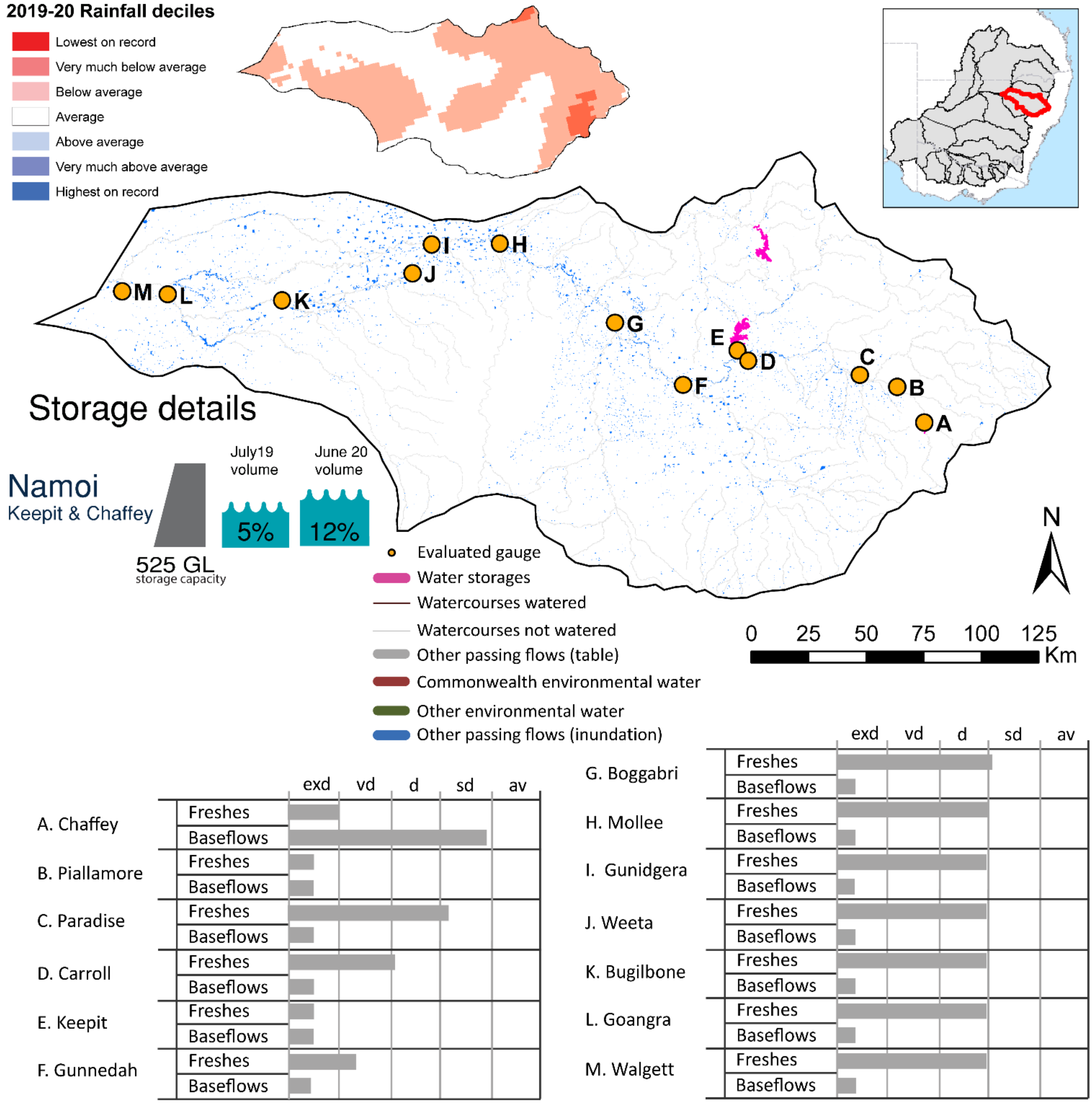


Figure NAM1: Watercourses influenced, areas inundated (where applicable) and gauge stations evaluated in the Namoi valley during the 2019–20 water year. Inset bar graphs report the condition of annual flow regimes by showing the improvements in hydrological condition with the addition of environmental water as well as the hypothetical scenario in 'grey' (if no environmental flow had been delivered). Rainfall conditions (rainfall deciles) and trend in storage levels for the water year are also shown. The classified bands are: exd = extremely dry, vd=very dry, sd=somewhat dry and av=average.

2.1 Summary

The volume of environmental water delivery for the 2019–20 year in the Namoi valley is quantified using data for 13 sites. This evaluation only considers the contribution of held environmental water, which is a primary focus for the Commonwealth. The contributions of planned environmental water (e.g. passing flows), unregulated tributary inflows and clever use of irrigation flows for environmental benefits can all be very important but these are outside the scope of this report. Environmental watering actions lasted on average 0 days over the course of the year. The volume of environmental water at these 13 sites was 0% of the total streamflow. There was no contribution of Commonwealth environmental water. Ideally, baseflows should be maintained and long periods of excessively low flows avoided. In this valley, the baseflow regime was generally considered to be extremely dry relative to the pre-development flow regime. In our analysis, a low fresh refers to a period of increased flow, when the water level rises at least one eighth of the way up the river bank (above the low flow level). These low freshes are a regular part of the natural flow regime and support a range of natural processes. In the Namoi valley, in terms of the occurrence and duration of low freshes, the year was assessed as being very dry. In our analysis, a medium fresh refers to a period of increased flow, when the water level rises at least one quarter of the way up the river bank. These medium freshes are not as frequent as low freshes but are also a regular and important part of the natural flow regime. In the Namoi valley, in terms of the occurrence of medium freshes, the year was assessed as being dry. In our analysis, a high fresh refers to a period of increased flow, when the water level rises more than half way up the river. A high fresh may not occur every year but they are still important and long periods without major freshes can have serious consequences for floodplains and their contribution to river ecosystem health. Delivering environmental high in channel flows normally requires that all risks to riparian landholders and infrastructure have been resolved. In the Namoi valley, in terms of the occurrence of high freshes, the year was assessed as being somewhat dry.

2.2 Water delivery context

During the 2019–20 water year, the Commonwealth Environmental Water Holder (CEWH) held water entitlements of up to 14,910 ML for environmental use in the Namoi valley. Each year, water utilities allocate water entitlement holders a percentage of water based on their holding, licence type and carryover (the exact rules vary among Jurisdictions and licence type). In 2019–20, the Namoi entitlements held by the CEWH were allocated 53 ML of water, representing 0% of the Long term average annual yield for the Namoi valley (10,543 ML). Information and data relating to the portfolio of held Commonwealth environmental water is shown in Table NAM1.

The 2019–20 water allocation (53 ML) together with the carryover volume of 552 ML of water meant the CEWH had 604 ML of water available for delivery. A total of 0 ML of Commonwealth environmental water was delivered in the Namoi valley. A total of 604 ML (100%) of available Commonwealth environmental water was carried over for environmental use into the 2020–21 water year.

Access to the lower Namoi general security carryover water was restricted until late February 2020 and Keepit Dam was down to dead storage for most of the water year. Similarly, no Commonwealth environmental water was available for take from the Peel licences.

2.3 Environmental conditions and resource availability

The water available for environmental delivery combined with the present and antecedent environmental conditions are key inputs used by environmental water managers in planning and implementing watering actions. *Post hoc*, this information provides important context when evaluating the effectiveness and appropriateness of environmental water use with respect to hydrological outputs.

The rainfall conditions in the Namoi valley were classified as below average, based on rainfall percentile data for the entire record held by the Bureau of Meteorology for this valley. The water held in major storages in the Namoi valley increased over the water year, for example Keepit and Chaffey dam was 5.2% full at the beginning of the water year and 11.6% full by the end of the year (Figure NAM1).

The CEWO calculates resource availability scenarios (RAS) to guide the use and prioritisation of held environmental water. The RAS are progressively calculated over the year as part of the continual adaptive management planning processes. The RAS are based on the availability of held environmental water (including progressive licence acquisitions and allocations) as well as the potential for unregulated or planned environmental flows. The outcome is then used to determine the demand for environmental water across the Basin.

In 2019–20, the resource availability of held Commonwealth environmental water in the Namoi was classified as very low, whilst the overall demand for environmental water was classified as critical to high. The physical conditions meant that the CEWO was managing to avoid damage to the health and resilience of aquatic ecosystems in the Lower Namoi River, wetlands and anabranches, and the Peel River, subject to water availability.

2.4 Watering actions

The Commonwealth did not deliver any environmental water in the Namoi during 2019–20.

Table NAM1. Commonwealth environmental water accounting information for the Namoi valley over 2019–20 water year.

Total registered volume (ML)	Allocated volume (ML)	Carry over + allocated volume (ML)	Delivered (ML)	LTAAY (ML)	Carried over to 2020–21
14,910	53	604	0	10,543	604

2.5 Contribution of Commonwealth environmental water to flow regimes

2.5.1 Keepit

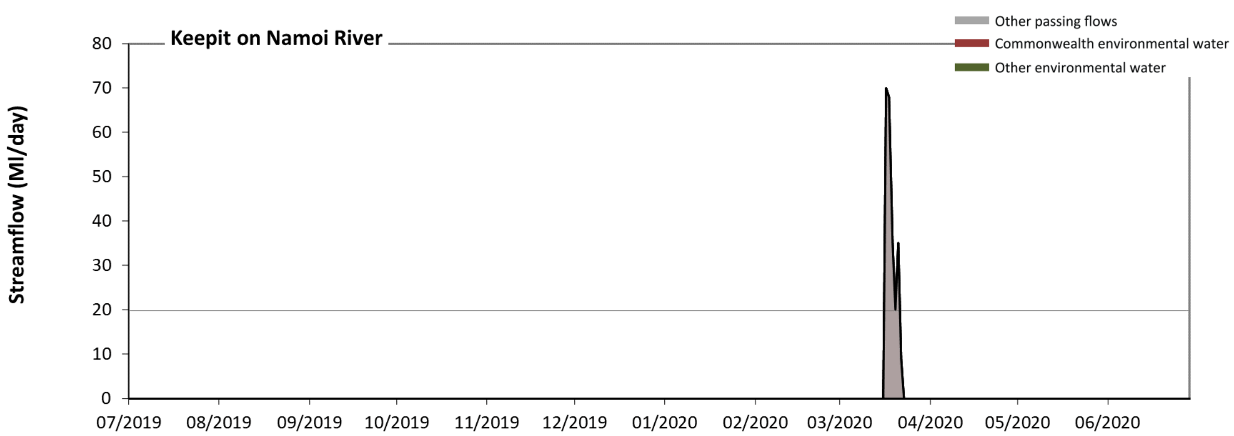


Figure NAM2: Contribution of environmental water delivery at Keepit. Horizontal lines indicate thresholds for very low flows and low flows (from lowest to highest)

There was no environmental water delivered at Keepit on Namoi River. Without environmental water, the durations of very low flows (i.e. < 20 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. Similarly, without environmental water, the durations of low flows (i.e. < 99 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime.

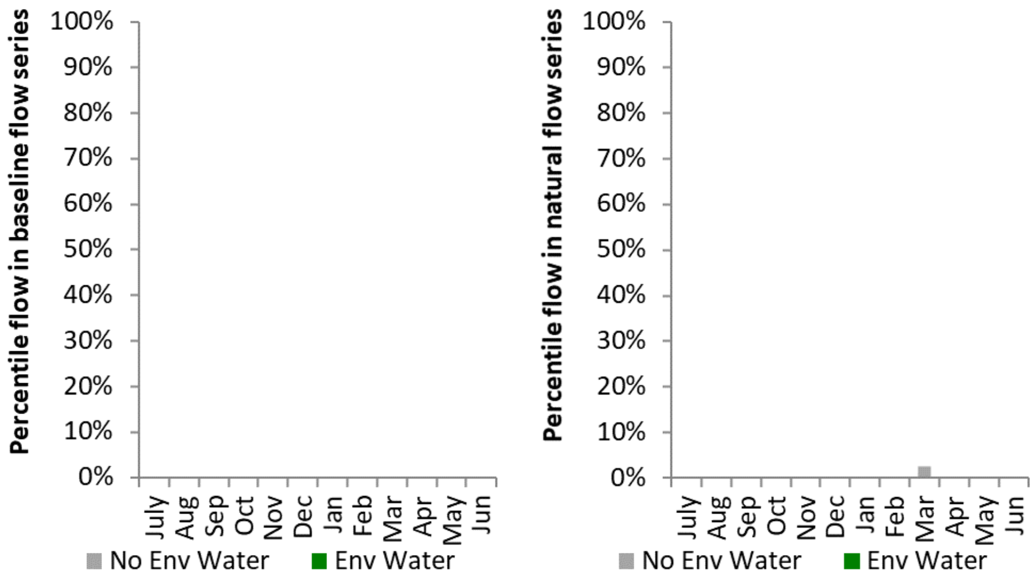


Figure NAM3: Contribution of environmental water delivery at Keepit as percentiles in the natural and baseline flow series.

2.5.2 Gunnedah

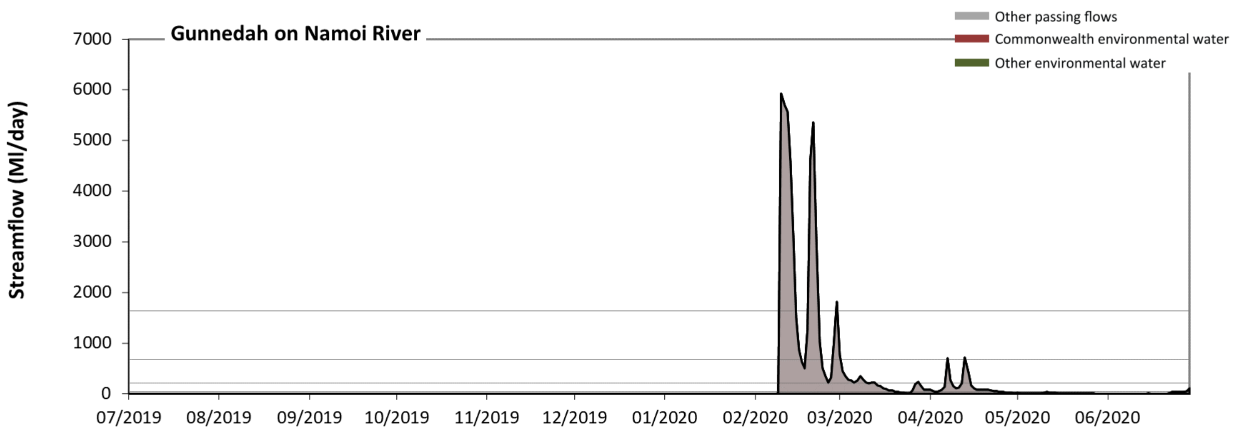


Figure NAM4: Contribution of environmental water delivery at Gunnedah. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

There was no environmental water delivered at Gunnedah on Namoi River. Without environmental water, the durations of very low flows (i.e. < 41 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. Similarly, without environmental water, the durations of low flows (i.e. < 210 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. There was at least one low fresh (i.e. > 670 ML/day) in the periods January to March and April to June. There was at least one medium fresh (i.e. > 1600 ML/day) in the period January to March. There was no high freshes (i.e. > 6000 ML/day) this year.

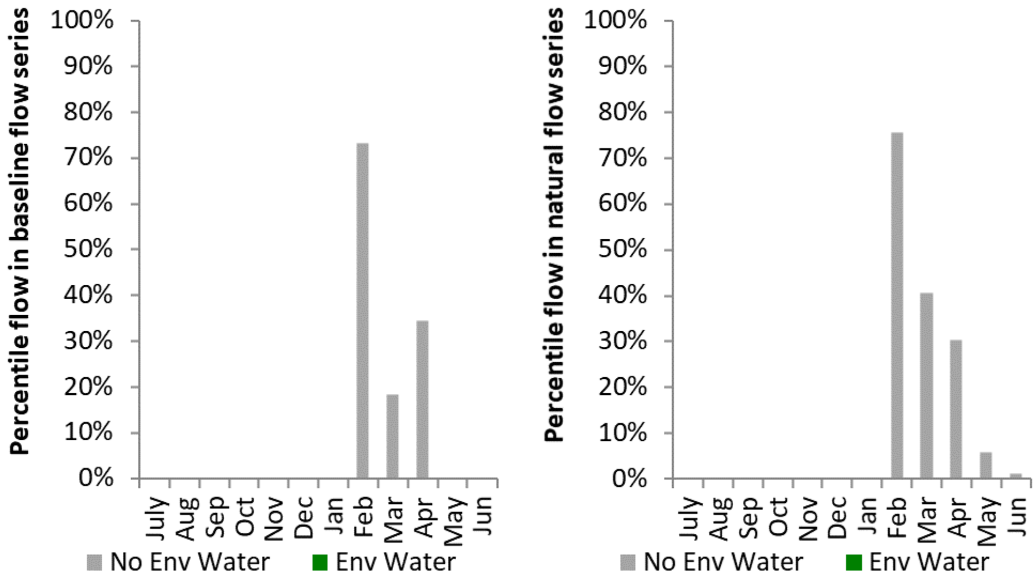


Figure NAM5: Contribution of environmental water delivery at Gunnedah as percentiles in the natural and baseline flow series.

2.5.3 Boggabri

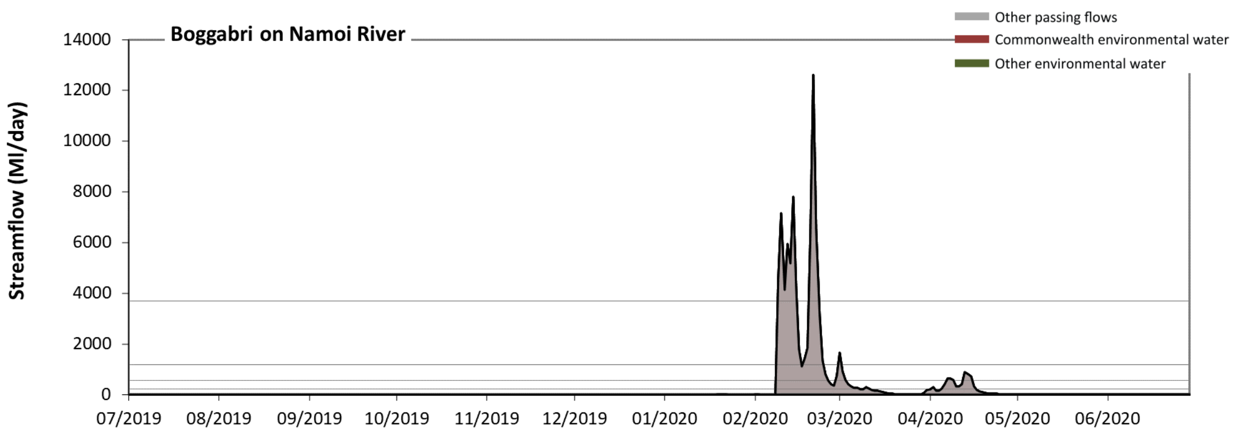


Figure NAM6: Contribution of environmental water delivery at Boggabri. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

There was no environmental water delivered at Boggabri on Namoi River. Without environmental water, the durations of very low flows (i.e. < 42 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. Similarly, without environmental water, the durations of low flows (i.e. < 210 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. There was at least one low fresh (i.e. > 550 ML/day) in the periods January to March and April to June. There was at least one medium fresh (i.e. > 1200 ML/day) in the period January to March. In the absence of environmental water there was at least one high fresh in the period January to March.

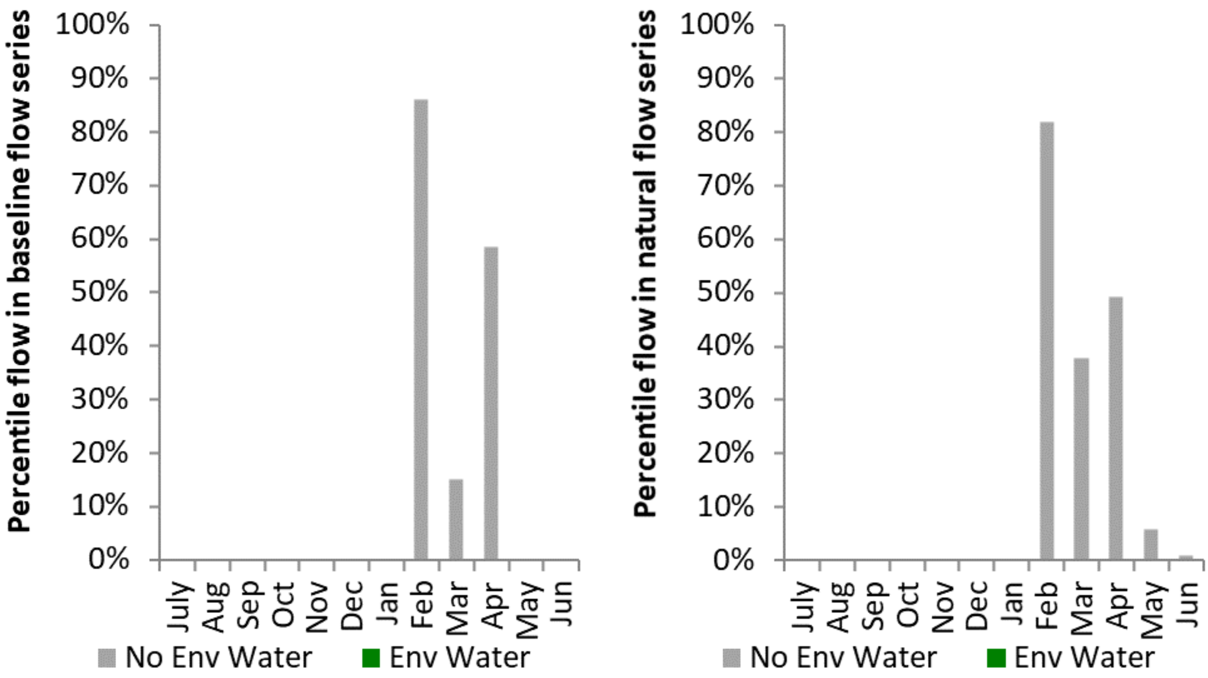


Figure NAM7: Contribution of environmental water delivery at Boggabri as percentiles in the natural and baseline flow series.

2.5.4 Mollee

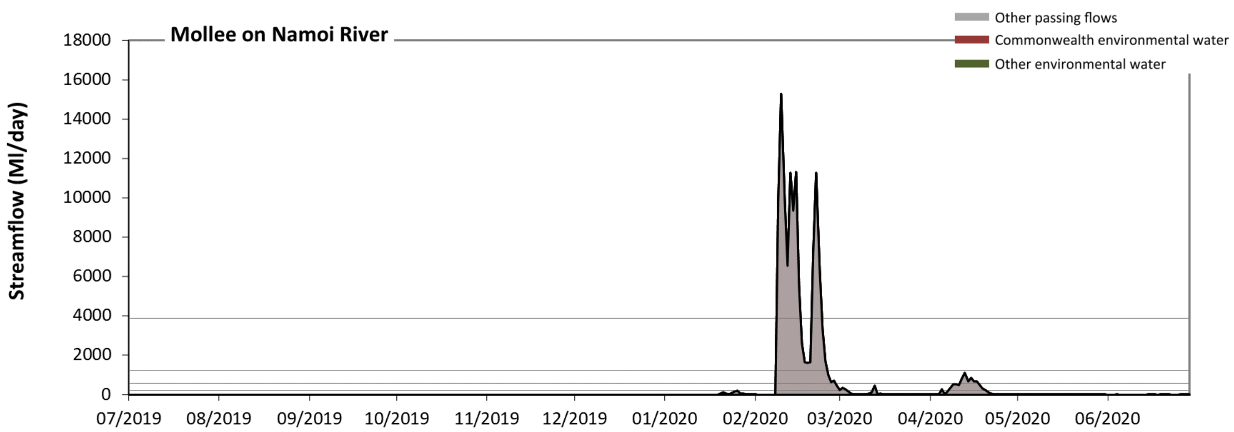


Figure NAM8: Contribution of environmental water delivery at Mollee. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

There was no environmental water delivered at Mollee on Namoi River. Without environmental water, the durations of very low flows (i.e. < 44 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. Similarly, without environmental water, the durations of low flows (i.e. < 220 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. There was at least one low fresh (i.e. > 570 ML/day) in the periods January to March and April to June. There was at least one medium fresh (i.e. > 1200 ML/day) in the period January to March. In the absence of environmental water there was at least one high fresh in the period January to March.

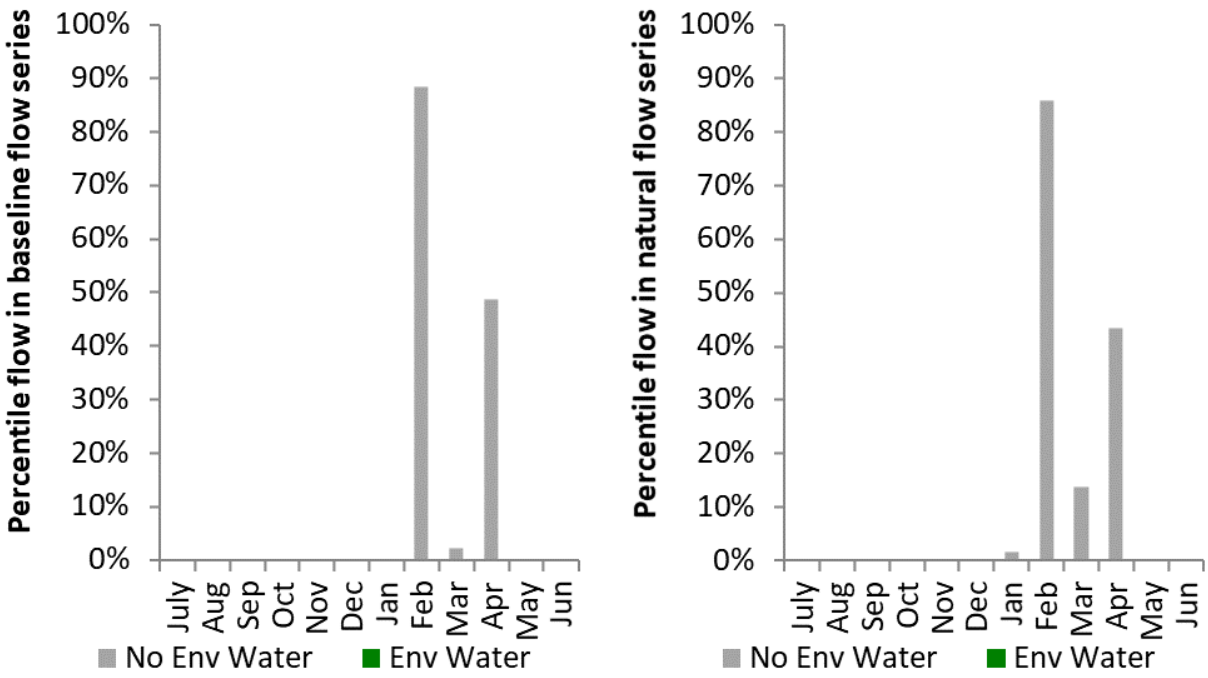


Figure NAM9: Contribution of environmental water delivery at Mollee as percentiles in the natural and baseline flow series.

2.5.5 Gunidgera

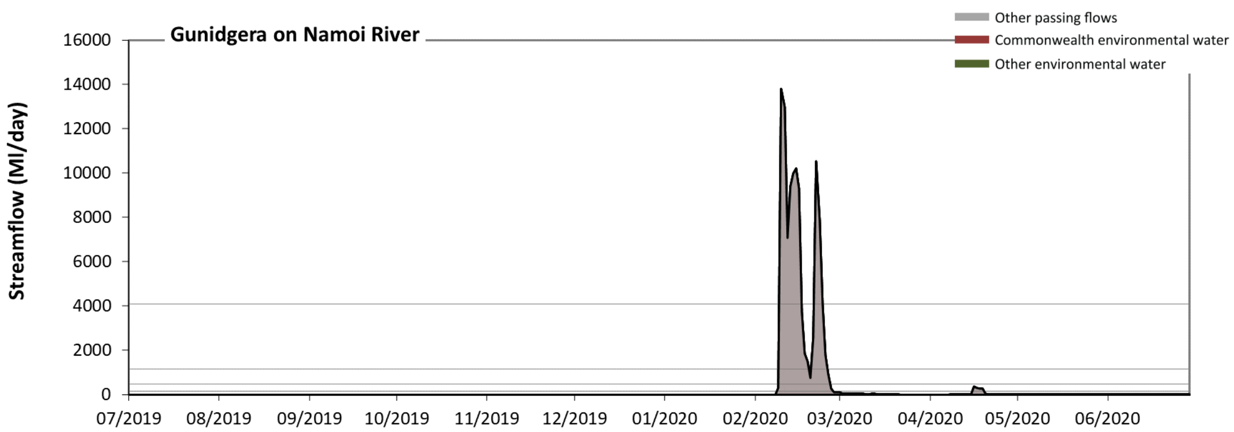


Figure NAM10: Contribution of environmental water delivery at Gunidgera. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

There was no environmental water delivered at Gunidgera on Namoi River. Without environmental water, the durations of very low flows (i.e. < 32 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. Similarly, without environmental water, the durations of low flows (i.e. < 160 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. There was at least one low fresh (i.e. > 490 ML/day) in the period January to March. There was at least one medium fresh (i.e. > 1100 ML/day) in the period January to March. In the absence of environmental water there was at least one high fresh in the period January to March.

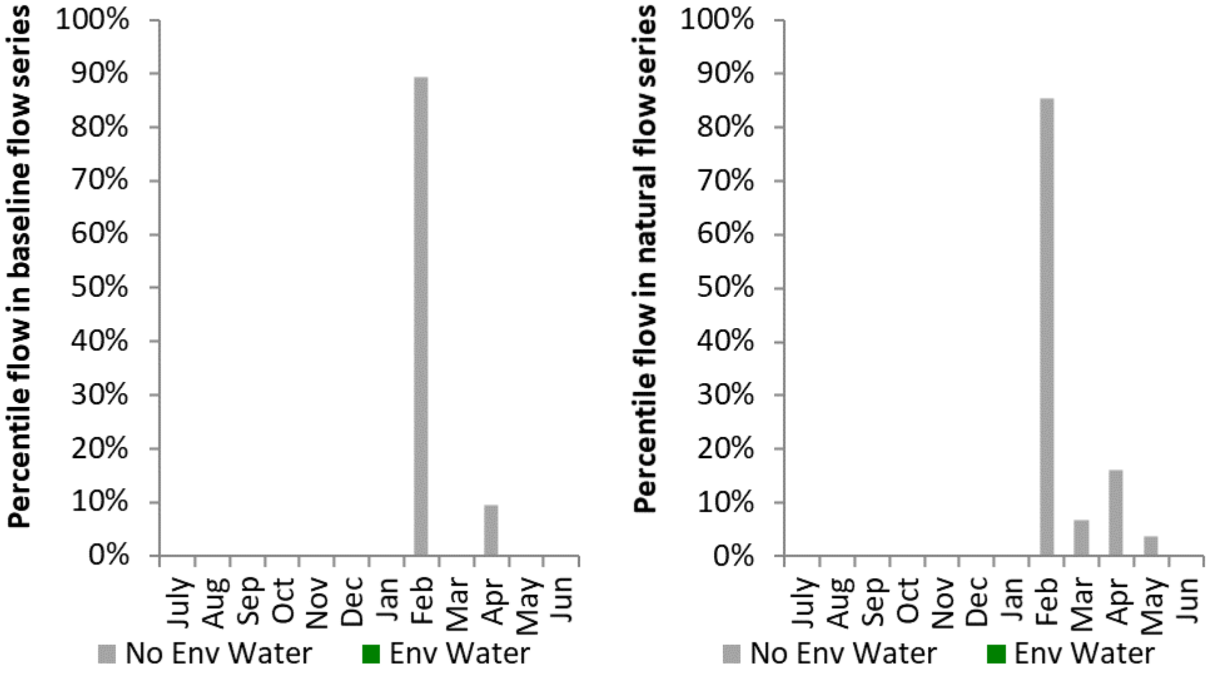


Figure NAM11: Contribution of environmental water delivery at Gunidgera as percentiles in the natural and baseline flow series.

2.5.6 Weeta

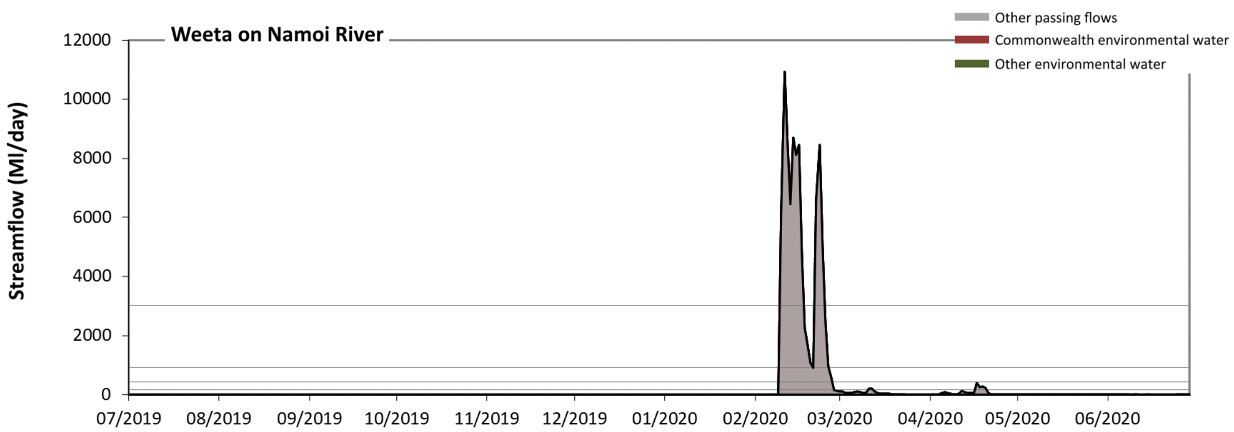


Figure NAM12: Contribution of environmental water delivery at Weeta. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

There was no environmental water delivered at Weeta on Namoi River. Without environmental water, the durations of very low flows (i.e. < 31 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. Similarly, without environmental water, the durations of low flows (i.e. < 150 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. There was at least one low fresh (i.e. > 420 ML/day) in the period January to March. There was at least one medium fresh (i.e. > 920 ML/day) in the period January to March. In the absence of environmental water there was at least one high fresh in the period January to March.

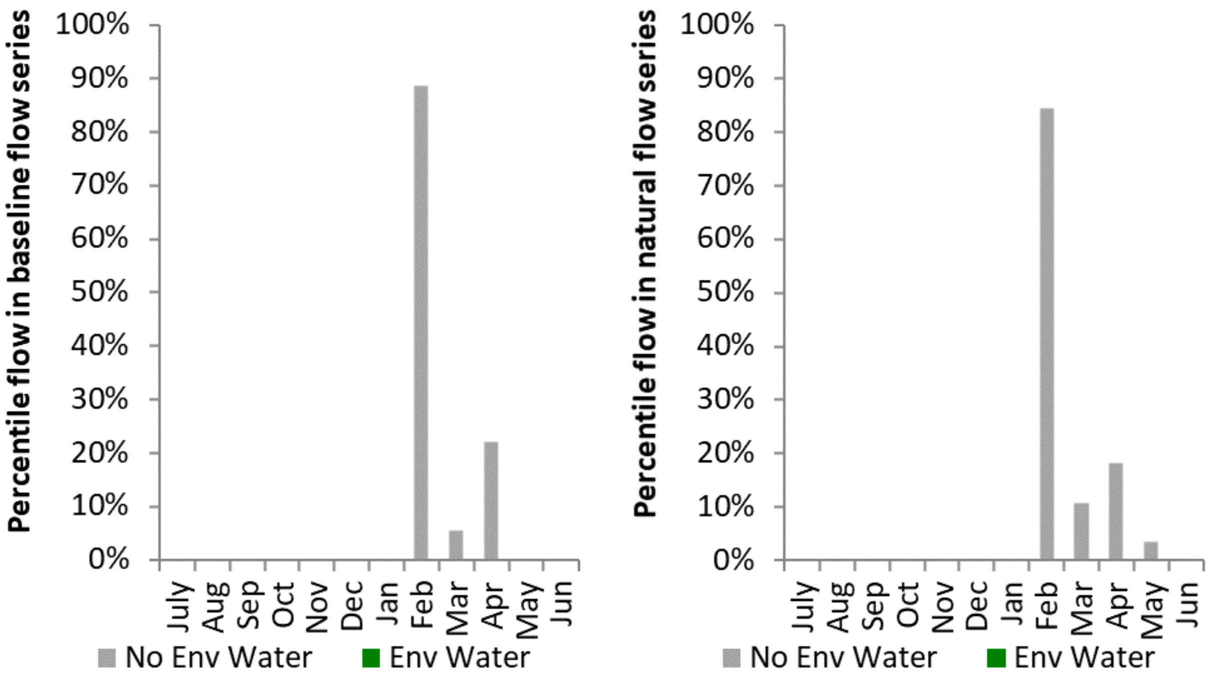


Figure NAM13: Contribution of environmental water delivery at Weeta as percentiles in the natural and baseline flow series.

2.5.7 Bugilbone

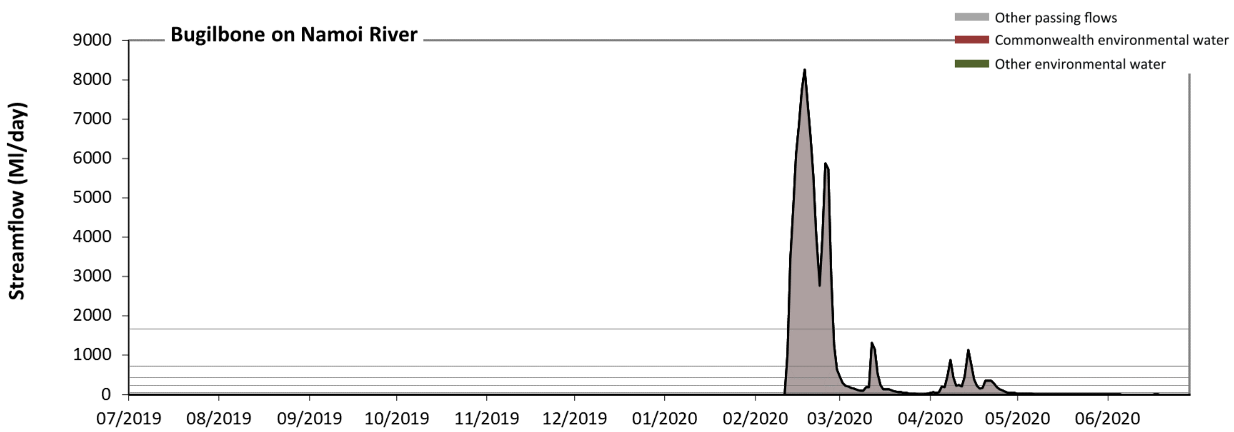


Figure NAM14: Contribution of environmental water delivery at Bugilbone. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

There was no environmental water delivered at Bugilbone on Namoi River. Without environmental water, the durations of very low flows (i.e. < 47 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. Similarly, without environmental water, the durations of low flows (i.e. < 240 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. There was at least one low fresh (i.e. > 430 ML/day) in the periods January to March and April to June. There was at least one medium fresh (i.e. > 710 ML/day) in the periods January to March and April to June. In the absence of environmental water there was at least one high fresh in the period January to March.

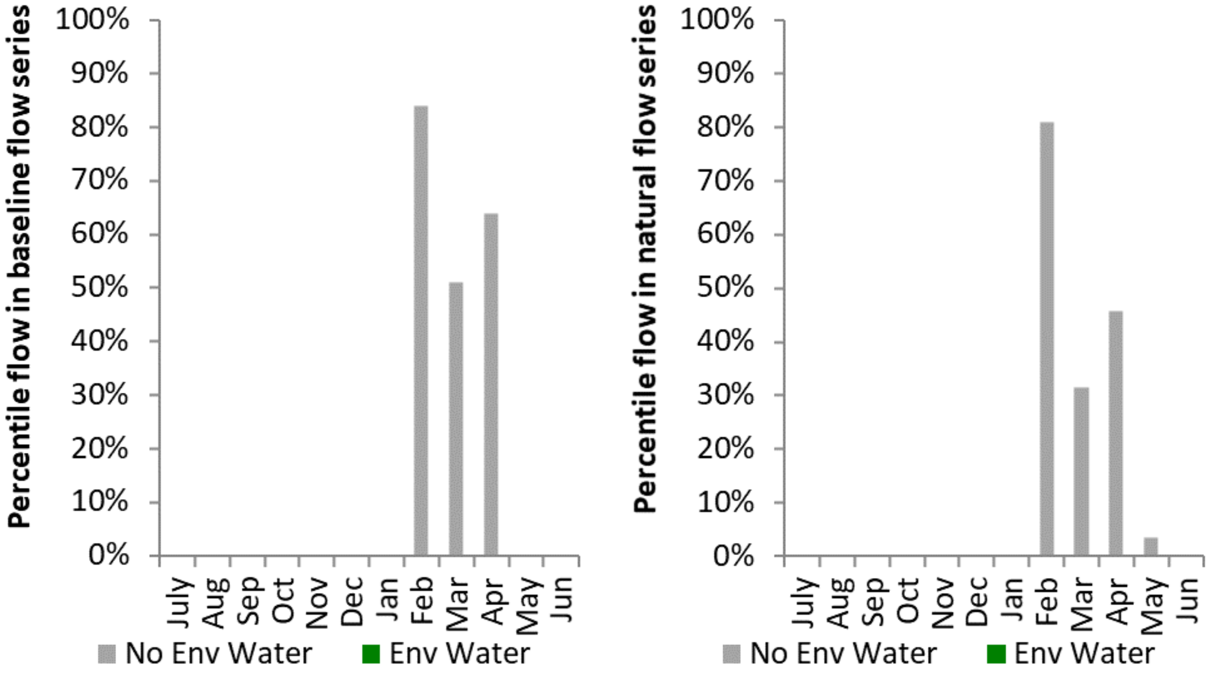


Figure NAM15: Contribution of environmental water delivery at Bugilbone as percentiles in the natural and baseline flow series.

2.5.8 Goangra

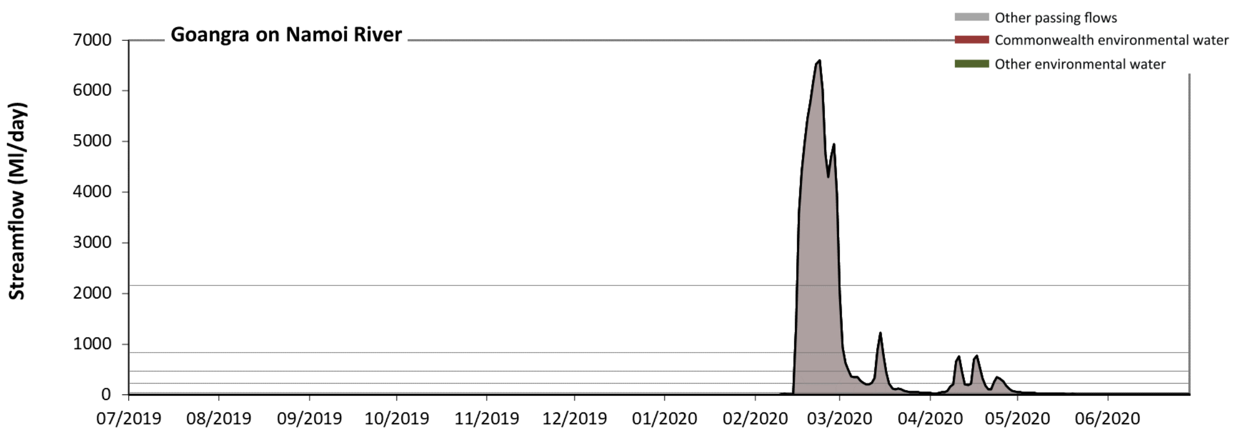


Figure NAM16: Contribution of environmental water delivery at Goangra. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

There was no environmental water delivered at Goangra on Namoi River. Without environmental water, the durations of very low flows (i.e. < 45 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. Similarly, without environmental water, the durations of low flows (i.e. < 220 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. There was at least one low fresh (i.e. > 460 ML/day) in the periods January to March and April to June. There was at least one medium fresh (i.e. > 830 ML/day) in the period January to March. In the absence of environmental water there was at least one high fresh in the period January to March.

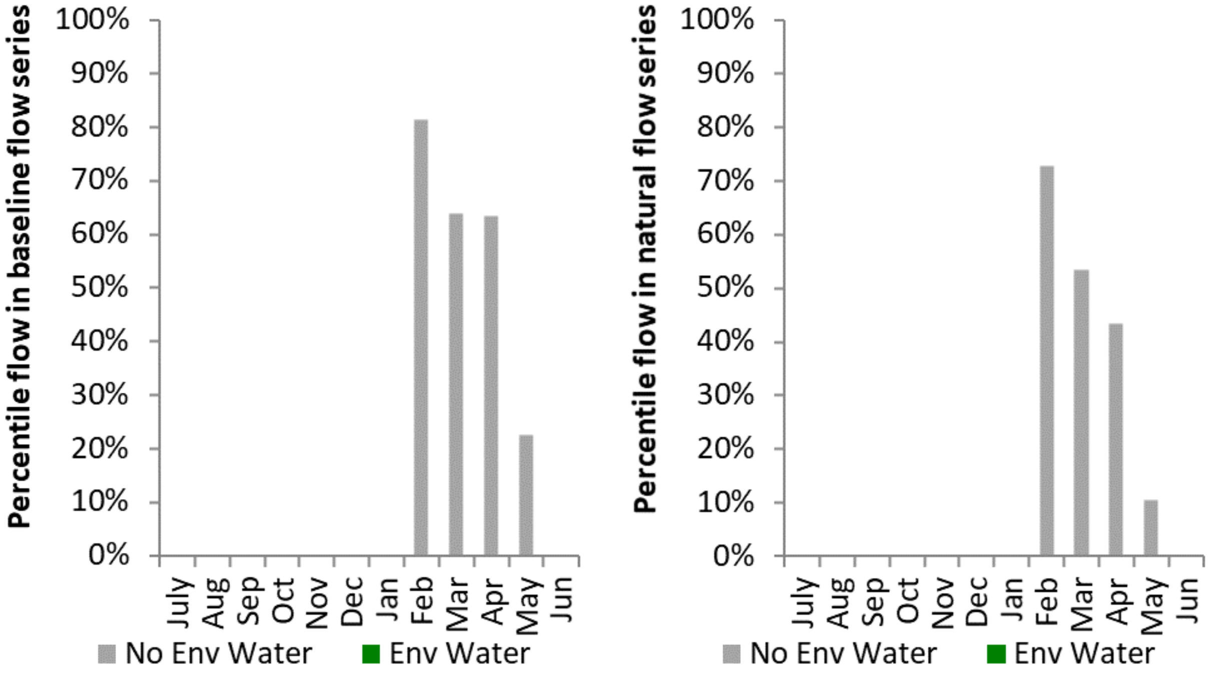


Figure NAM17: Contribution of environmental water delivery at Goangra as percentiles in the natural and baseline flow series.

2.5.9 Walgett

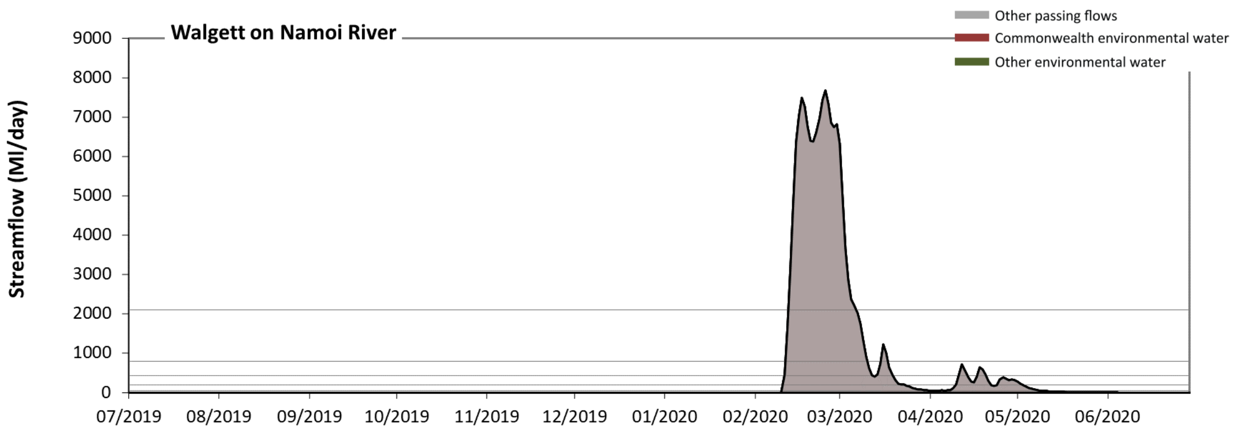


Figure NAM18: Contribution of environmental water delivery at Walgett. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

There was no environmental water delivered at Walgett on Namoi River. Without environmental water, the durations of very low flows (i.e. < 41 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. Similarly, without environmental water, the durations of low flows (i.e. < 200 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. There was at least one low fresh (i.e. > 430 ML/day) in the periods January to March and April to June. There was at least one medium fresh (i.e. > 790 ML/day) in the period January to March. In the absence of environmental water there was at least one high fresh in the period January to March.

2.5.10 Chaffey

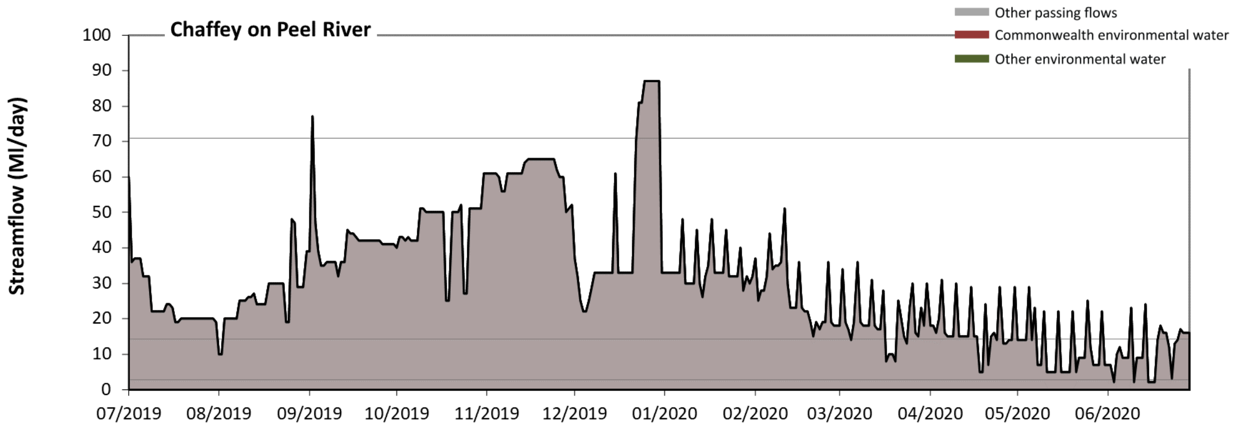


Figure NAM20: Contribution of environmental water delivery at Chaffey. Horizontal lines indicate thresholds for very low flows, low flows and low freshes (from lowest to highest).

There was no environmental water delivered at Chaffey on Peel River. Flow regulation does not substantially increase the duration of very low flows (i.e. < 2.9 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the duration of low flows (i.e. < 14 ML/day) in the period April to June was substantially in excess of durations expected in an average year in the natural flow regime. There was at least one low fresh (i.e. > 71 ML/day) in the periods July to September and October to December. There was no medium or high freshes this year.

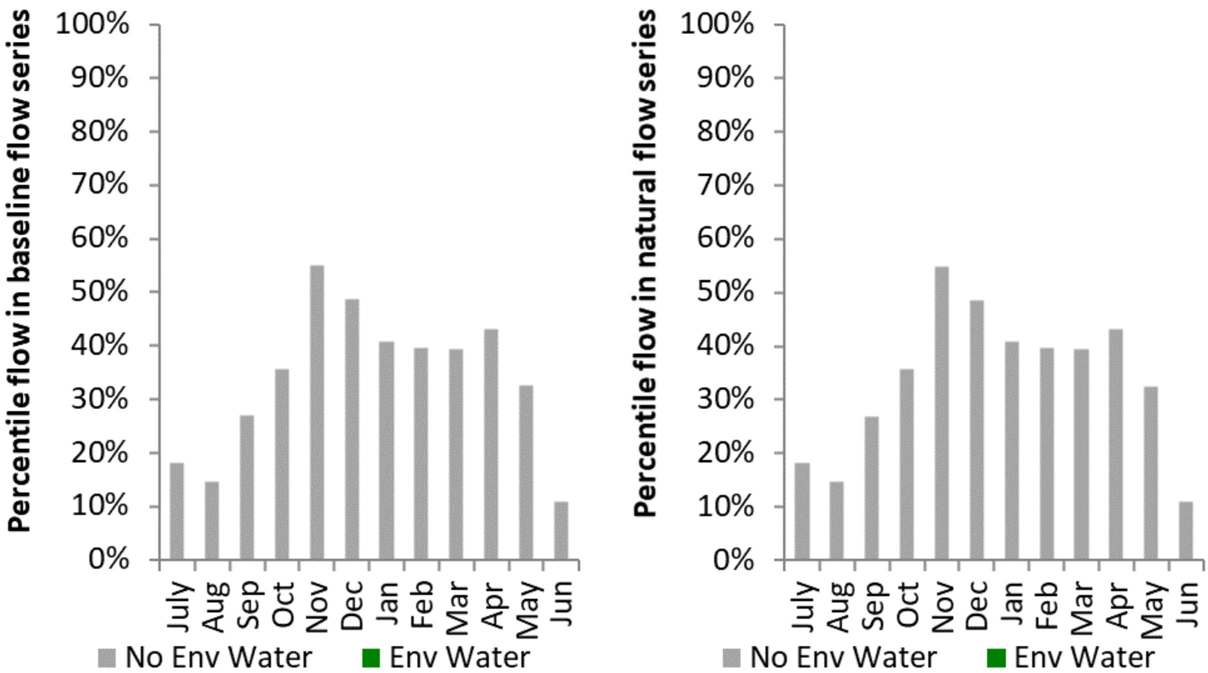


Figure NAM21: Contribution of environmental water delivery at Chaffey as percentiles in the natural and baseline flow series.

2.5.11 Piallamore

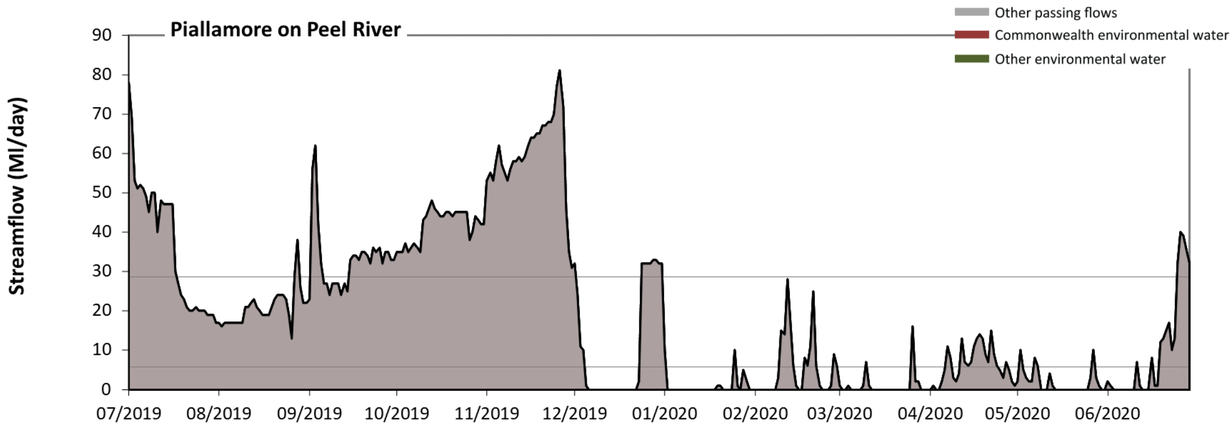
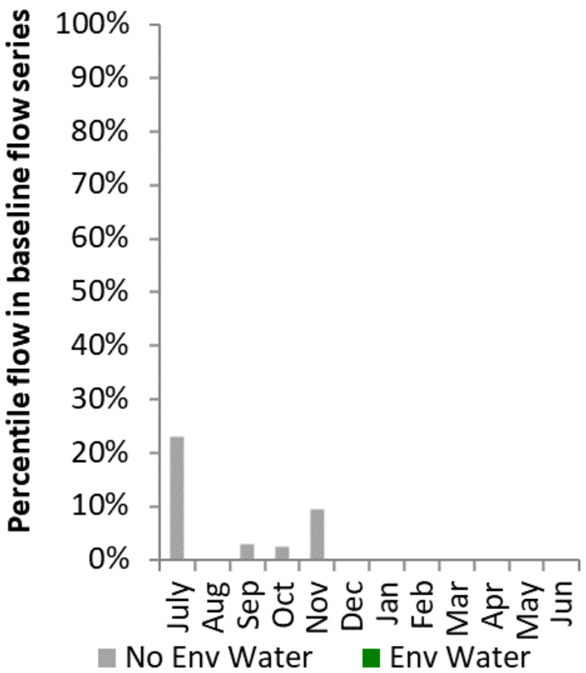


Figure NAM22: Contribution of environmental water delivery at Piallamore. Horizontal lines indicate thresholds for very low flows and low flows (from lowest to highest).

There was no environmental water delivered at Piallamore on Peel River. Without environmental water, the durations of very low flows (i.e. < 5.7 ML/day) in the periods October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. Similarly, without environmental water, the durations of low flows (i.e. < 29 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime.



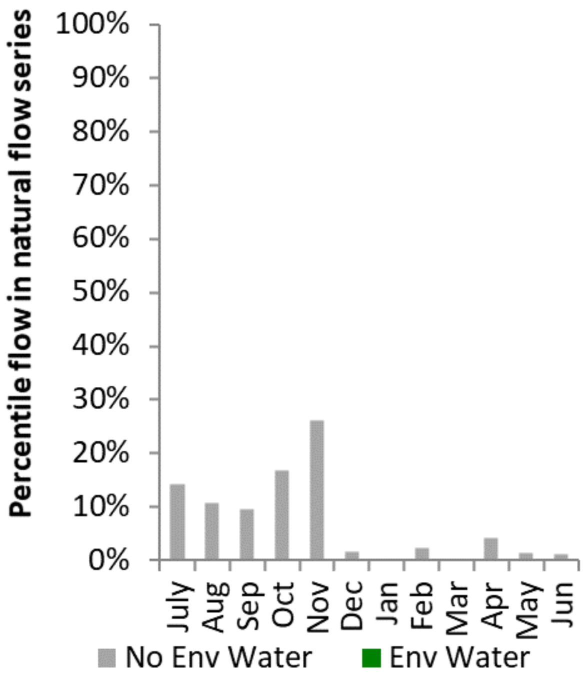


Figure NAM23: Contribution of environmental water delivery at Piallamore as percentiles in the natural and baseline flow series.

2.5.12 Paradise

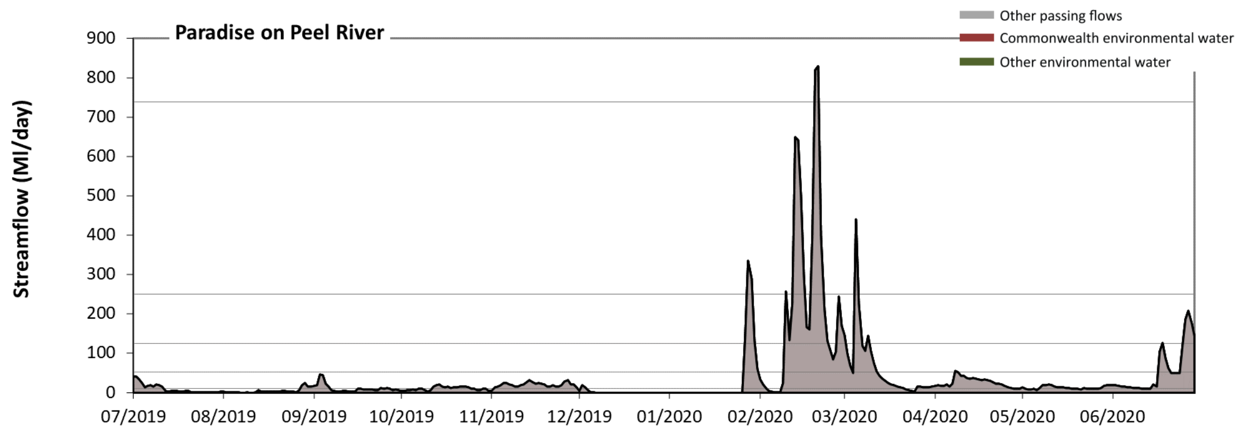


Figure NAM24: Contribution of environmental water delivery at Paradise. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

There was no environmental water delivered at Paradise on Peel River. Without environmental water, the durations of very low flows (i.e. < 11 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. Similarly, without environmental water, the durations of low flows (i.e. < 53 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. There was at least one low fresh (i.e. > 130 ML/day) in the periods January to March and April to June. There was at least one medium fresh (i.e. > 250 ML/day) in the period January to March. In the absence of environmental water there was at least one high fresh in the period January to March.

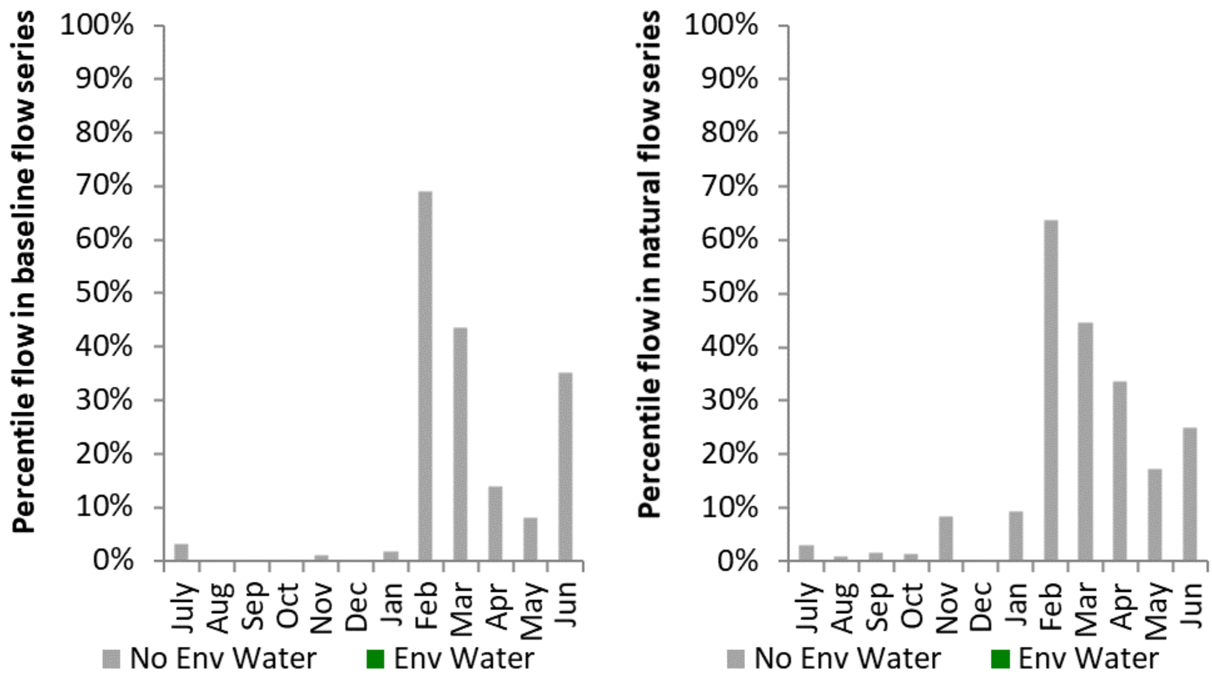


Figure NAM25: Contribution of environmental water delivery at Paradise as percentiles in the natural and baseline flow series.

2.5.13 Carroll

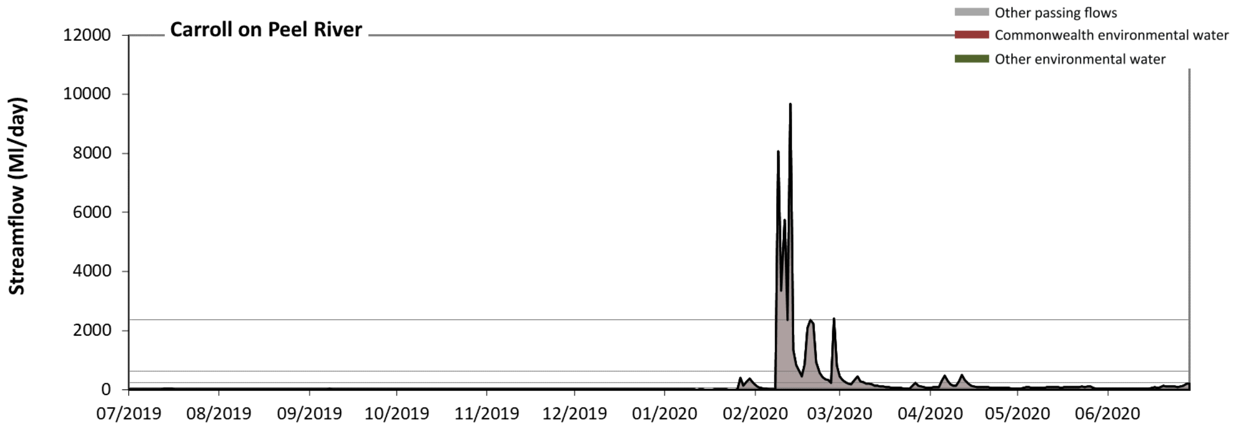


Figure NAM26: Contribution of environmental water delivery at Carroll. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

There was no environmental water delivered at Carroll on Peel River. Without environmental water, the durations of very low flows (i.e. < 14 ML/day) in the periods July to September, October to December and January to March was substantially in excess of durations expected in an average year in the natural flow regime. Similarly, without environmental water, the durations of low flows (i.e. < 70 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. There was at least one low fresh (i.e. > 240 ML/day) in the periods January to March and April to June. There was at least one medium fresh (i.e. > 620 ML/day) in the period January to March. In the absence of environmental water there was at least one high fresh in the period January to March.

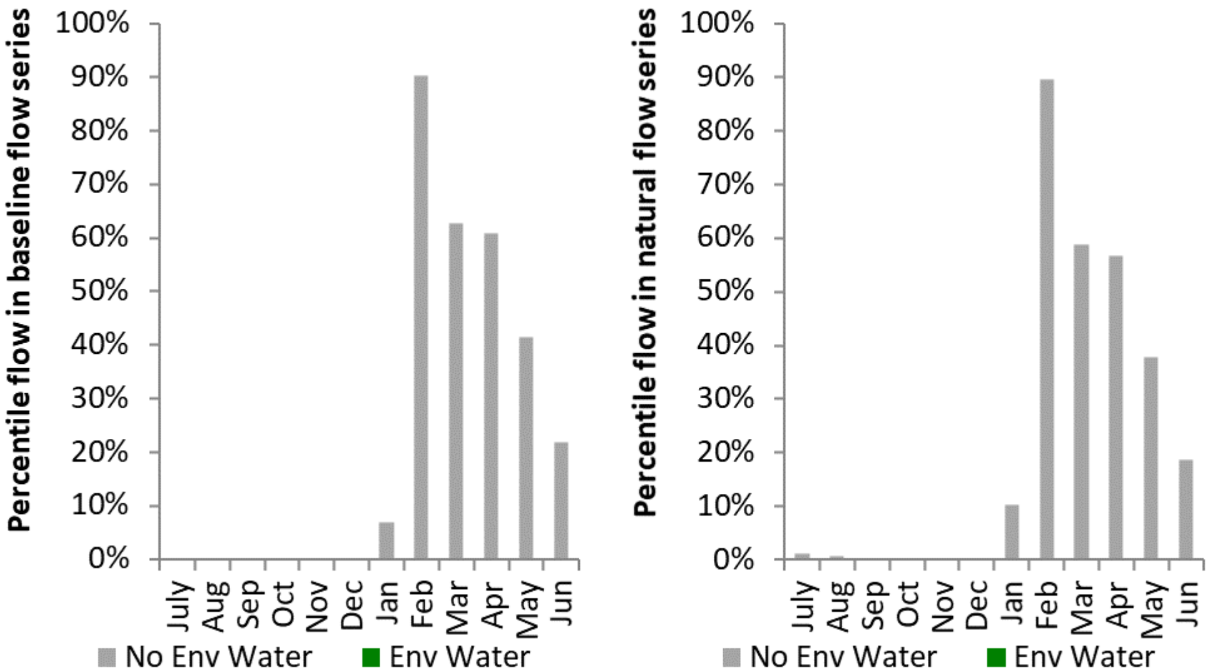


Figure NAM27: Contribution of environmental water delivery at Carroll as percentiles in the natural and baseline flow series.

3 Murrumbidgee Valley

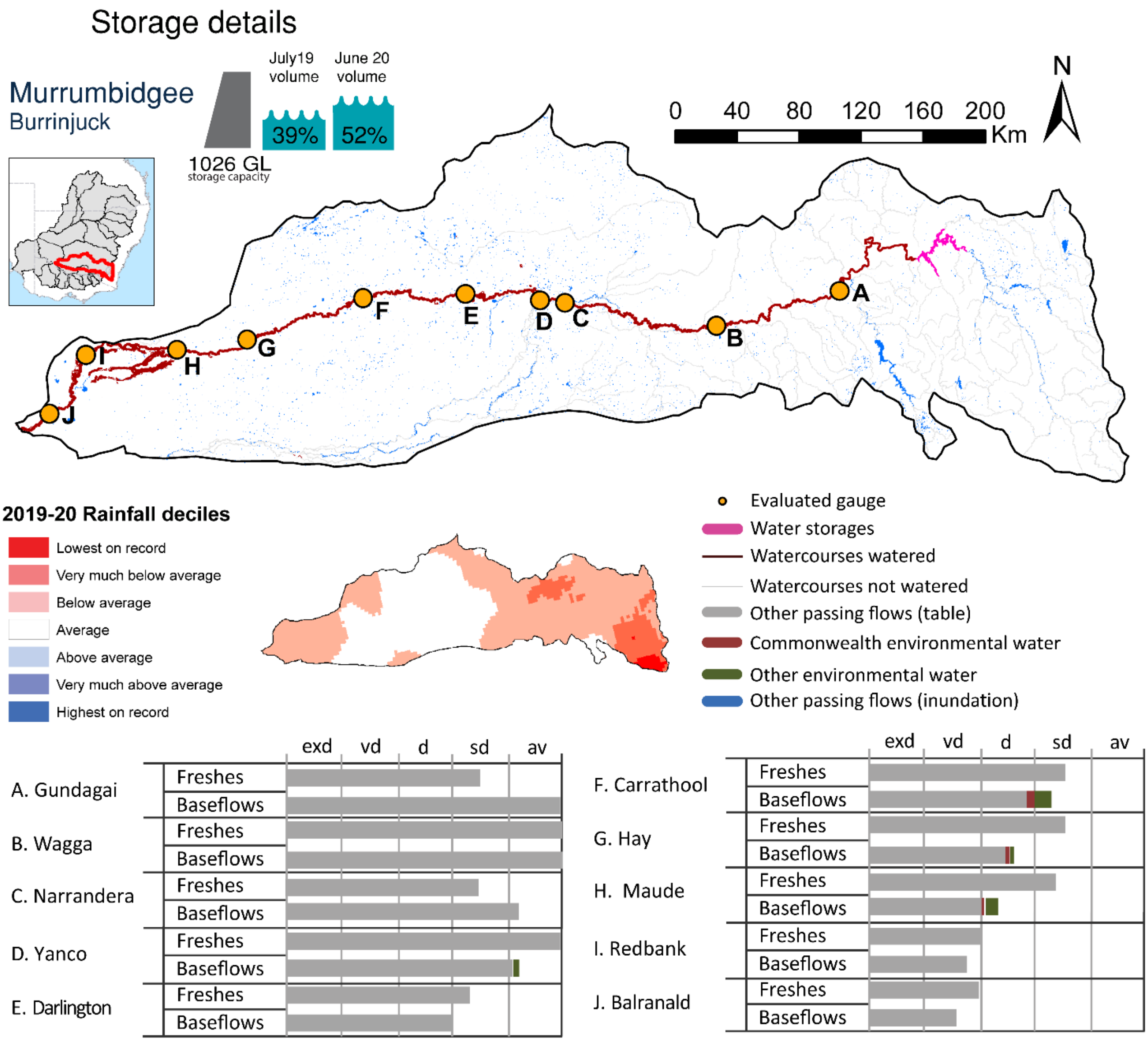


Figure MBG1: Watercourses influenced, areas inundated (where applicable) and gauge stations evaluated in the Murrumbidgee valley during the 2019–20 water year. Inset bar graphs report the condition of annual flow regimes by showing the improvements in hydrological condition with the addition of environmental water as well as the hypothetical scenario in 'grey' (if no environmental flow had been delivered). Rainfall conditions (rainfall deciles) and trend in storage levels for the water year are also shown. The classified bands are: exd = extremely dry, vd=very dry, sd=somewhat dry and av=average.

3.1 Summary

The volume of environmental water delivery for the 2019–20 year in the Murrumbidgee valley is quantified using data for 10 sites. This evaluation only considers the contribution of held environmental water, which is a primary focus for the Commonwealth. The contributions of planned environmental water (e.g. passing flows), unregulated tributary inflows and clever use of irrigation flows for environmental benefits can all be very important but these are outside the scope of this report. Environmental watering actions lasted on average 149 days over the course of the year. The volume of environmental water at these 10 sites was between 1% and 12% of the total streamflow. Commonwealth environmental water contributed on average 70% of this environmental water. The contribution of environmental water delivery to improved flow regimes is evaluated using data for 10 sites. Ideally, baseflows should be maintained and long periods of excessively low flows avoided. In this valley, the baseflow regime was generally considered to be dry relative to the pre-development flow regime. In our analysis, a low fresh refers to a period of increased flow, when the water level rises at least one eighth of the way up the river bank (above the low flow level). These low freshes are a regular part of the natural flow regime and support a range of natural processes. In the Murrumbidgee valley, in terms of the occurrence and duration of low freshes, the year was assessed as being average. In our analysis, a medium fresh refers to a period of increased flow, when the water level rises at least one quarter of the way up the river bank. These medium freshes are not as frequent as low freshes but are also a regular and important part of the natural flow regime. In the Murrumbidgee valley, in terms of the occurrence of medium freshes, the year was assessed as being average. In our analysis, a high fresh refers to a period of increased flow, when the water level rises more than half way up the river. A high fresh may not occur every year but they are still important and long periods without major freshes can have serious consequences for floodplains and their contribution to river ecosystem health. Delivering environmental high in channel flows normally requires that all risks to riparian landholders and infrastructure have been resolved. In the Murrumbidgee valley, in terms of the occurrence of high freshes, the year was assessed as being very dry.

3.2 Water delivery context

During the 2019–20 water year, the Commonwealth Environmental Water Holder (CEWH) held water entitlements of up to 779,676 ML for environmental use in the Murrumbidgee valley. Each year, water utilities allocate water entitlement holders a percentage of water based on their holding, licence type and carryover (the exact rules vary among Jurisdictions and licence type). In 2019–20, the Murrumbidgee entitlements held by the CEWH were allocated 71,796 ML of water, representing 17% of the Long term average annual yield for the Murrumbidgee valley (416,216 ML). Information and data relating to the portfolio of held Commonwealth environmental water is shown in Table MBG1.

The 2019–20 water allocation (71,796 ML) together with the carryover volume of 36,926 ML of water meant the CEWH had 108,722 ML of water available for delivery. A total of 46,742 ML of Commonwealth environmental water was delivered in the Murrumbidgee valley. A total of 61,980 ML (57%) of available Commonwealth environmental water was carried over for environmental use into the 2020–21 water year.

3.3 Environmental conditions and resource availability

The water available for environmental delivery combined with the present and antecedent environmental conditions are key inputs used by environmental water managers in planning and implementing watering actions. *Post hoc*, this information provides important context when evaluating the effectiveness and appropriateness of environmental water use with respect to hydrological outputs.

The rainfall conditions in the Murrumbidgee valley were classified as below average, based on rainfall percentile data for the entire record held by the Bureau of Meteorology for this valley. The water held in major storages in the Murrumbidgee valley increased over the water year, for example Burrinjuck dam was 39.2% full at the beginning of the water year and 52.1% full by the end of the year (Figure MBG1).

The CEWO calculates resource availability scenarios (RAS) to guide the use and prioritisation of held environmental water. The RAS are progressively calculated over the year as part of the continual adaptive management planning processes. The RAS are based on the availability of held environmental water (including progressive licence acquisitions and allocations) as well as the potential for unregulated or planned environmental flows. The outcome is then used to determine the demand for environmental water across the Basin.

In 2019–20, the resource availability of held Commonwealth environmental water in the Murrumbidgee was classified as very low, whilst the overall demand for environmental water was classified as critical to low. The physical conditions meant that the CEWO was managing to avoid damage and protect the health and resilience of aquatic ecosystems in the Macquarie River and Macquarie Marshes, and other important sites in the valley as required.

3.4 Watering actions

A total of 14 watering actions were delivered over the 2019–20 water year, the duration of these actions varied (range of individual actions: 2 - 184 days) and Commonwealth environmental water was delivered for a total of 365 days. The number of water actions commencing in each season included, summer (8), autumn (3), winter (2), spring (1). Similarly, the count of flow component types delivered in the Murrumbidgee valley were; (0) baseflow, (0) baseflow-fresh, (0) baseflow-fresh-bankfull, (0) baseflow-fresh-overbank-wetland, (0) fresh, (0) fresh-wetland, (0) bankfull, (0) overbank, (12) wetland and (2) wetland-overbank.

In the Murrumbidgee, watering actions were delivered for biota, frogs, fish, vegetation and waterbirds purposes, but water was also delivered for other purposes too. The percentage of watering actions delivered across the nine main themes included fish (20%), vegetation (20%), waterbirds (20%), frogs (20%), other biota (20%), connectivity (0.0%), process (0.0%), resilience (0.0%) and water quality (0.0%).

Table MBG1. Commonwealth environmental water accounting information for the Murrumbidgee valley over 2019–20 water year.

Total registered volume (ML)	Allocated volume (ML)	Carry over + allocated volume (ML)	Delivered (ML)	LTAAY (ML)	Carried over to 2020–21
779,676	71,796	108,722	46,742	416,216	61,980

3.5 Contribution of Commonwealth environmental water to flow regimes

3.5.1 Gundagai

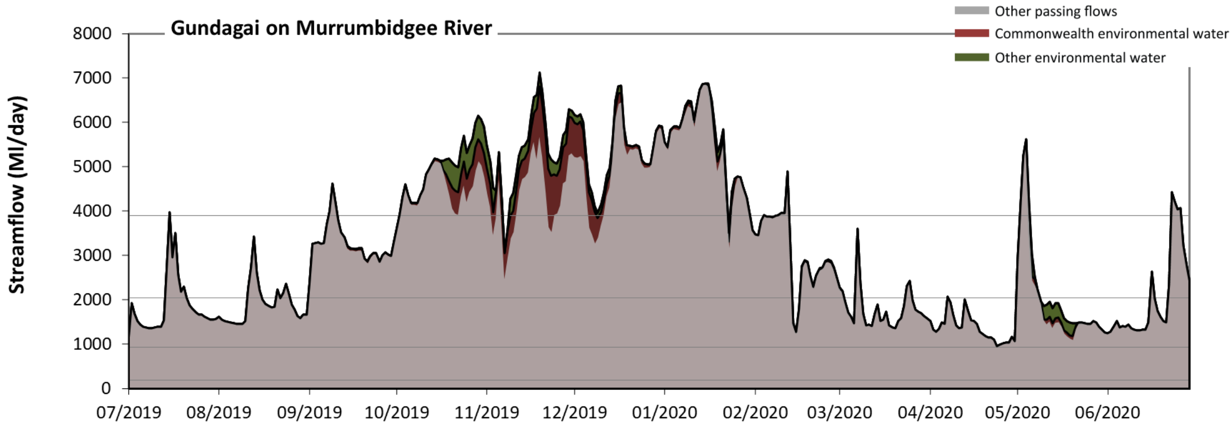


Figure MBG2: Contribution of environmental water delivery at Gundagai. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Gundagai on Murrumbidgee River environmental water contributed 6% of the total streamflow volume (much of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 48% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 190 ML/day) compared to an average year in the natural flow regime. Flow regulation does not substantially increase the duration of low flows (i.e. < 930 ML/day) compared to an average year in the natural flow regime. There was at least one low fresh (i.e. > 2000 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water made little change to the duration of these low freshes. In the absence of environmental water there would have been at least one medium fresh (i.e. > 3900 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest medium fresh during the period October to December (from 32 days to 53 days). Commonwealth environmental water was almost entirely responsible for these increased durations of medium freshes. There were no high freshes (i.e. > 11000 ML/day) this year.

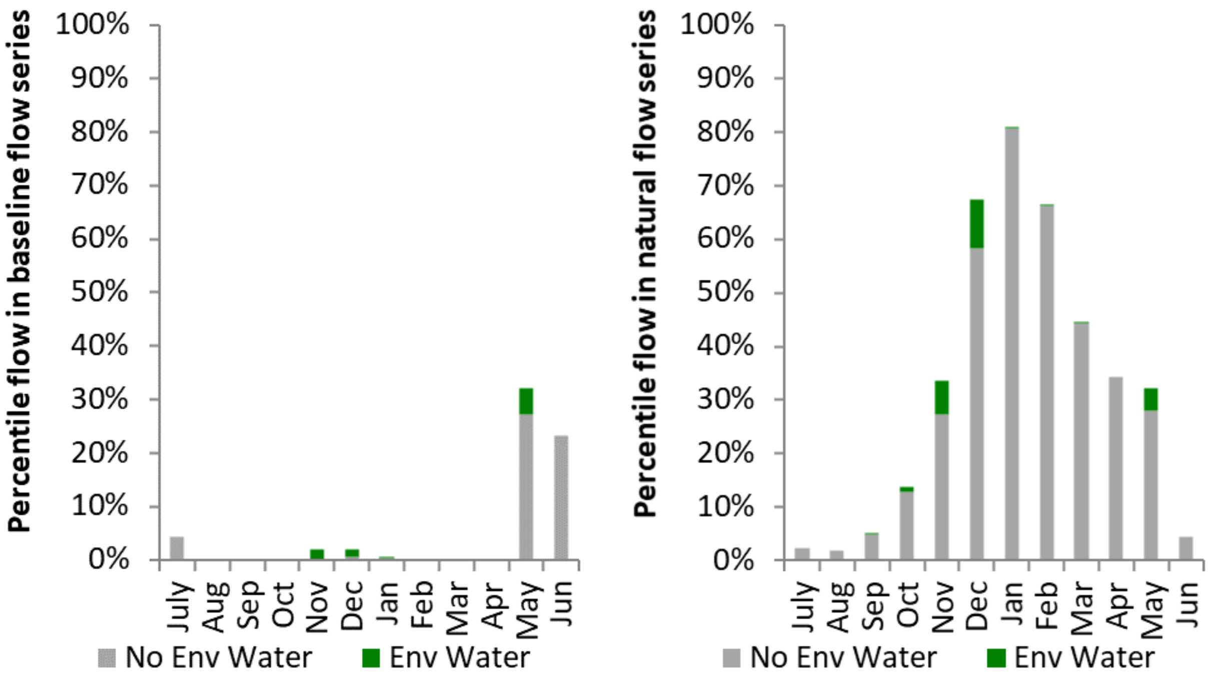


Figure MBG3: Contribution of environmental water delivery at Gundagai as percentiles in the natural and baseline flow series.

3.5.2 Wagga

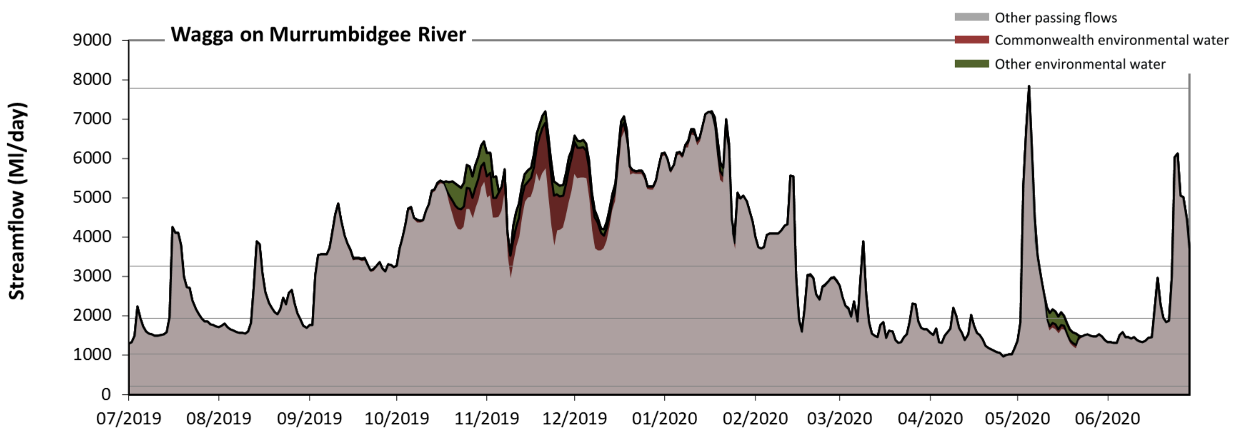


Figure MBG4: Contribution of environmental water delivery at Wagga. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Wagga on Murrumbidgee River environmental water contributed 6% of the total streamflow volume (much of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 48% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 210 ML/day) compared to an average year in the natural flow regime. Flow regulation does not substantially increase the duration of low flows (i.e. < 1000 ML/day) compared to an average year in the natural flow regime. In the absence of environmental water there would have been at least one low fresh (i.e. > 1900 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the period April to June (from 8 days to 15 days). Commonwealth environmental water made little or no contribution to these increased durations of low freshes. In the absence of environmental water there would have been at least one medium fresh (i.e. > 3300 ML/day) in the periods July to

September, October to December, January to March and April to June. Environmental water increased the duration of the longest medium fresh during the period October to December (from 52 days to 91 days). Commonwealth environmental water was entirely responsible for these increased durations of medium freshes. In the absence of environmental water there would have been at least one high fresh in the period April to June. Environmental water made no change to the duration of these high freshes.

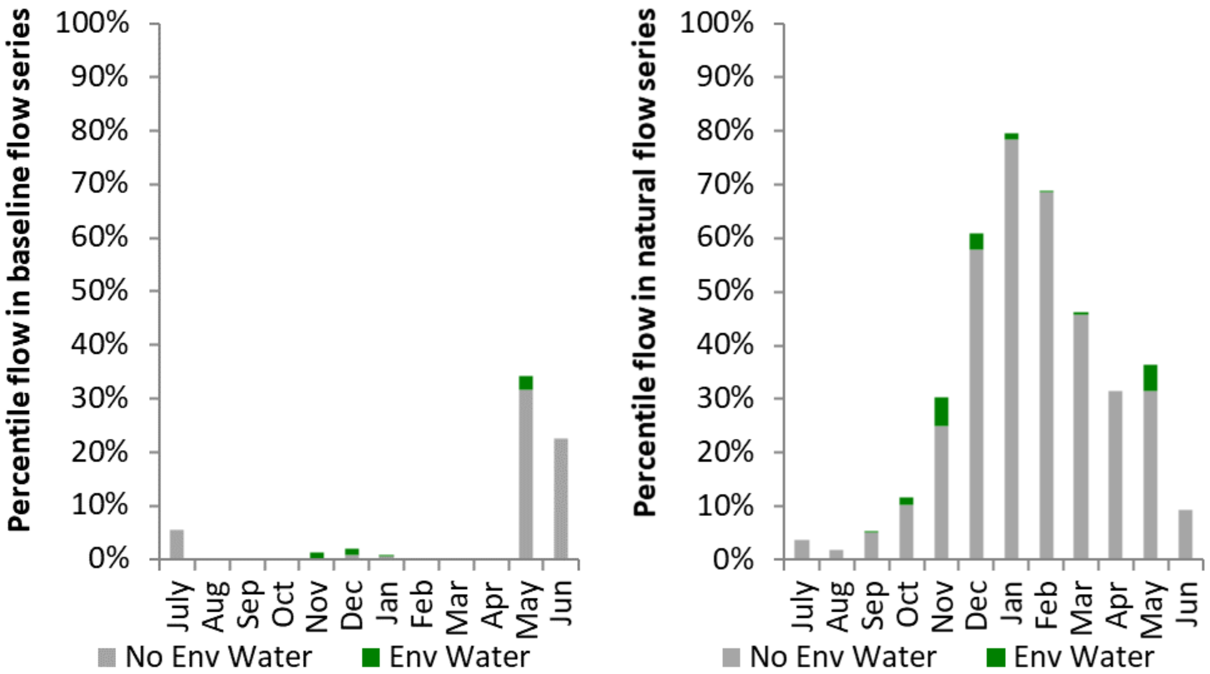


Figure MBG5: Contribution of environmental water delivery at Wagga as percentiles in the natural and baseline flow series.

3.5.3 Narrandera

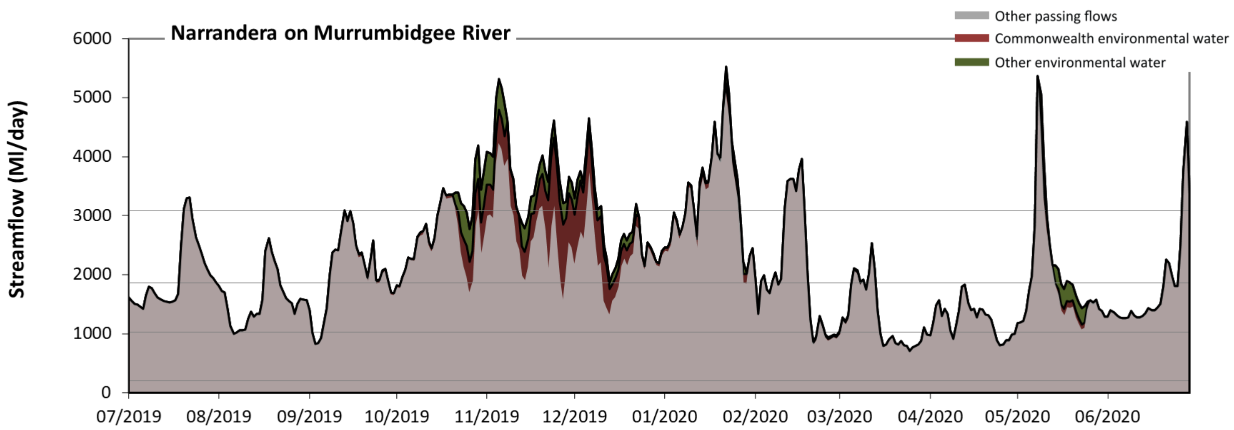


Figure MBG6: Contribution of environmental water delivery at Narrandera. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Narrandera on Murrumbidgee River environmental water contributed 9% of the total streamflow volume (much of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 48% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 210 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the duration of low flows (i.e. < 1000 ML/day) in the period July to September would have substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these low flows, which occurred for 11% of the year. In the absence of environmental water there would have been at least one low fresh (i.e. > 1900 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the periods July to September (from 16 days to 21 days) and October to December (from 31 days to 90 days). Commonwealth environmental water equally shared responsibility with other environmental water holders for these increased durations of low freshes. In the absence of environmental water there would have been at least one medium fresh (i.e. > 3100 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest medium fresh during the period October to December (from 6 days to 25 days). Commonwealth environmental water made the dominant contribution to these increased durations of medium freshes. There was no high freshes (i.e. > 7200 ML/day) this year.

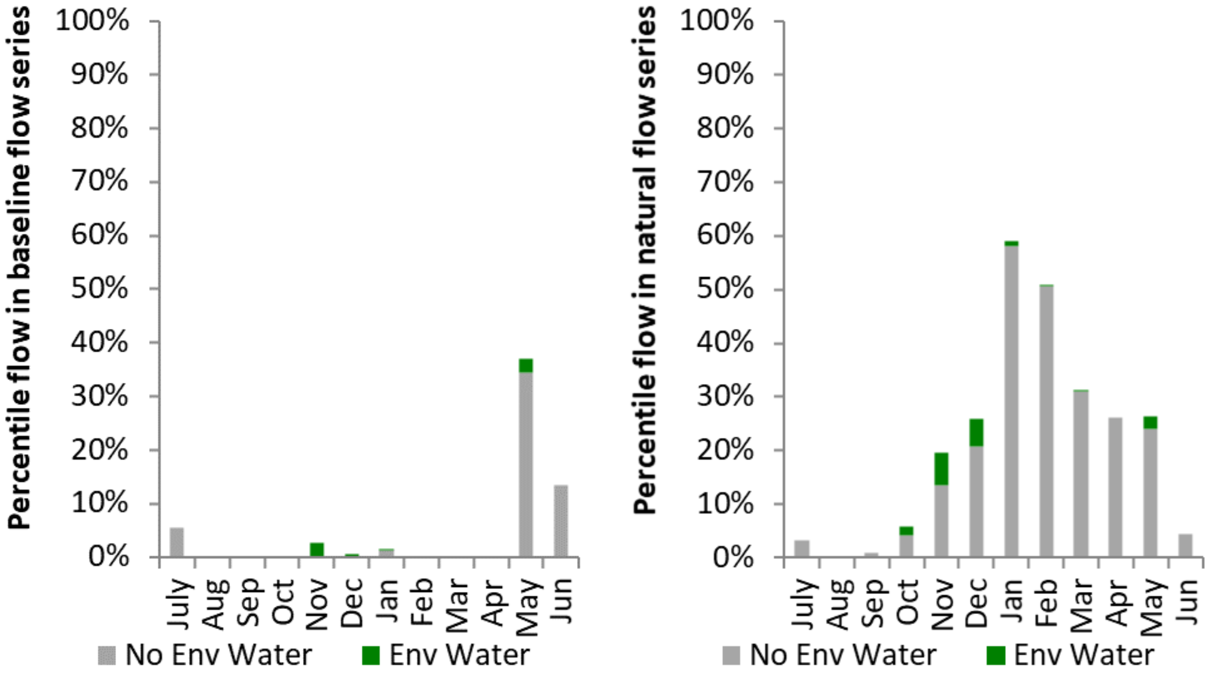


Figure MBG7: Contribution of environmental water delivery at Narrandera as percentiles in the natural and baseline flow series.

3.5.4 Yanco Offtake

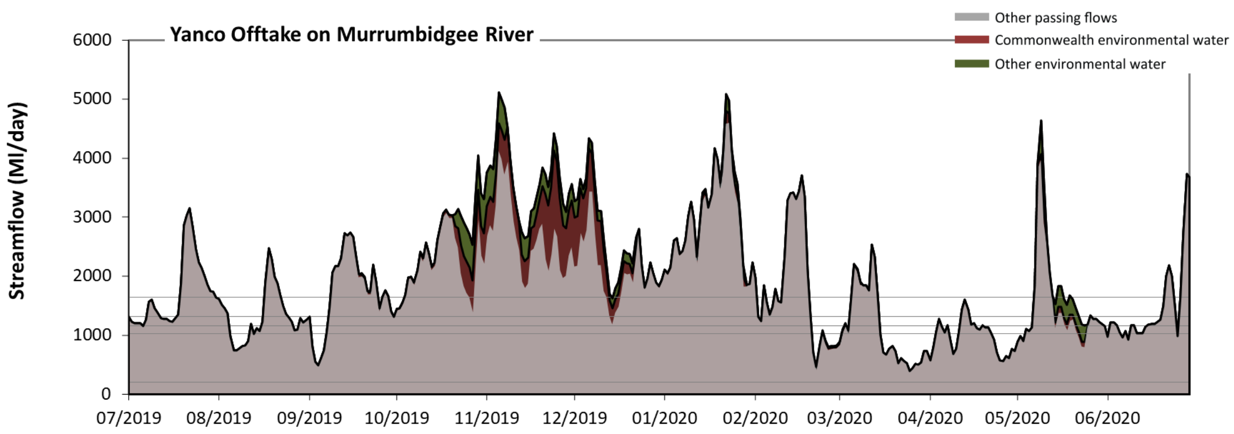


Figure MBG8: Contribution of environmental water delivery at Yanco Offtake. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Yanco Offtake on Murrumbidgee River environmental water contributed 9% of the total streamflow volume (much of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 48% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 210 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the durations of low flows (i.e. < 1000 ML/day) in the periods July to September, January to March and April to June would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 17% to 16% of the year, with greatest influence in the period April to June. In the absence of environmental water there would have been at least one low fresh (i.e. > 1200 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the period April to June (from 10 days to 24 days). Commonwealth environmental water equally shared responsibility with other environmental water holders for these increased durations of low freshes. In the absence of environmental water there would have been at least one medium fresh (i.e. > 1300 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest medium fresh during the period April to June (from 7 days to 15 days). Commonwealth environmental water made little or no contribution to these increased durations of medium freshes. In the absence of environmental water there would have been at least one high fresh in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest medium fresh during the period October to December (from 45 days to 71 days). Commonwealth environmental water equally shared responsibility with other environmental water holders for these increased durations of high freshes.

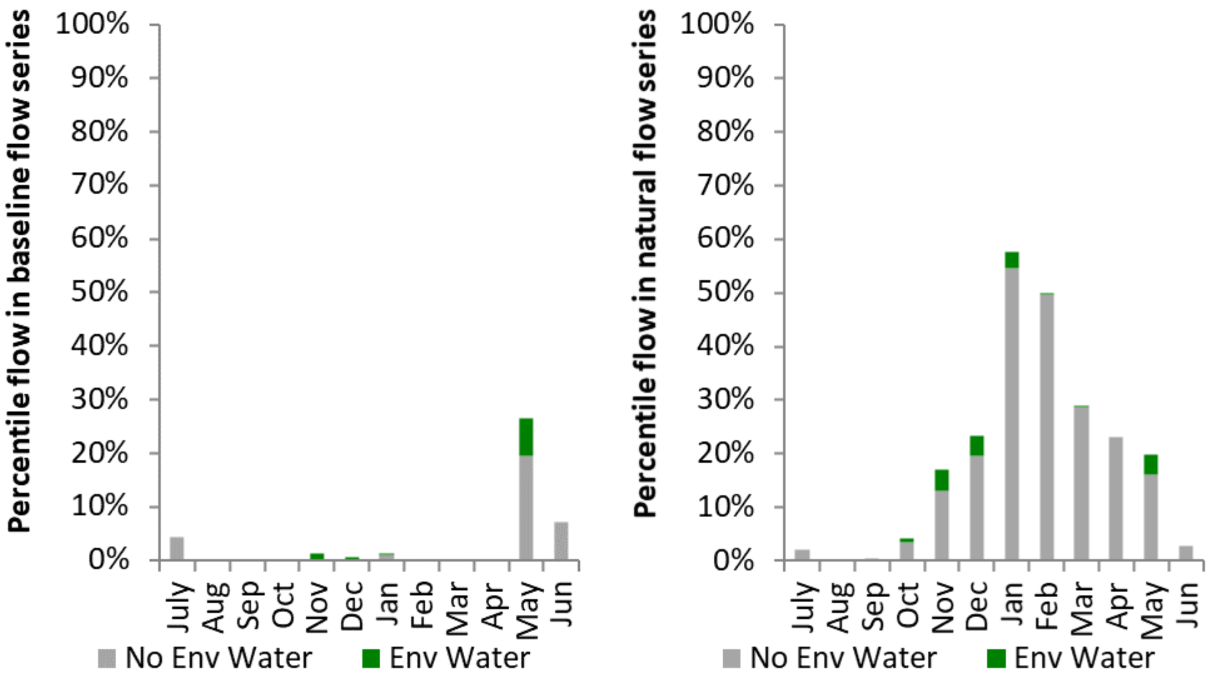


Figure MBG9: Contribution of environmental water delivery at Yanco Offtake as percentiles in the natural and baseline flow series.

3.5.5 Darlington

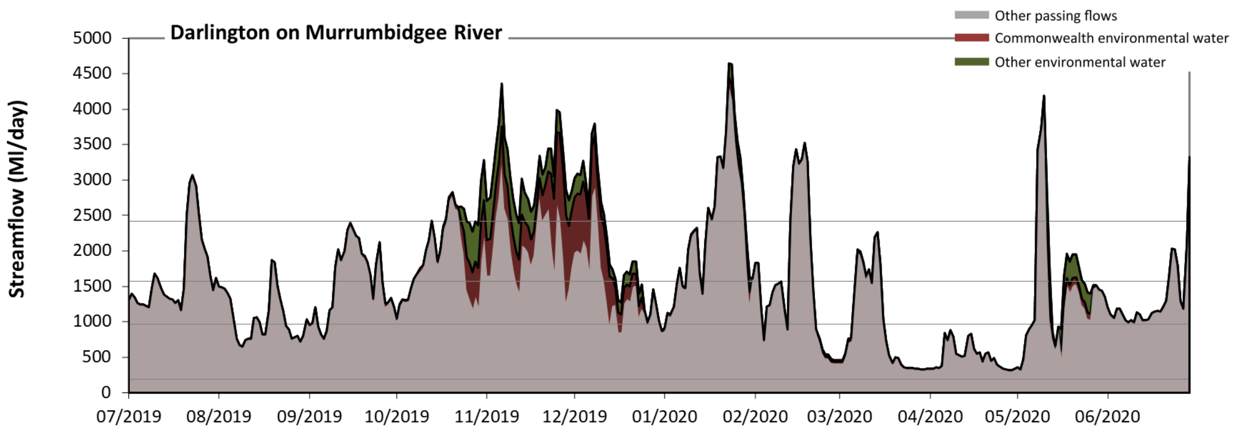


Figure MBG10: Contribution of environmental water delivery at Darlington. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Darlington on Murrumbidgee River environmental water contributed 11% of the total streamflow volume (with approximately half contributed by Commonwealth environmental water). Environmental watering actions affected streamflows for 47% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 190 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the durations of low flows (i.e. < 960 ML/day) in the periods July to September, January to March and April to June would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water reduced the cumulative duration of low flow spells from 26% to 25% of the year, with greatest influence in the period October to December. In the absence of environmental water there would have been at least one low fresh (i.e. > 1600 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the periods October to December (from 18 days to 70 days), January to March (from 15 days to 19 days) and April to June (from 4 days to 7 days). Commonwealth environmental water equally shared responsibility with other environmental water holders for these increased durations of low freshes. In the absence of environmental water there would have been at least one medium fresh (i.e. > 2400 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest medium fresh during the periods October to December (from 5 days to 29 days) and April to June (from 3 days to 4 days). Commonwealth environmental water made a modest contribution to these increased durations of medium freshes. There was no high freshes (i.e. > 5000 ML/day) this year.

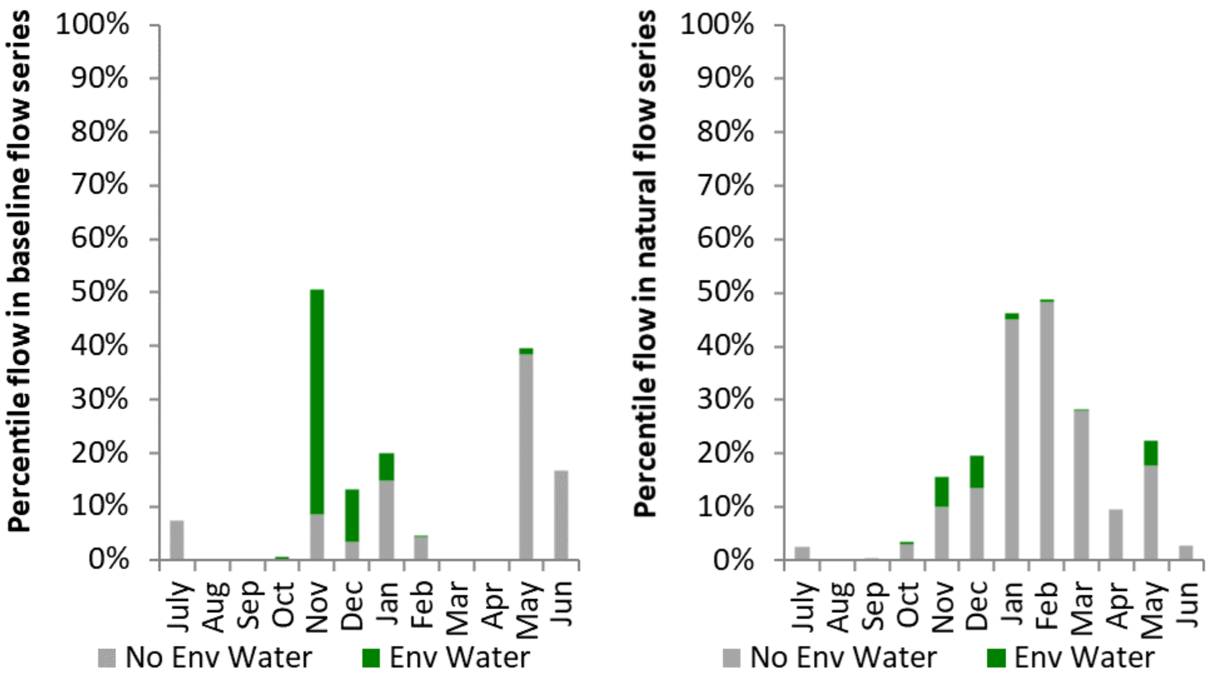


Figure MBG11: Contribution of environmental water delivery at Darlington as percentiles in the natural and baseline flow series.

3.5.6 Carrathool

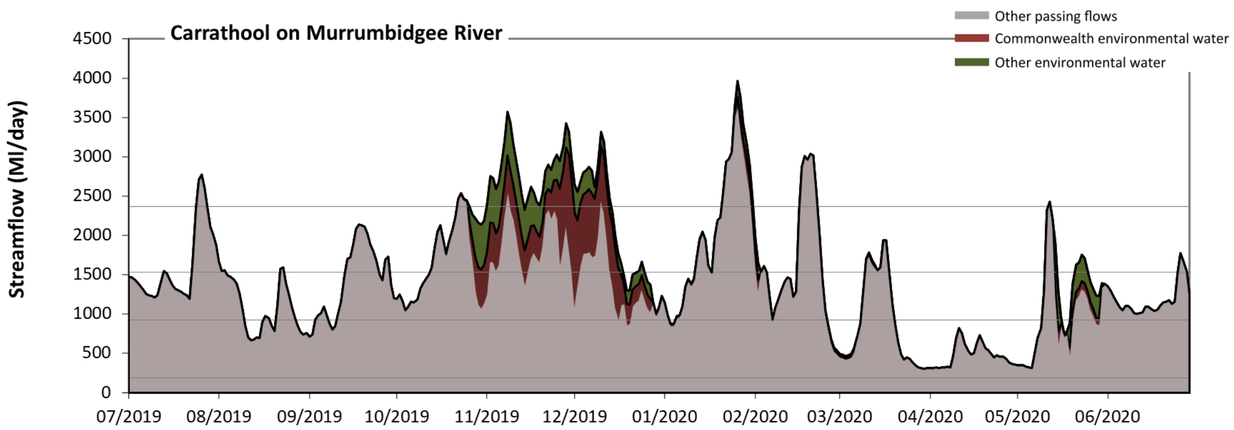


Figure MBG12: Contribution of environmental water delivery at Carrathool. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest)

At Carrathool on Murrumbidgee River environmental water contributed 12% of the total streamflow volume (with approximately half contributed by Commonwealth environmental water). Environmental watering actions affected streamflows for 41% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 190 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the durations of low flows (i.e. < 930 ML/day) in the periods July to September and April to June would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 26% to 24% of the year, with greatest influence in the periods October to December and April to June. In the absence of environmental water there would have been at least one low fresh (i.e. > 1500 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the periods October to December (from 16 days to 66 days) and April to June (from 3 days to 5 days). Commonwealth environmental water made a modest contribution to these increased durations of low freshes. In the absence of environmental water there would have been at least one medium fresh (i.e. > 2400 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest medium fresh during the period October to December (from 4 days to 29 days). Commonwealth environmental water made the dominant contribution to these increased durations of medium freshes. There was no high freshes (i.e. > 5000 ML/day) this year.

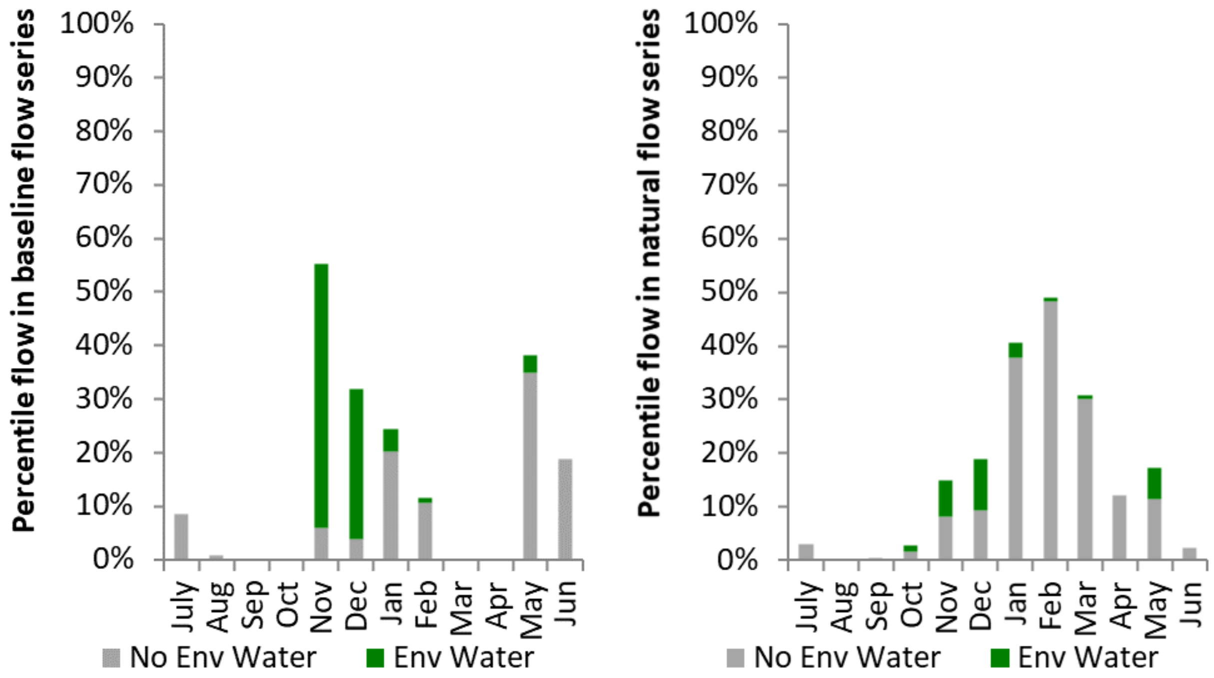


Figure MBG13: Contribution of environmental water delivery at Carrathool as percentiles in the natural and baseline flow series

3.5.7 Hay

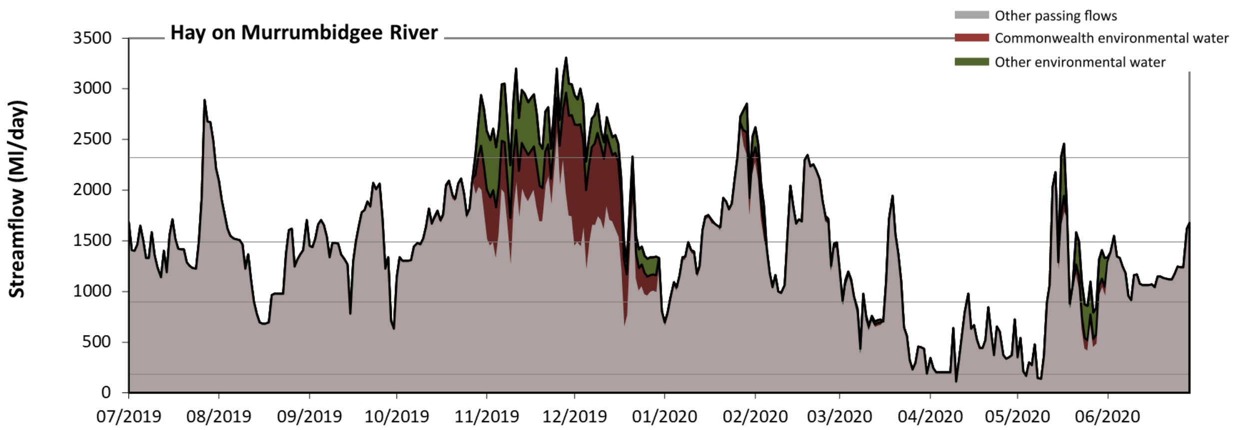


Figure MBG14: Contribution of environmental water delivery at Hay. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest)

At Hay on Murrumbidgee River environmental water contributed 12% of the total streamflow volume (with approximately half contributed by Commonwealth environmental water). Environmental watering actions affected streamflows for 41% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 180 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the durations of low flows (i.e. < 900 ML/day) in the periods July to September and April to June would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 22% to 20% of the year, with greatest influence in the periods October to December and April to June. In the absence of environmental water there would have been at least one low fresh (i.e. > 1500 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the period October to December (from 23 days to 70 days). Commonwealth environmental water equally shared responsibility with other environmental water holders for these increased durations of low freshes. In the absence of environmental water there would have been at least one medium fresh (i.e. > 2300 ML/day) in the periods July to September, October to December and January to March. Environmental water increased the duration of the longest medium fresh during the periods October to December (from 1 days to 25 days), January to March (from 3 days to 4 days) and April to June (from 0 days to 2 days). Commonwealth environmental water equally shared responsibility with other environmental water holders for these increased durations of medium freshes. There was no high freshes (i.e. > 4900 ML/day) this year.

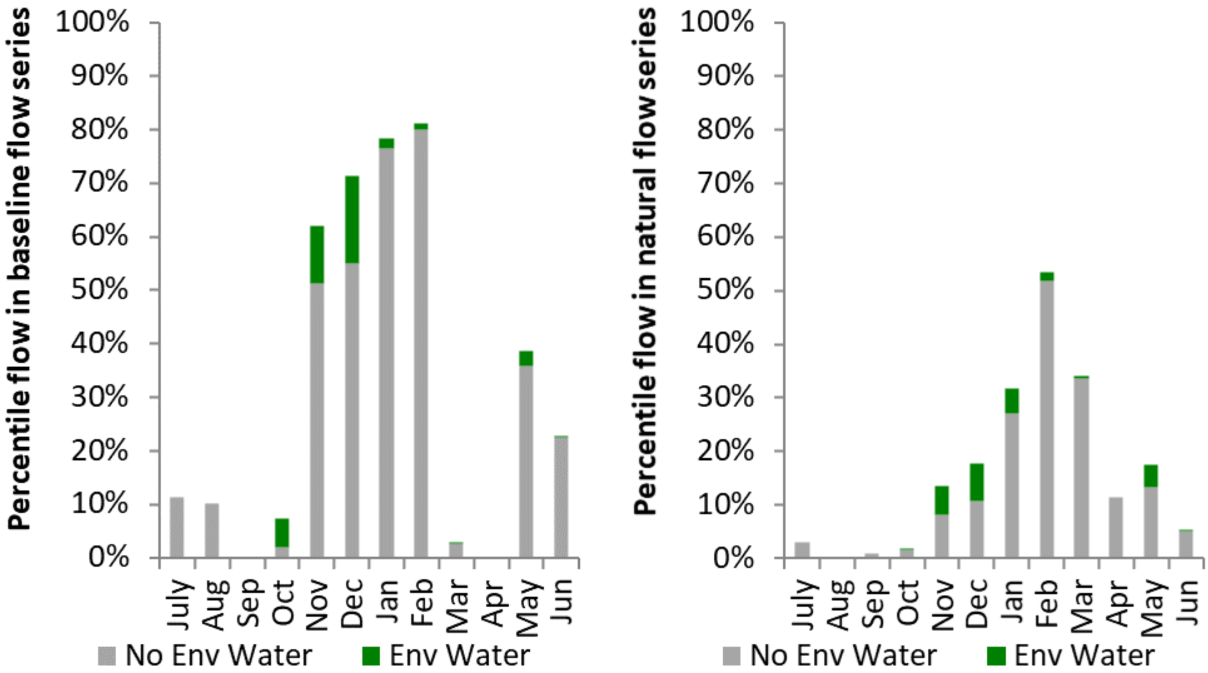


Figure MBG15: Contribution of environmental water delivery at Hay as percentiles in the natural and baseline flow series.

3.5.8 Maude

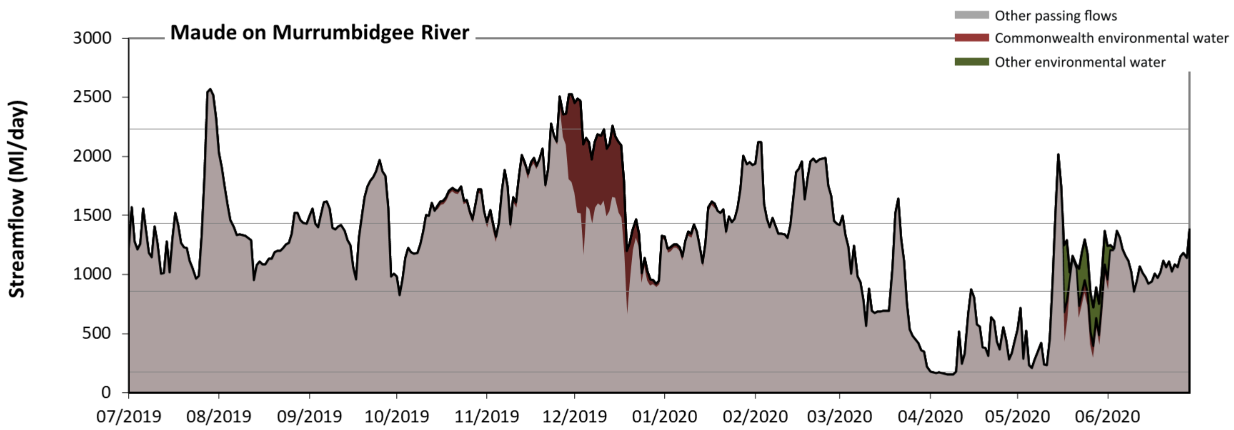


Figure MBG16: Contribution of environmental water delivery at Maude. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Maude on Murrumbidgee River environmental water contributed 5% of the total streamflow volume (most of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 33% of days between 1 July 2019 and 30 June 2020. Without environmental water, the duration of very low flows (i.e. < 170 ML/day) in the period April to June would have substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these very low flows, which occurred for 2% of the year. Similarly, without environmental water, the duration of low flows (i.e. < 860 ML/day) in the period April to June would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 20% to 17% of the year, with greatest influence in the period April to June. Commonwealth environmental water made a modest contribution to these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 1400 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the period October to December (from 24 days to 39 days). Commonwealth environmental water was entirely responsible for these increased durations of low freshes. In the absence of environmental water there would have been at least one medium fresh (i.e. > 2200 ML/day) in the periods July to September and October to December. Environmental water increased the duration of the longest medium fresh during the period October to December (from 1 days to 8 days). Commonwealth environmental water was entirely responsible for these increased durations of medium freshes. There was no high freshes (i.e. > 4700 ML/day) this year.

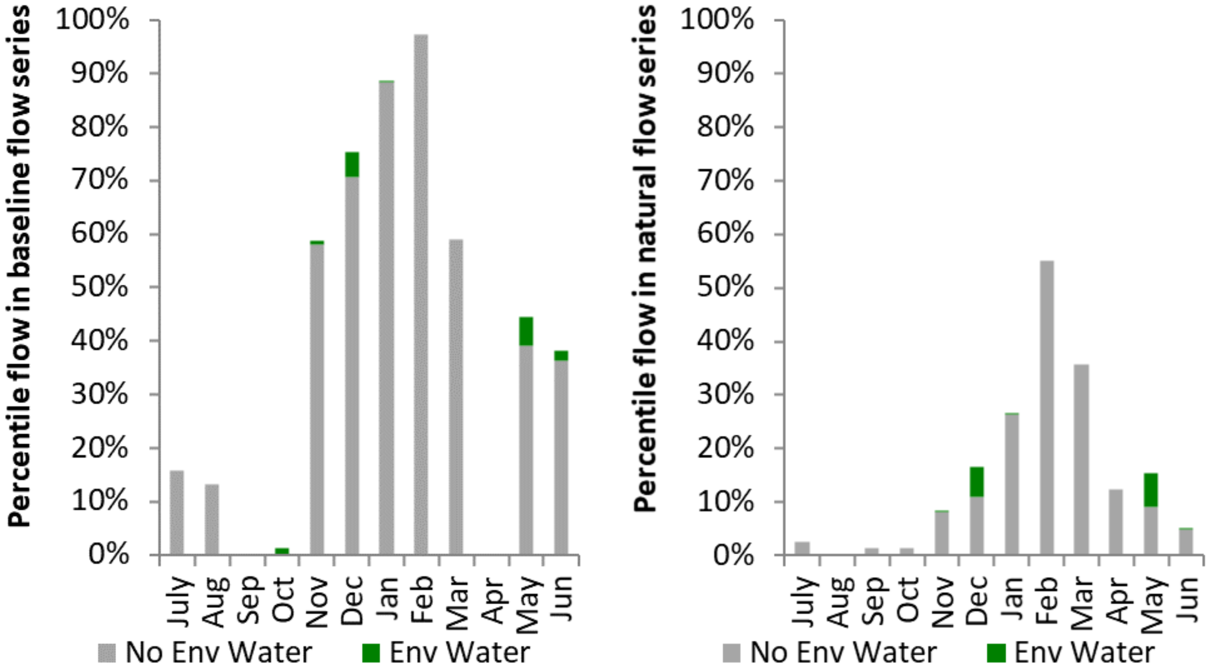


Figure MBG17: Contribution of environmental water delivery at Maude as percentiles in the natural and baseline flow series.

3.5.9 Redbank

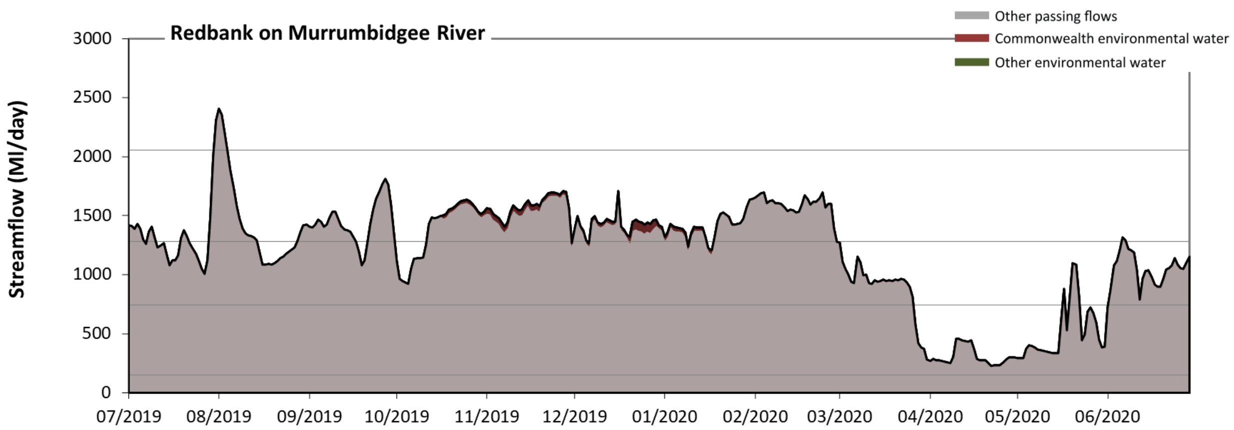


Figure MBG18: Contribution of environmental water delivery at Redbank. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Redbank on Murrumbidgee River environmental water contributed 1% of the total streamflow volume (all of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 27% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 150 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the duration of low flows (i.e. < 740 ML/day) in the period April to June would have substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these low flows, which occurred for 17% of the year. There was at least one low fresh (i.e. > 1300 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water made no change to the duration of these low freshes. There was at least one medium fresh (i.e. > 2100 ML/day) in the period July to September. Environmental water made no change to the duration of these medium freshes. There was no high freshes (i.e. > 4500 ML/day) this year.

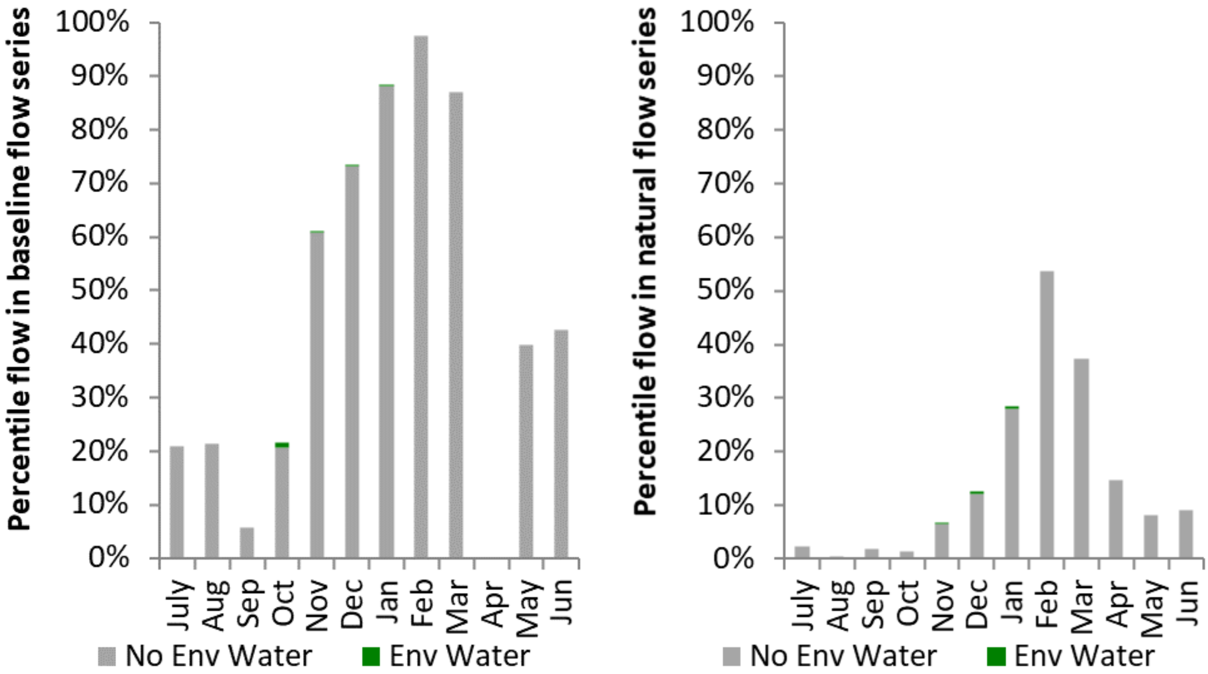


Figure MBG19: Contribution of environmental water delivery at Redbank as percentiles in the natural and baseline flow series.

3.5.10 Balranald

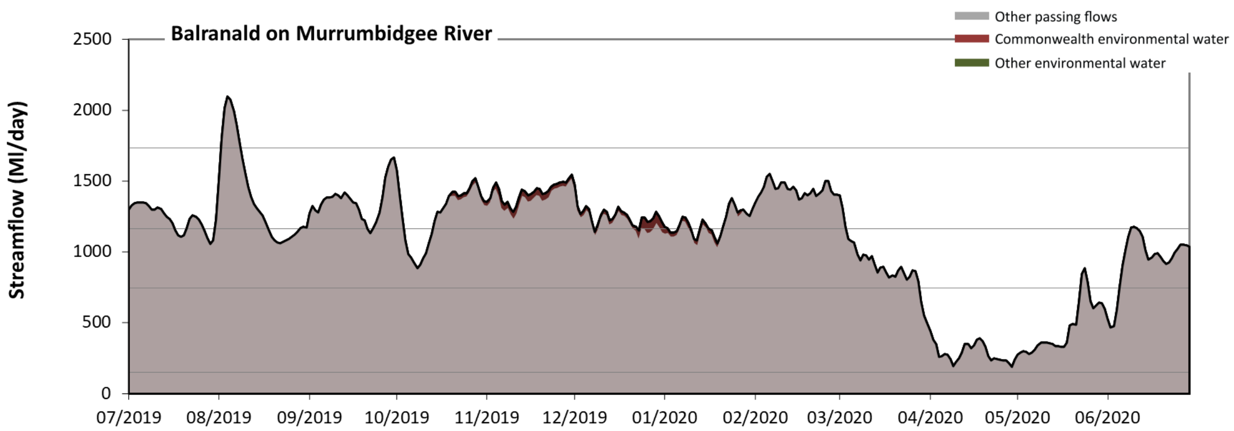


Figure MBG20: Contribution of environmental water delivery at Balranald. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Balranald on Murrumbidgee River environmental water contributed 1% of the total streamflow volume (all of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 27% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 150 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the duration of low flows (i.e. < 740 ML/day) in the period April to June would have substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these low flows, which occurred for 18% of the year. There was at least one low fresh (i.e. > 1200 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water made no change to the duration of these low freshes. There was at least one medium fresh (i.e. > 1700 ML/day) in the period July to September. Environmental water made no change to the duration of these medium freshes. There was no high freshes (i.e. > 3400 ML/day) this year.

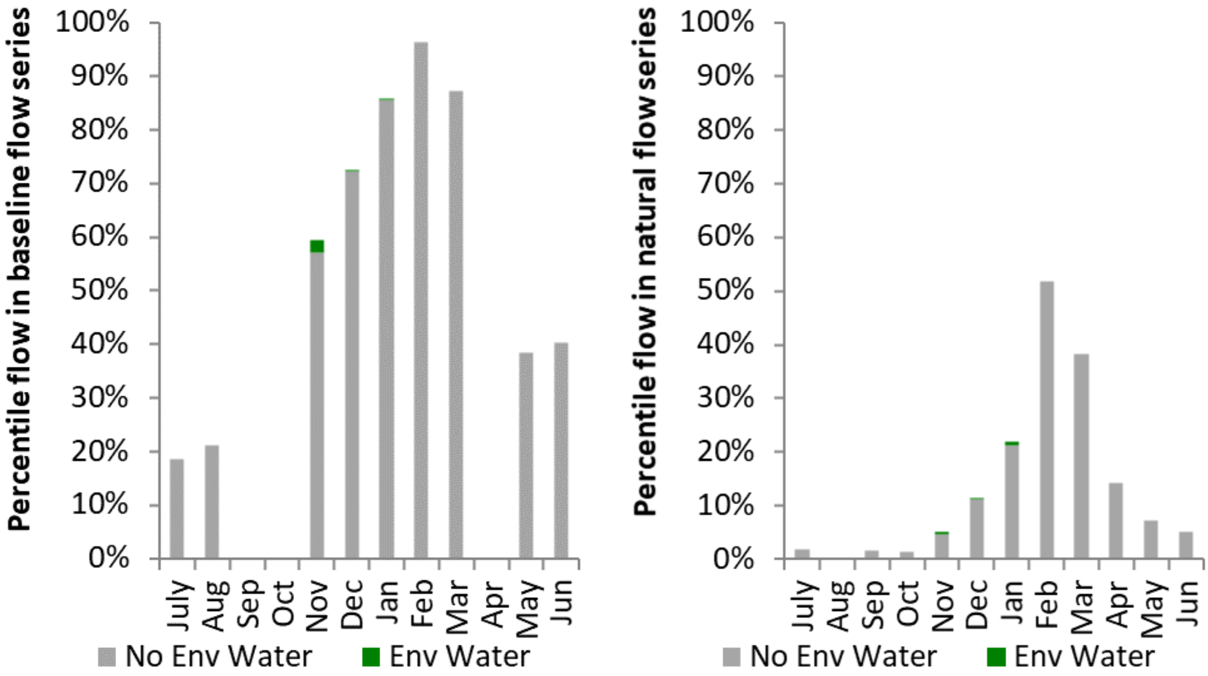


Figure MBG21: Contribution of environmental water delivery at Balranald as percentiles in the natural and baseline flow series.

4 Lachlan Valley

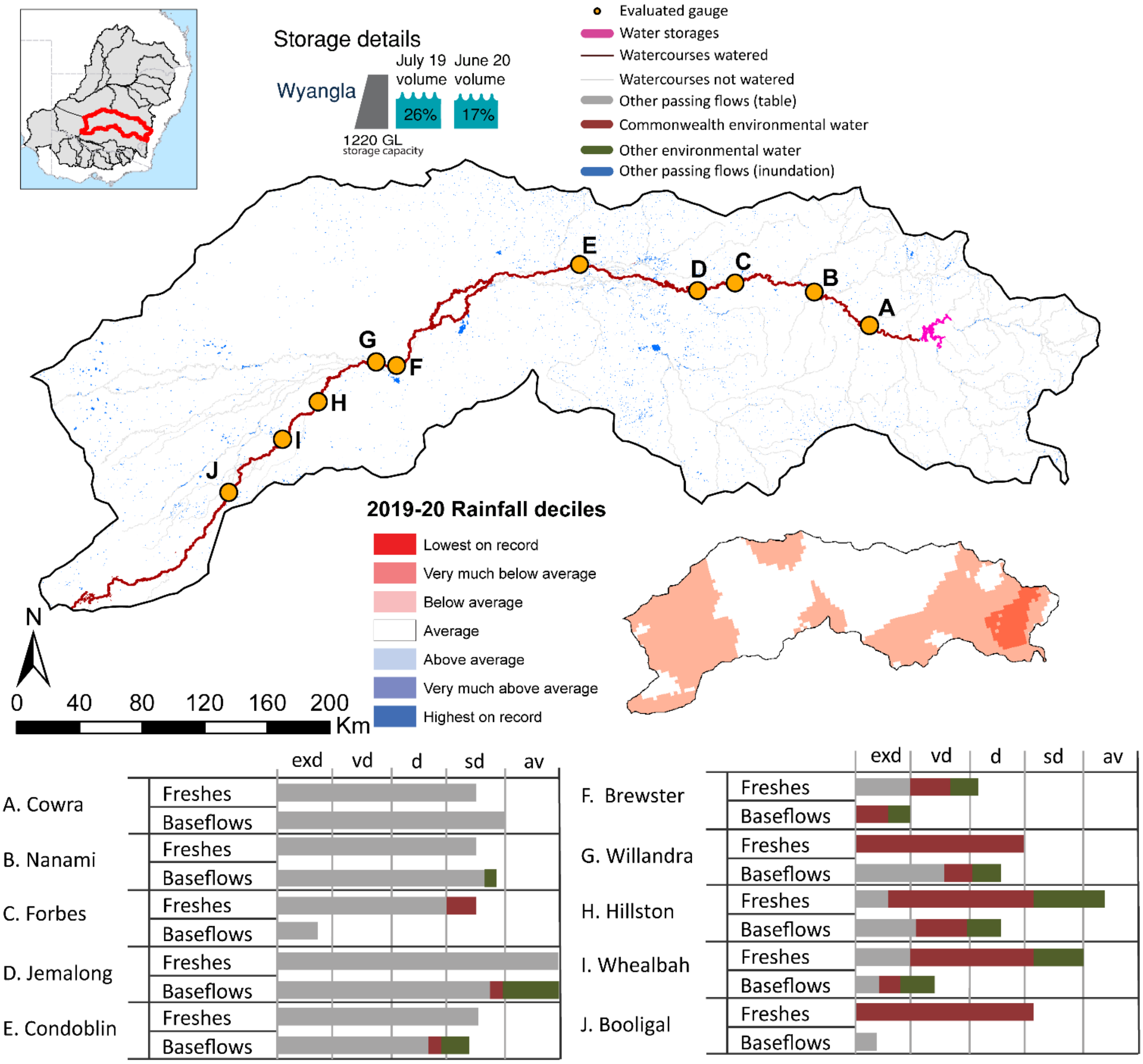


Figure LCH1: Watercourses influenced, areas inundated (where applicable) and gauge stations evaluated in the Lachlan valley during the 2019–20 water year. Inset bar graphs report the condition of annual flow regimes by showing the improvements in hydrological condition with the addition of environmental water as well as the hypothetical scenario in 'grey' (if no environmental flow had been delivered). Rainfall conditions (rainfall deciles) and trend in storage levels for the water year are also shown. The classified bands are: exd = extremely dry, vd=very dry, sd=somewhat dry and av=average.

4.1 Summary

The volume of environmental water delivery for the 2019–20 year in the Lachlan valley is quantified using data for 10 sites. This evaluation only considers the contribution of held environmental water, which is a primary focus for the Commonwealth. The contributions of planned environmental water (e.g. passing flows), unregulated tributary inflows and clever use of irrigation flows for environmental benefits can all be very important but these are outside the scope of this report. Environmental watering actions lasted on average 171 days over the course of the year. The volume of environmental water at these 10 sites was between 10% and 45% of the total streamflow. Commonwealth environmental water contributed on average 67% of this environmental water. The contribution of environmental water delivery to improved flow regimes is evaluated using data for 10 sites. Ideally, baseflows should be maintained and long periods of excessively low flows avoided. In this valley, the baseflow regime was generally considered to be very dry relative to the pre-development flow regime. In our analysis, a low fresh refers to a period of increased flow, when the water level rises at least one eighth of the way up the river bank (above the low flow level). These low freshes are a regular part of the natural flow regime and support a range of natural processes. In the Lachlan valley, in terms of the occurrence and duration of low freshes, the year was assessed as being average. In our analysis, a medium fresh refers to a period of increased flow, when the water level rises at least one quarter of the way up the river bank. These medium freshes are not as frequent as low freshes but are also a regular and important part of the natural flow regime. In the Lachlan valley, in terms of the occurrence of medium freshes, the year was assessed as being somewhat dry. In our analysis, a high fresh refers to a period of increased flow, when the water level rises more than half way up the river. A high fresh may not occur every year but they are still important and long periods without major freshes can have serious consequences for floodplains and their contribution to river ecosystem health. Delivering environmental high in channel flows normally requires that all risks to riparian landholders and infrastructure have been resolved. In the Lachlan valley, in terms of the occurrence of high freshes, the year was assessed as being dry.

4.2 Water delivery context

During the 2019–20 water year, the Commonwealth Environmental Water Holder (CEWH) held water entitlements of up to 87,856 ML for environmental use in the Lachlan valley. Each year, water utilities allocate water entitlement holders a percentage of water based on their holding, licence type and carryover (the exact rules vary among Jurisdictions and licence type). In 2019–20, the Lachlan entitlements held by the CEWH were allocated 812 ML of water, representing 2% of the Long term average annual yield for the Lachlan valley (35,286 ML). Information and data relating to the portfolio of held Commonwealth environmental water is shown in Table LCH1.

The 2019–20 water allocation (812 ML) together with the carryover volume of 37,219 ML of water meant the CEWH had 38,030 ML of water available for delivery. A total of 22,026 ML of Commonwealth environmental water was delivered in the Lachlan valley. A total of 16004 ML (42%) of available Commonwealth environmental water was carried over for environmental use into the 2020–21 water year.

4.3 Environmental conditions and resource availability

The water available for environmental delivery combined with the present and antecedent environmental conditions are key inputs used by environmental water managers in planning and implementing watering actions. *Post hoc*, this information provides important context when evaluating the effectiveness and appropriateness of environmental water use with respect to hydrological outputs.

The rainfall conditions in the Lachlan valley were classified as average, based on rainfall percentile data for the entire record held by the Bureau of Meteorology for this valley. The water held in major storages in the Lachlan valley increased over the water year, for example Wyangla Dam was 26.3% full at the beginning of the water year and 16.7% full by the end of the year (Figure LCH1).

The CEWO calculates resource availability scenarios (RAS) to guide the use and prioritisation of held environmental water. The RAS are progressively calculated over the year as part of the continual adaptive management planning processes. The RAS are based on the availability of held environmental water (including progressive licence acquisitions and allocations) as well as the potential for unregulated or planned environmental flows. The outcome is then used to determine the demand for environmental water across the Basin.

In 2019–20, the resource availability of held Commonwealth environmental water in the Lachlan was classified as very low to low, whilst the overall demand for environmental water was classified as critical to high. The physical conditions meant that the CEWO was managing to maintain refuge habitats through current drought conditions and to continue to support the native fish populations remaining after the hypoxic conditions experienced in the mid-Lachlan during previous water years.

4.4 Watering actions

A total of 5 watering actions were delivered over the 2019–20 water year, the duration of these actions varied (range of individual actions: 17 - 254 days) and Commonwealth environmental water was delivered for a total of 365 days. The number of water actions commencing in each season included, summer (0), autumn (2), winter (0), spring (3). Similarly, the count of flow component types delivered in the Lachlan valley were; (0) baseflow, (0) baseflow-fresh, (0) baseflow-fresh-bankfull, (0) baseflow-fresh-overbank-wetland, (2) fresh, (1) fresh-wetland, (0) bankfull, (0) overbank, (2) wetland and (0) wetland-overbank.

In the Lachlan, watering actions were delivered for water quality, connectivity, frogs, fish, vegetation and waterbirds purposes, but water was also delivered for other purposes too. The percentage of watering actions delivered across the nine main themes included fish (8.33%), vegetation (20.83%), waterbirds (20.83%), frogs (16.67%), other biota (0.0%), connectivity (20.83%), process (0.0%), resilience (0.0%) and water quality (12.5%).

Table LCH1. Commonwealth environmental water accounting information for the Lachlan valley over 2019–20 water year.

Total registered volume (ML)	Allocated volume (ML)	Carry over + allocated volume (ML)	Delivered (ML)	LTAAY (ML)	Carried over to 2020–21
87,856	812	38,030	22,026	35,286	16,004

4.5 Contribution of Commonwealth environmental water to flow regimes

4.5.1 Cowra

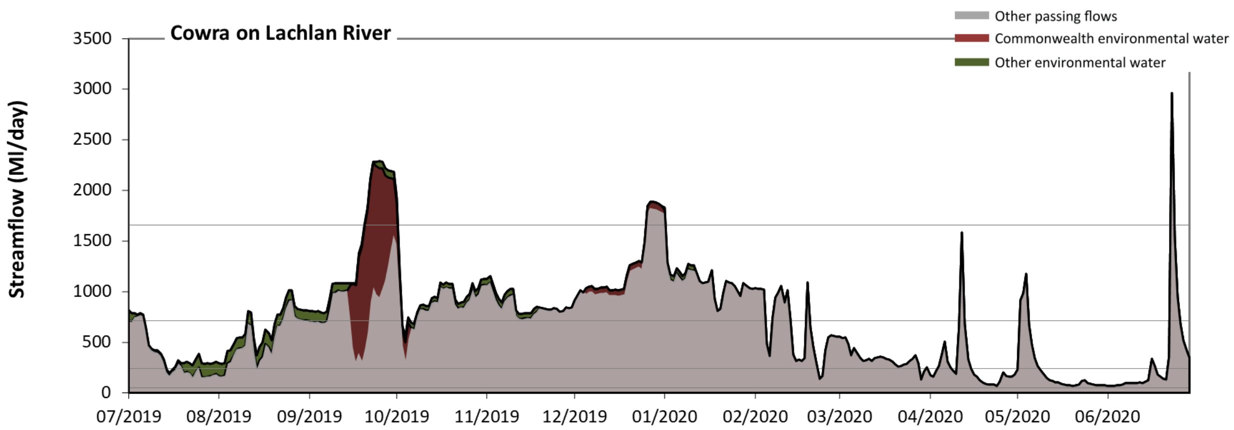


Figure LCH2: Contribution of environmental water delivery at Cowra. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Cowra on Lachlan River environmental water contributed 11% of the total streamflow volume (much of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 49% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 47 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the durations of low flows (i.e. < 240 ML/day) in the periods July to September and April to June would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 24% to 19% of the year, with greatest influence in the period July to September. Commonwealth environmental water made little or no contribution to these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 710 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the period July to September (from 9 days to 41 days). Commonwealth environmental water equally shared responsibility with other environmental water holders for these increased durations of low freshes. In the absence of environmental water there would have been at least one medium fresh (i.e. > 1700 ML/day) in the periods October to December, January to March and April to June. Environmental water increased the duration of the longest medium fresh during the period July to September (from 0 days to 11 days). Commonwealth environmental water was entirely responsible for these increased durations of medium freshes. There was no high freshes (i.e. > 5800 ML/day) this year.

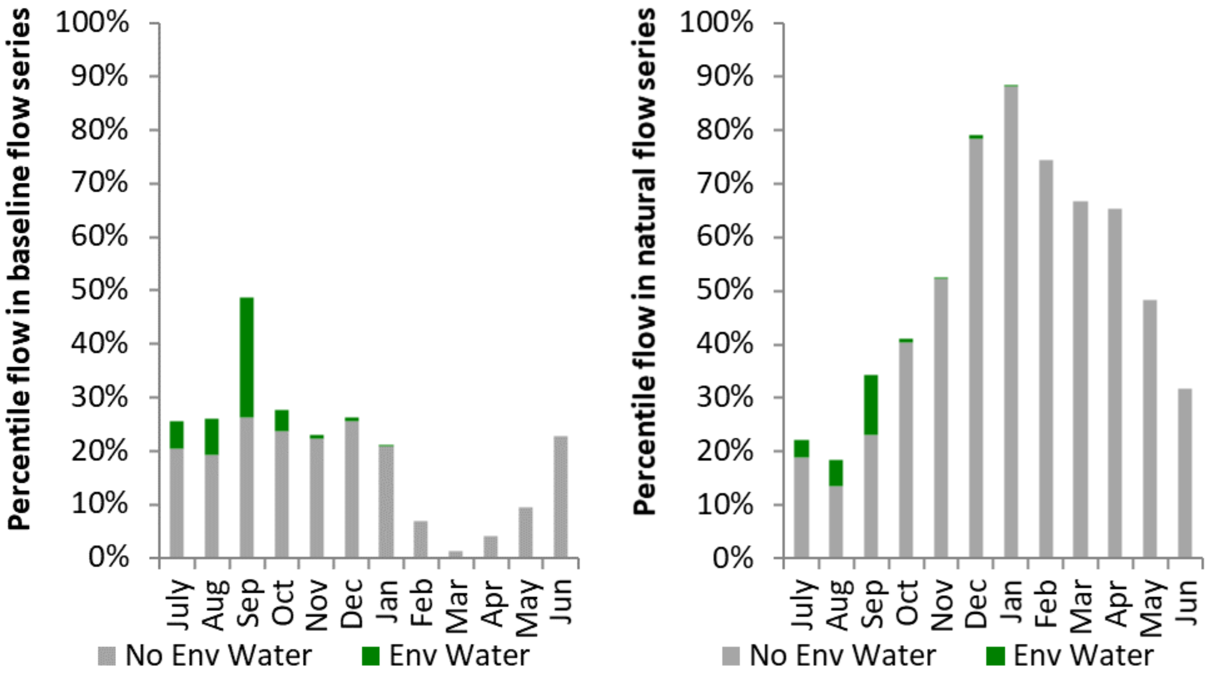


Figure LCH3: Contribution of environmental water delivery at Cowra as percentiles in the natural and baseline flow series.

4.5.2 Nanami

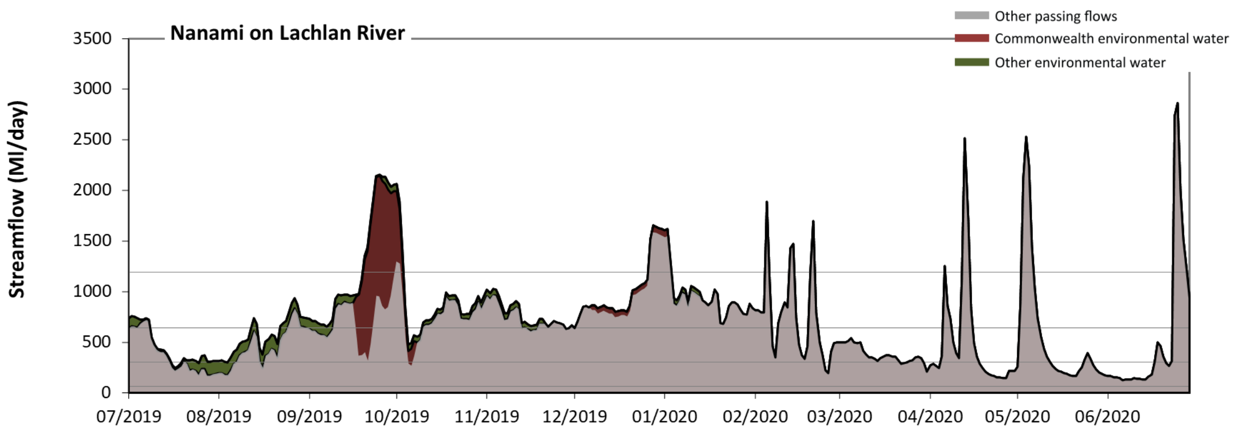


Figure LCH4: Contribution of environmental water delivery at Nanami. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Nanami on Lachlan River environmental water contributed 11% of the total streamflow volume (much of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 50% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 61 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the durations of low flows (i.e. < 300 ML/day) in the periods July to September and April to June would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 23% to 19% of the year, with greatest influence in the period July to September. Commonwealth environmental water made a small contribution to these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 640 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the periods July to

September (from 8 days to 40 days) and October to December (from 34 days to 49 days). Commonwealth environmental water made a modest contribution to these increased durations of low freshes. In the absence of environmental water there would have been at least one medium fresh (i.e. > 1200 ML/day) in the periods October to December, January to March and April to June. Environmental water increased the duration of the longest medium fresh during the period July to September (from 0 days to 11 days). Commonwealth environmental water was almost entirely responsible for these increased durations of medium freshes. There was no high freshes (i.e. > 3200 ML/day) this year.

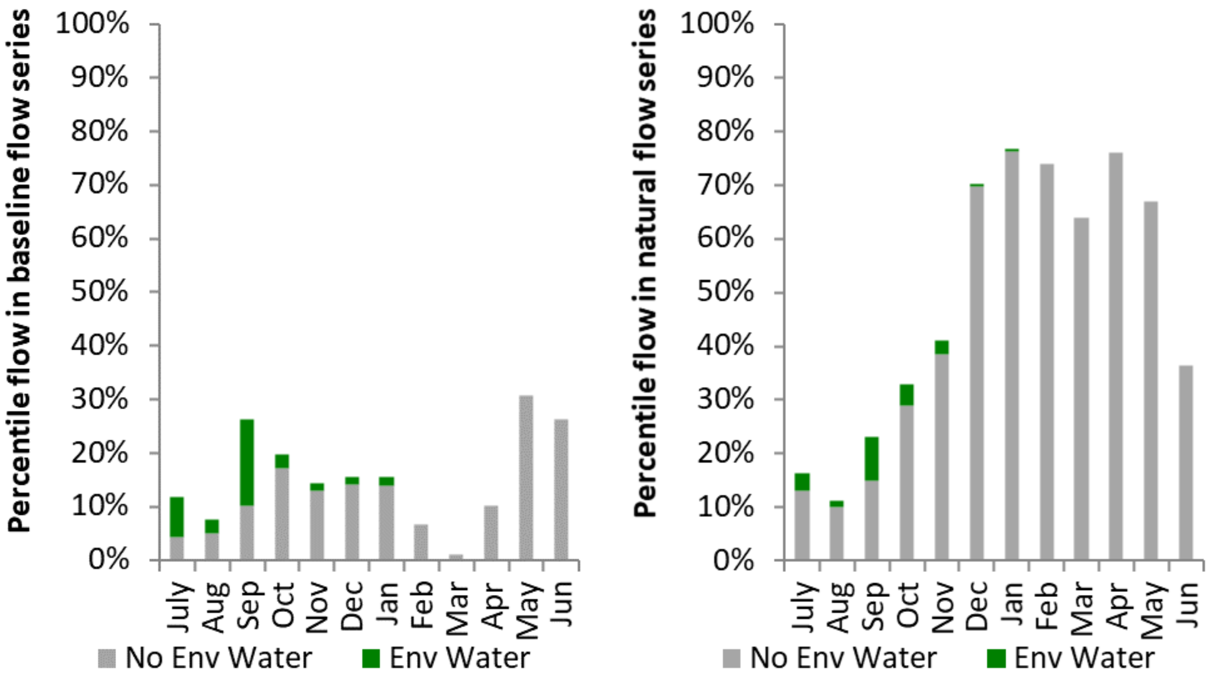


Figure LCH5: Contribution of environmental water delivery at Nanami as percentiles in the natural and baseline flow series.

4.5.3 Forbes

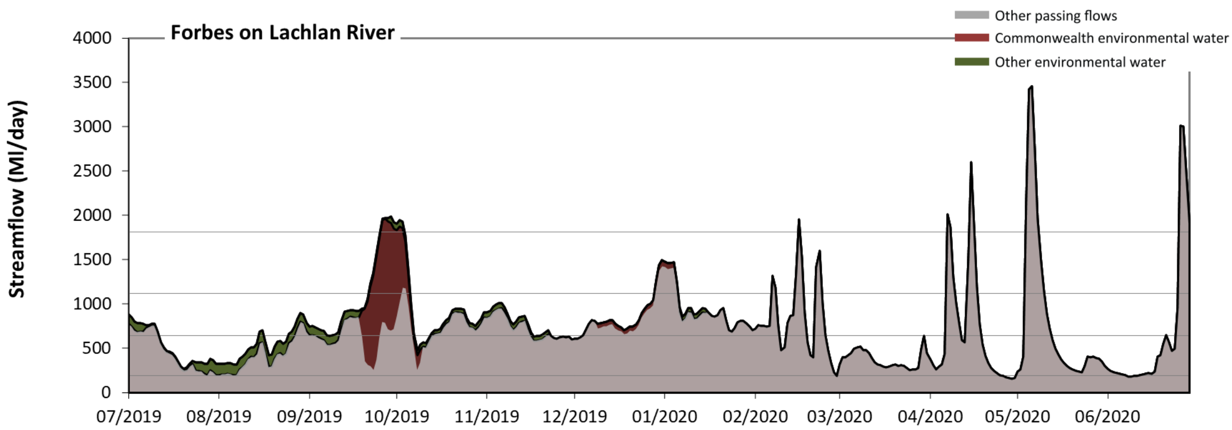


Figure LCH6: Contribution of environmental water delivery at Forbes. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Forbes on Lachlan River environmental water contributed 10% of the total streamflow volume (much of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 50% of days between 1 July 2019 and 30 June 2020. Without environmental water, the duration of very low flows (i.e. < 190 ML/day) in the period April to June would have substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these very low flows, which occurred for 3% of the year. Similarly, without environmental water, the durations of low flows (i.e. < 640 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 53% to 46% of the year, with greatest influence in the period July to September. Commonwealth environmental water made a modest contribution to these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 1100 ML/day) in the periods October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the periods July to September (from 0 days to 9 days) and October to December (from 3 days to 5 days). Commonwealth environmental water was entirely responsible for these increased durations of low freshes. In the absence of environmental water there would have been at least one medium fresh (i.e. > 1800 ML/day) in the periods January to March and April to June. Environmental water increased the duration of the longest medium fresh during the periods July to September (from 0 days to 5 days) and October to December (from 0 days to 3 days). Commonwealth environmental water was entirely responsible for these increased durations of medium freshes. There was no high freshes (i.e. > 4000 ML/day) this year.

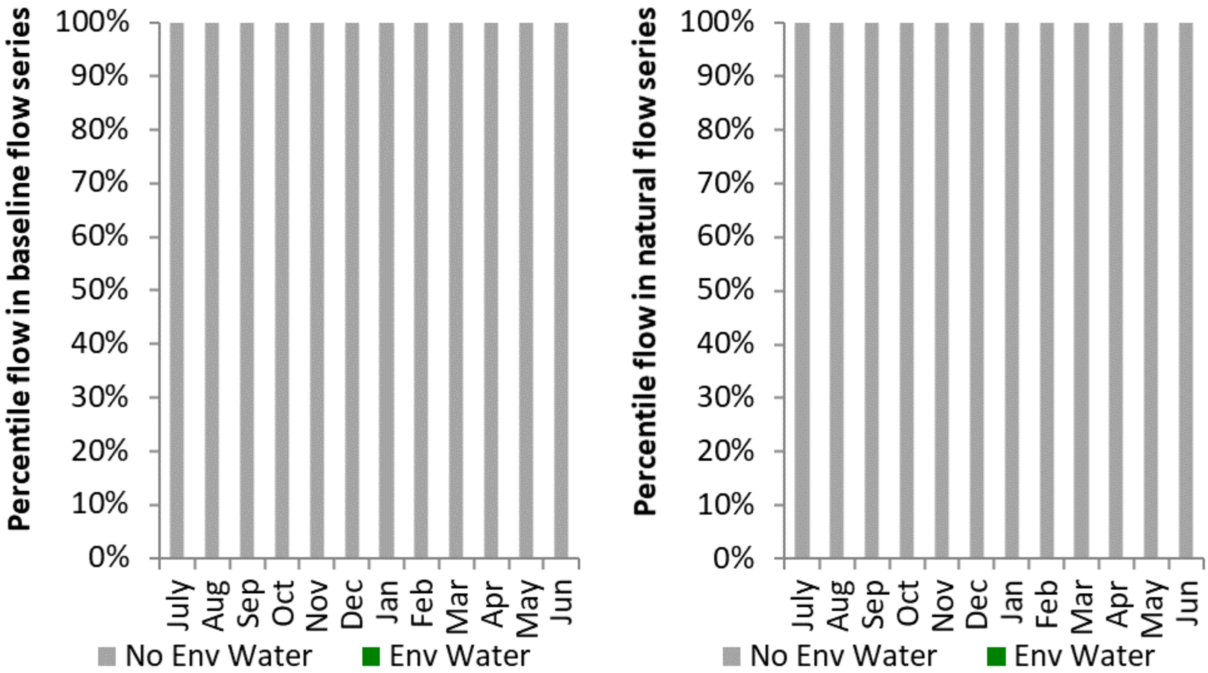


Figure LCH7: Contribution of environmental water delivery at Forbes as percentiles in the natural and baseline flow series.

4.5.4 Jemalong

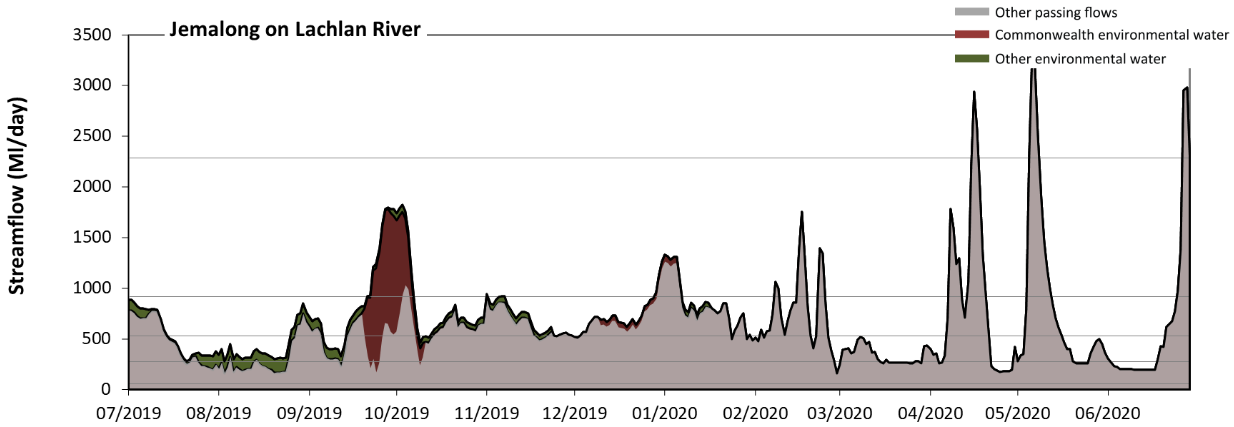


Figure LCH8: Contribution of environmental water delivery at Jemalong. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Jemalong on Lachlan River environmental water contributed 11% of the total streamflow volume (much of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 51% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 54 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the duration of low flows (i.e. < 270 ML/day) in the period July to September would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 22% to 12% of the year, with greatest influence in the period July to September. Commonwealth environmental water made a small contribution to these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 520 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the period July to September (from 13 days to 17 days). Commonwealth environmental water made the dominant contribution to these increased durations of low freshes. In the absence of environmental water there would have been at least one medium fresh (i.e. > 920 ML/day) in the periods October to December, January to March and April to June. Environmental water increased the duration of the longest medium fresh during the periods July to September (from 0 days to 9 days) and October to December (from 3 days to 6 days). Commonwealth environmental water was entirely responsible for these increased durations of medium freshes. In the absence of environmental water there would have been at least one high fresh in the period April to June. Environmental water made no change to the duration of these high freshes.

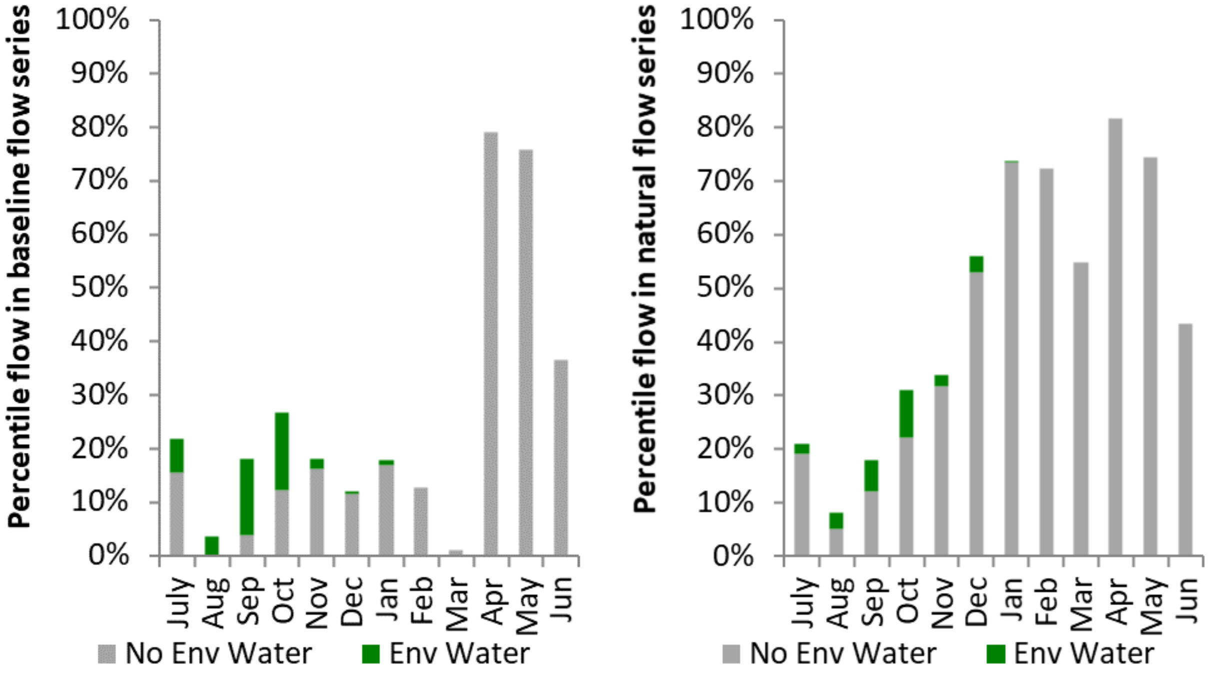


Figure LCH9: Contribution of environmental water delivery at Jemalong as percentiles in the natural and baseline flow series.

4.5.5 Condobolin

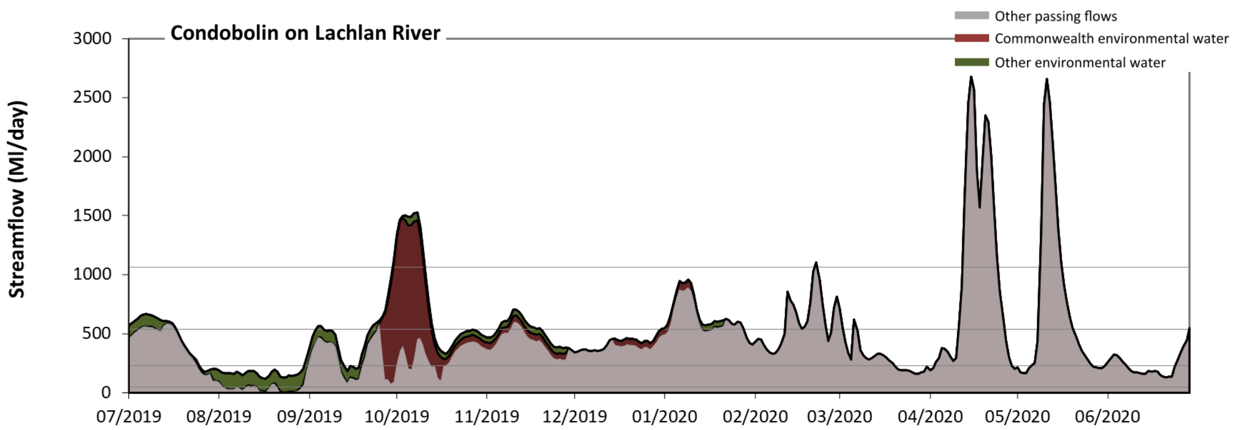


Figure LCH10: Contribution of environmental water delivery at Condobolin. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Condobolin on Lachlan River environmental water contributed 16% of the total streamflow volume (much of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 52% of days between 1 July 2019 and 30 June 2020. Without environmental water, the duration of very low flows (i.e. < 46 ML/day) in the period July to September would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 5% to 0% of the year, with greatest influence in the period July to September. Similarly, without environmental water, the duration of low flows (i.e. < 230 ML/day) in the period July to September would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 27% to 23% of the year, with greatest influence in the periods July to September and October to December. Commonwealth environmental water made a modest contribution to these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 530 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the periods July to September (from 6 days to 17 days), October to December (from 5 days to 15 days) and January to March (from 14 days to 28 days). Commonwealth environmental water made a modest contribution to these increased durations of low freshes. In the absence of environmental water there would have been at least one medium fresh (i.e. > 1100 ML/day) in the periods January to March and April to June. Environmental water increased the duration of the longest medium fresh during the periods July to September (from 0 days to 1 days) and October to December (from 0 days to 10 days). Commonwealth environmental water was entirely responsible for these increased durations of medium freshes. There was no high freshes (i.e. > 3100 ML/day) this year.

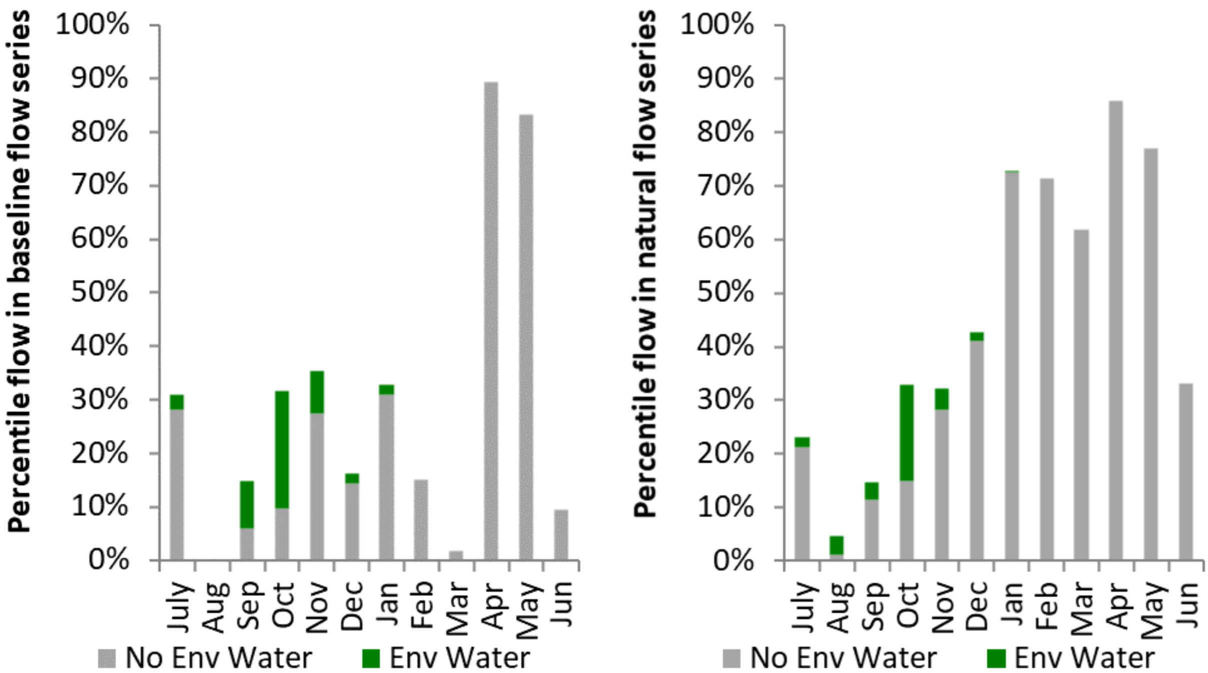


Figure LCH11: Contribution of environmental water delivery at Condobolin as percentiles in the natural and baseline flow series.

4.5.6 Brewster

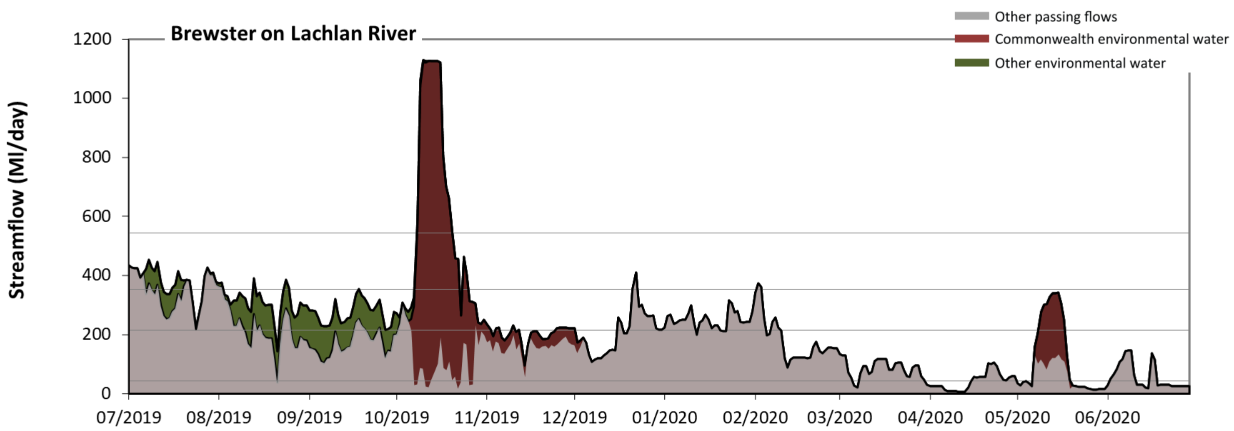


Figure LCH12: Contribution of environmental water delivery at Brewster. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Brewster on Lachlan River environmental water contributed 30% of the total streamflow volume (much of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 44% of days between 1 July 2019 and 30 June 2020. Without environmental water, the duration of very low flows (i.e. < 43 ML/day) in the period April to June would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water reduced the cumulative duration of very low flow spells from 18% to 15% of the year, with greatest influence in the period October to December. Similarly, without environmental water, the durations of low flows (i.e. < 220 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 72% to 47% of the year, with greatest influence in the periods July to September and October to December. Commonwealth environmental water equally shared responsibility with other environmental water holders for these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 350 ML/day) in the periods July to September, October to December and January to March. Environmental water increased the duration of the longest low fresh during the periods July to September (from 7 days to 12 days) and October to December (from 2 days to 15 days). Commonwealth environmental water equally shared responsibility with other environmental water holders for these increased durations of low freshes. In the absence of environmental water there would have been no medium or high freshes this year. Environmental water increased the duration of the longest medium fresh during the period October to December (from 0 days to 12 days). Commonwealth environmental water was entirely responsible for these increased durations of medium freshes.

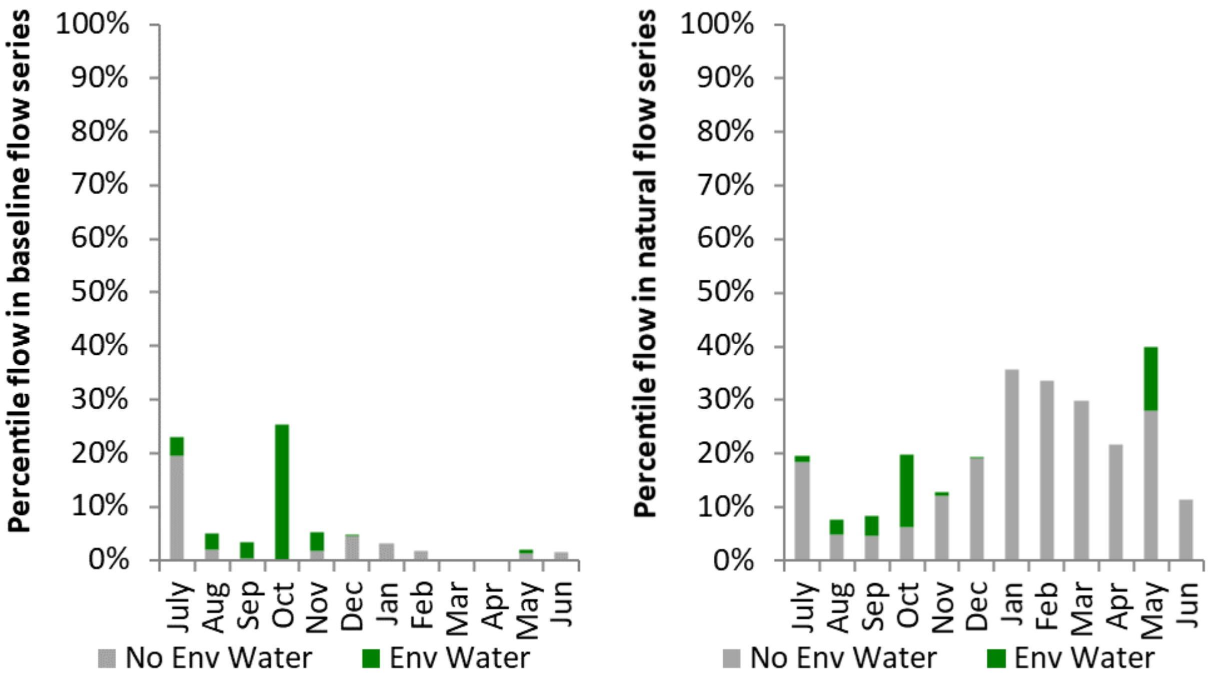


Figure LCH13: Contribution of environmental water delivery at Brewster as percentiles in the natural and baseline flow series.

4.5.7 Willandra

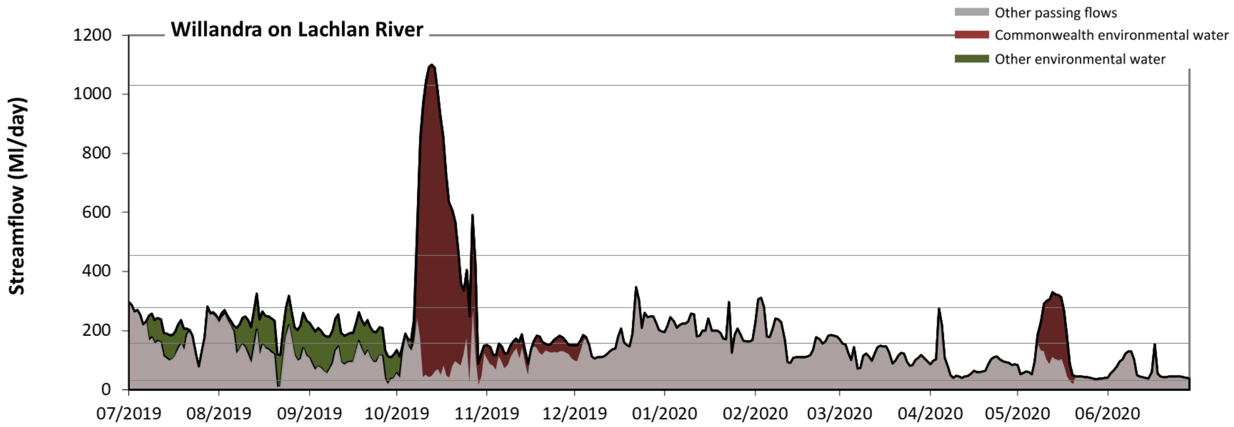


Figure LCH14: Contribution of environmental water delivery at Willandra. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Willandra on Lachlan River environmental water contributed 34% of the total streamflow volume (much of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 44% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 31 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the durations of low flows (i.e. < 160 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 72% to 45% of the year, with greatest influence in the periods July to September and October to December. Commonwealth environmental water equally shared responsibility with other environmental water holders for these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 280 ML/day) in the periods July to September, October to December and January to March. Environmental water increased the duration of the longest low fresh during the periods October to December (from 2 days to 18 days) and April to June (from 0 days to 7 days). Commonwealth environmental water was entirely responsible for these increased durations of low freshes. In the absence of environmental water there would have been no medium or high freshes this year. Environmental water increased the duration of the longest medium fresh during the period October to December (from 0 days to 15 days). Commonwealth environmental water was entirely responsible for these increased durations of medium freshes. Environmental water increased the duration of the longest medium fresh during the period October to December (from 0 days to 4 days). Commonwealth environmental water was entirely responsible for these increased durations of high freshes.

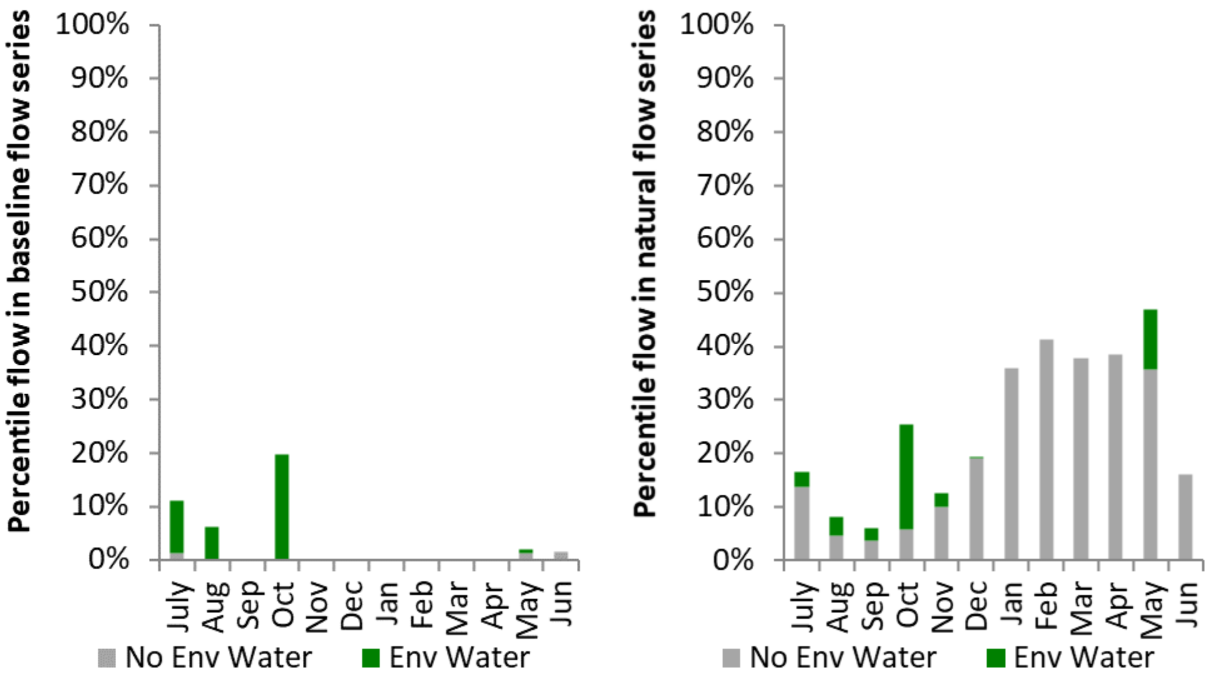


Figure LCH15: Contribution of environmental water delivery at Willandra as percentiles in the natural and baseline flow series.

4.5.8 Hillston

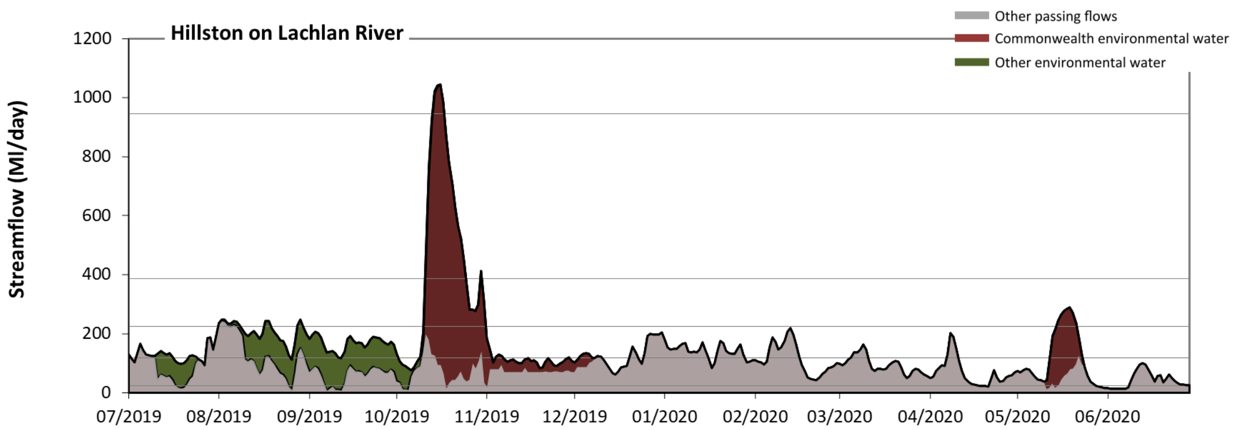


Figure LCH16: Contribution of environmental water delivery at Hillston. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Hillston on Lachlan River environmental water contributed 40% of the total streamflow volume (much of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 44% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 23 ML/day) in the periods July to September and April to June would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 9% to 4% of the year, with greatest influence in the periods July to September and October to December. Similarly, without environmental water, the durations of low flows (i.e. < 120 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 75% to 49% of the year, with greatest influence in the periods July to September and October to December. Commonwealth environmental water made a modest contribution to these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 220 ML/day) in the period July to September. Environmental water increased the duration of the longest low fresh during the periods July to September (from 4 days to 8 days), October to December (from 0 days to 21 days) and April to June (from 0 days to 7 days). Commonwealth environmental water made the dominant contribution to these increased durations of low freshes. In the absence of environmental water there would have been no medium or high freshes this year. Environmental water increased the duration of the longest medium fresh during the period October to December (from 0 days to 14 days). Commonwealth environmental water was entirely responsible for these increased durations of medium freshes. Environmental water increased the duration of the longest medium fresh during the period October to December (from 0 days to 4 days). Commonwealth environmental water was entirely responsible for these increased durations of high freshes.

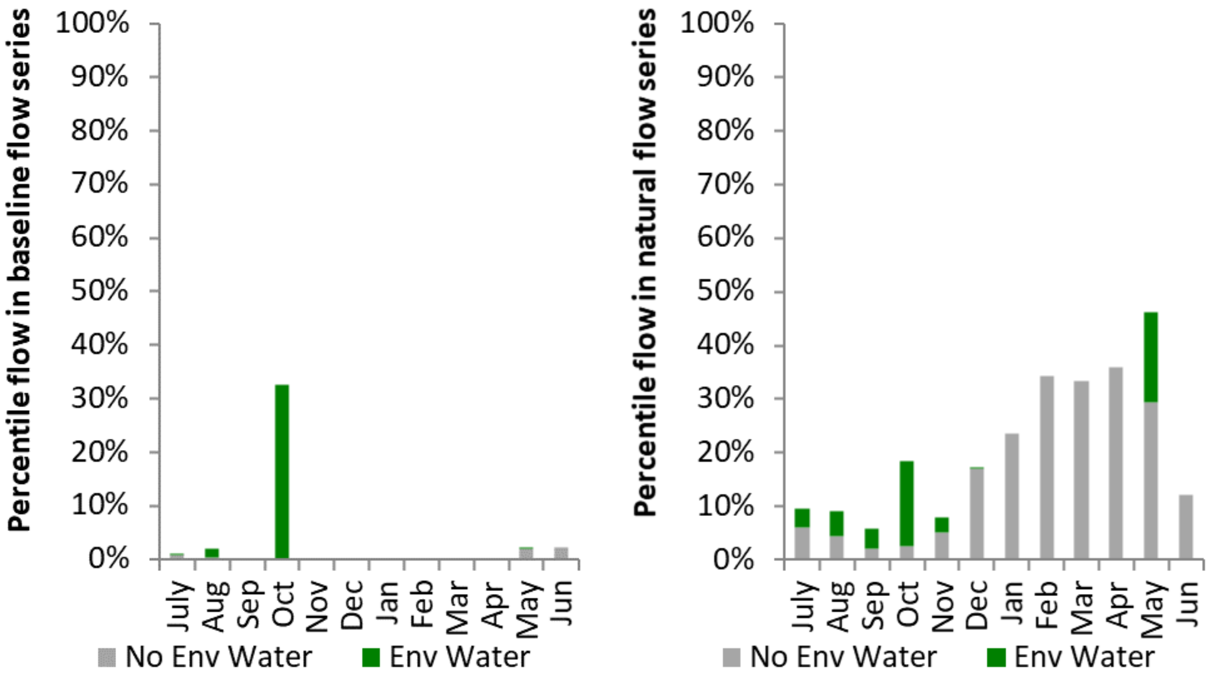


Figure LCH17: Contribution of environmental water delivery at Hillston as percentiles in the natural and baseline flow series.

4.5.9 Whealbah

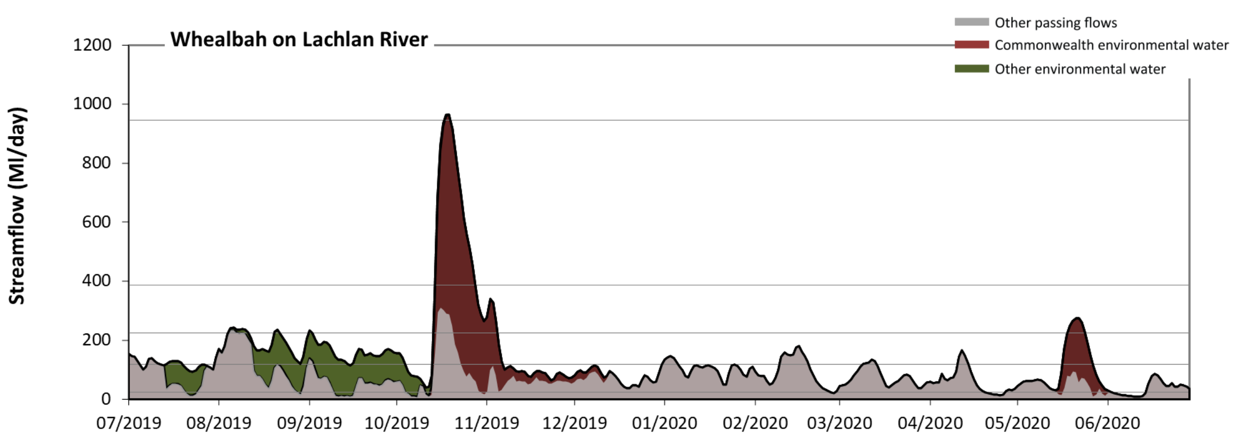


Figure LCH18: Contribution of environmental water delivery at Whealbah. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Whealbah on Lachlan River environmental water contributed 42% of the total streamflow volume (much of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 46% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 23 ML/day) in the periods July to September, October to December and April to June would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 14% to 6% of the year, with greatest influence in the periods July to September and October to December. Similarly, without environmental water, the durations of low flows (i.e. < 120 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 84% to 61% of the year, with greatest influence in the period July to September. Commonwealth environmental water made a modest contribution to these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 220 ML/day) in the periods July to September and October to December. Environmental water increased the duration of the longest low fresh during the periods July to September (from 3 days to 7 days), October to December (from 6 days to 22 days) and April to June (from 0 days to 6 days). Commonwealth environmental water made the dominant contribution to these increased durations of low freshes. In the absence of environmental water there would have been no medium or high freshes this year. Environmental water increased the duration of the longest medium fresh during the period October to December (from 0 days to 13 days). Commonwealth environmental water was entirely responsible for these increased durations of medium freshes. Environmental water increased the duration of the longest medium fresh during the period October to December (from 0 days to 2 days). Commonwealth environmental water was entirely responsible for these increased durations of high freshes.

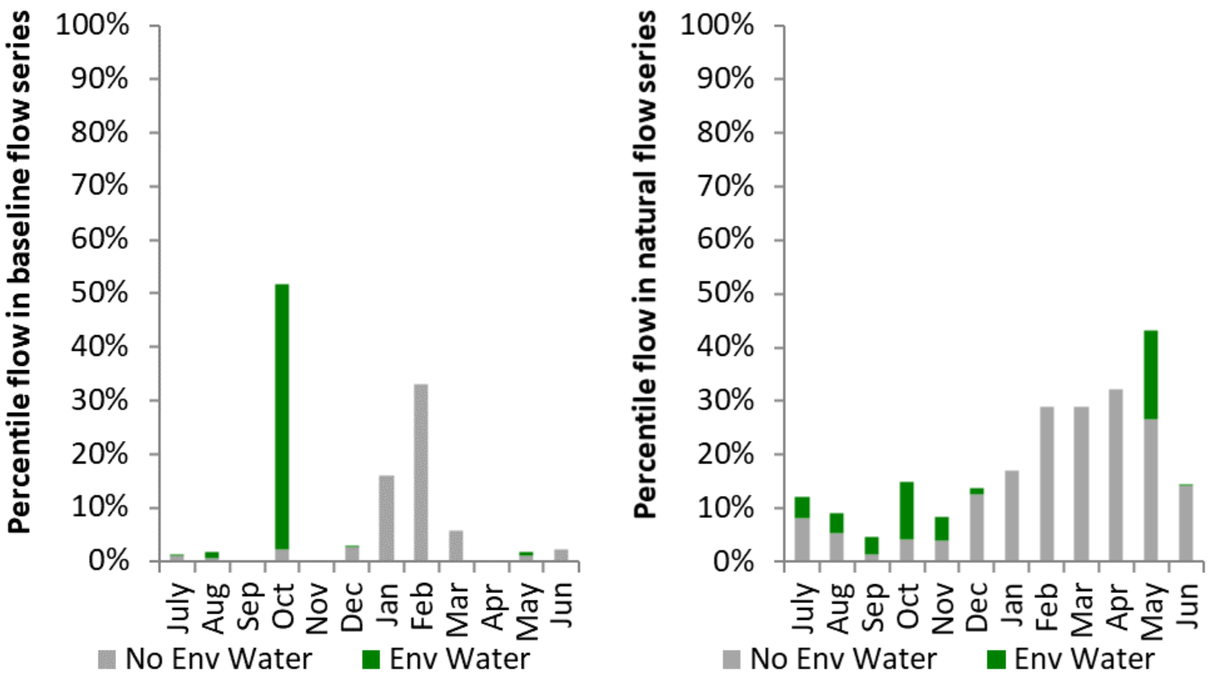


Figure LCH19: Contribution of environmental water delivery at Whealbah as percentiles in the natural and baseline flow series.

4.5.10 Booligal

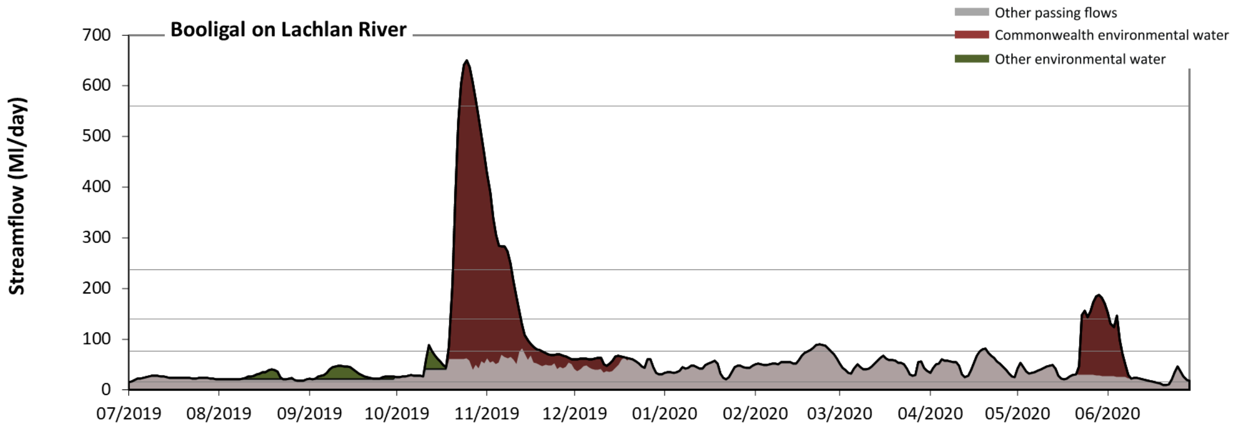


Figure LCH20: Contribution of environmental water delivery at Booligal. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Booligal on Lachlan River environmental water contributed 45% of the total streamflow volume (most of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 38% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 15 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the durations of low flows (i.e. < 76 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 97% to 84% of the year, with greatest influence in the periods October to December and April to June. Commonwealth environmental water was almost entirely responsible for these enhancements of environmental baseflows at this site. Environmental water increased the duration of the longest low fresh during the periods October to December (from 0 days to 24 days) and April to June (from 0 days to 10 days). Commonwealth environmental water was entirely responsible for these increased durations of low freshes. Environmental water increased the duration of the longest medium fresh during the period October to December (from 0 days to 20 days). Commonwealth environmental water was entirely responsible for these increased durations of medium freshes. Environmental water increased the duration of the longest medium fresh during the period October to December (from 0 days to 6 days). Commonwealth environmental water was entirely responsible for these increased durations of high freshes.

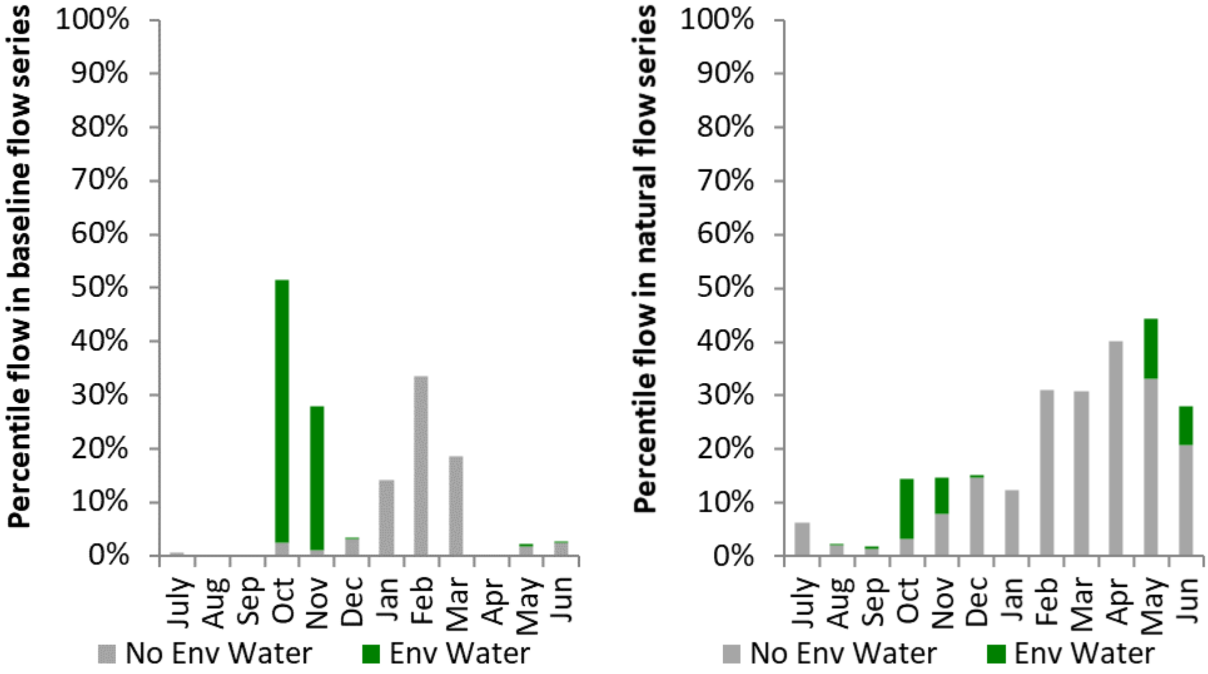


Figure LCH21: Contribution of environmental water delivery at Booligal as percentiles in the natural and baseline flow series.

5 Central Murray Valley

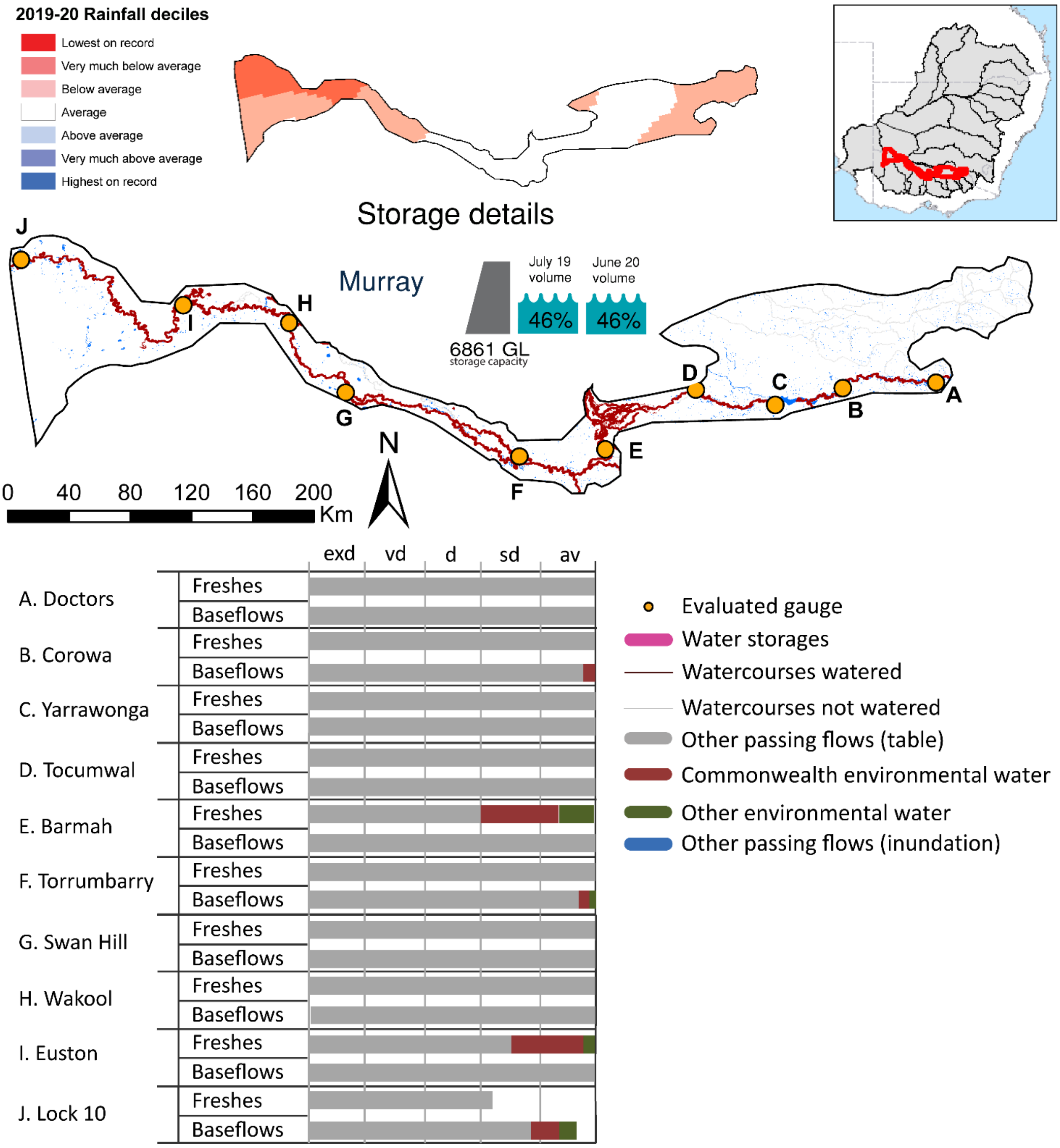


Figure CNM1: Watercourses influenced, areas inundated (where applicable) and gauge stations evaluated in the Central Murray valley during the 2019–20 water year. Inset bar graphs report the condition of annual flow regimes by showing the improvements in hydrological condition with the addition of environmental water as well as the hypothetical scenario in 'grey' (if no environmental flow had been delivered). Rainfall conditions (rainfall deciles) and trend in storage levels for the water year are also shown

5.1 Summary

The volume of environmental water delivery for the 2019–20 year in the Central Murray valley is quantified using data for 10 sites. This evaluation only considers the contribution of held environmental water, which is a primary focus for the Commonwealth. The contributions of planned environmental water (e.g. passing flows), unregulated tributary inflows and clever use of irrigation flows for environmental benefits can all be very important but these are outside the scope of this report. Environmental watering actions lasted on average 325 days over the course of the year. The volume of environmental water at these 10 sites was between 12% and 23% of the total streamflow. Commonwealth environmental water contributed on average 79% of this environmental water. The contribution of environmental water delivery to improved flow regimes is evaluated using data for 10 sites. Ideally, baseflows should be maintained and long periods of excessively low flows avoided. In this valley, the baseflow regime was generally considered to be average relative to the pre-development flow regime. In our analysis, a low fresh refers to a period of increased flow, when the water level rises at least one eighth of the way up the river bank (above the low flow level). These low freshes are a regular part of the natural flow regime and support a range of natural processes. In the CNM valley, in terms of the occurrence and duration of low freshes, the year was assessed as being average. In our analysis, a medium fresh refers to a period of increased flow, when the water level rises at least one quarter of the way up the river bank. These medium freshes are not as frequent as low freshes but are also a regular and important part of the natural flow regime. In the Central Murray valley, in terms of the occurrence of medium freshes, the year was assessed as being average. In our analysis, a high fresh refers to a period of increased flow, when the water level rises more than half way up the river. A high fresh may not occur every year but they are still important and long periods without major freshes can have serious consequences for floodplains and their contribution to river ecosystem health. Delivering environmental high in channel flows normally requires that all risks to riparian landholders and infrastructure have been resolved. In the Central Murray valley, in terms of the occurrence of high freshes, the year was assessed as being average.

5.2 Water delivery context

During the 2019–20 water year, the Commonwealth Environmental Water Holder (CEWH) held water entitlements of up to 805,869 ML for environmental use in the Central Murray valley. Each year, water utilities allocate water entitlement holders a percentage of water based on their holding, licence type and carryover (the exact rules vary among Jurisdictions and licence type). In 2019–20, the Central Murray entitlements held by the CEWH were allocated 277,880 ML of water, representing 42% of the Long term average annual yield for the Central Murray valley (665,018 ML). Information and data relating to the portfolio of held Commonwealth environmental water is shown in Table CNM1.

The 2019–20 water allocation (277,880 ML) together with the carryover volume of 246,907 ML of water meant the CEWH had 524,787 ML of water available for delivery. A total of 380,110 ML of Commonwealth environmental water was delivered in the Central Murray valley. A total 144,677 ML (28%) of available Commonwealth environmental water was carried over for environmental use into the 2020–21 water year.

5.3 Environmental conditions and resource availability

The water available for environmental delivery combined with the present and antecedent environmental conditions are key inputs used by environmental water managers in planning and implementing watering actions. *Post hoc*, this information provides important context when evaluating the effectiveness and appropriateness of environmental water use with respect to hydrological outputs.

The rainfall conditions in the Central Murray valley were classified as below average, based on rainfall percentile data for the entire record held by the Bureau of Meteorology for this valley. The water held in major storages in the Central Murray valley increased over the water year, for example Dartmouth and Hume dam was 46.4% full at the beginning of the water year and 45.9% full by the end of the year (Figure CNM1).

The CEWO calculates resource availability scenarios (RAS) to guide the use and prioritisation of held environmental water. The RAS are progressively calculated over the year as part of the continual adaptive management planning processes. The RAS are based on the availability of held environmental water (including progressive licence acquisitions and allocations) as well as the potential for unregulated or planned environmental flows. The outcome is then used to determine the demand for environmental water across the Basin.

In 2019–20, the resource availability of held Commonwealth environmental water in the Central Murray was classified as low to high, whilst the overall demand for environmental water was classified as high to moderate. The physical conditions meant that the CEWO was managing to maintain the ecological health and resilience of most environmental assets.

5.4 Watering actions

A total of 13 watering actions were delivered over the 2019–20 water year, the duration of these actions varied (range of individual actions: 20-365 days) and Commonwealth environmental water was delivered for a total of 365 days. The number of water actions commencing in each season included, summer (2), autumn (6), winter (2), spring (3). Similarly, the count of flow component types delivered in the Central Murray valley were; (6) baseflow, (0) baseflow-fresh, (0) baseflow-fresh-bankfull, (0) baseflow-fresh-overbank-wetland, (0) fresh, (0) fresh-wetland, (0) bankfull, (2) overbank, (5) wetland and (0) wetland-overbank.

In the Central Murray, watering actions were delivered for water quality, ecosystem processes, connectivity, biota, fish, vegetation and waterbirds purposes, but water was also delivered for other purposes too. The percentage of watering actions delivered across the nine main themes included fish (34.38%), vegetation (21.88%), waterbirds (6.25%), frogs (0.0%), other biota (3.13%), connectivity (3.13%), process (28.13%), resilience (0.0%) and water quality (3.13%).

Table CNM1. Commonwealth environmental water accounting information for the Central Murray valley over 2019–20 water year.

Total registered volume (ML)	Allocated volume (ML)	Carry over + allocated volume (ML)	Delivered (ML)	LTAAY (ML)	Carried over to 2020–21
805,869	277,880	246,907	380,110	665,018	138,448

5.5 Contribution of Commonwealth environmental water to flow regimes

5.5.1 Doctors

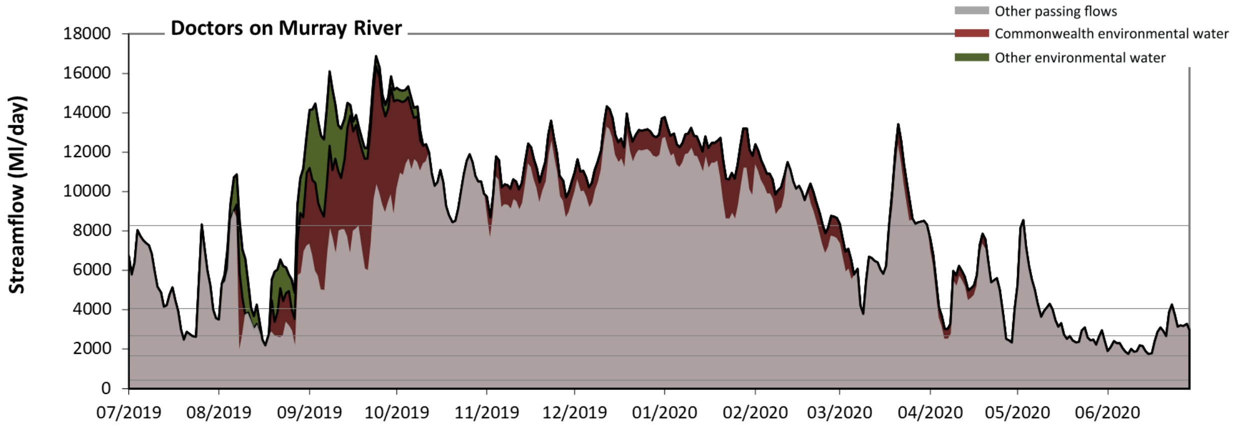


Figure CNM2: Contribution of environmental water delivery at Doctors. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Doctors on Murray River, environmental water contributed 14% of the total streamflow volume. Environmental watering actions affected streamflows for 59% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 410 ML/day) compared to an average year in the natural flow regime. Flow regulation does not substantially increase the duration of low flows (i.e. < 1700 ML/day) compared to an average year in the natural flow regime. In the absence of environmental water there would have been at least one low fresh (i.e. > 2700 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the periods July to September (from 34 days to 44 days) and April to June (from 19 days to 27 days). In the absence of environmental water there would have been at least one medium fresh (i.e. > 4000 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest medium fresh during the period July to September (from 34 days to 43 days). In the absence of environmental water there would have been at least one high fresh in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest high fresh during the periods July to September (from 8 days to 34 days) and October to December (from 59 days to 92 days).

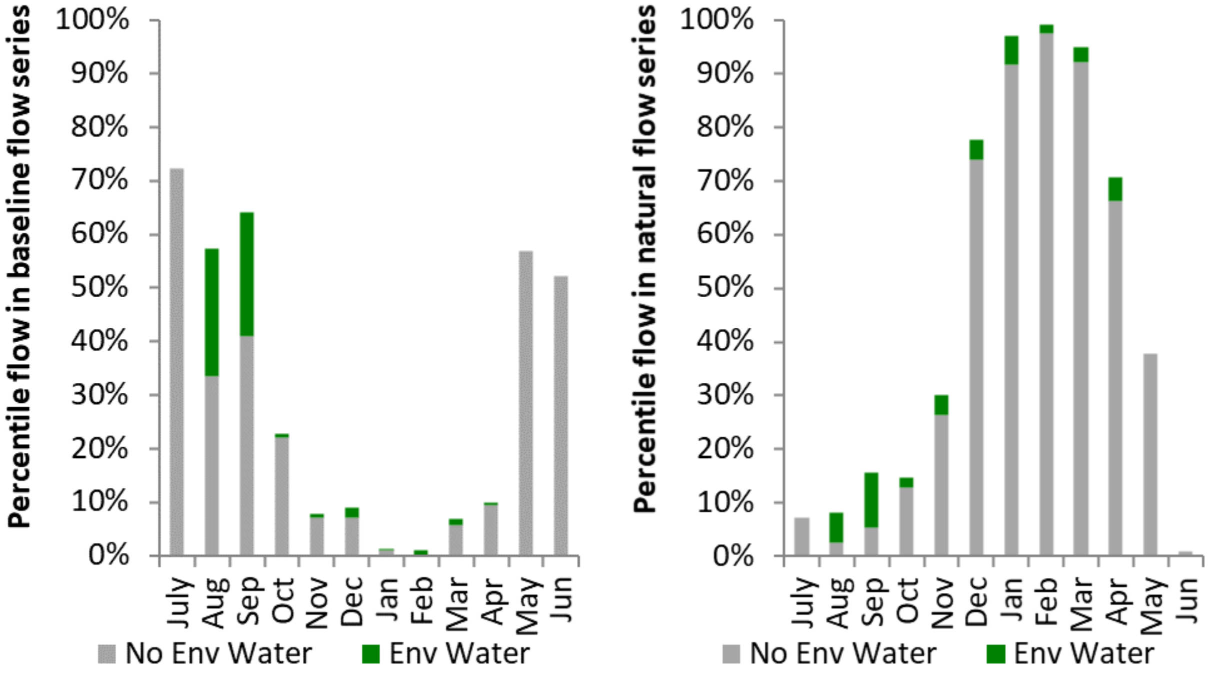


Figure CNM3: Contribution of environmental water delivery at Doctors as percentiles in the natural and baseline flow series.

5.5.2 Corowa

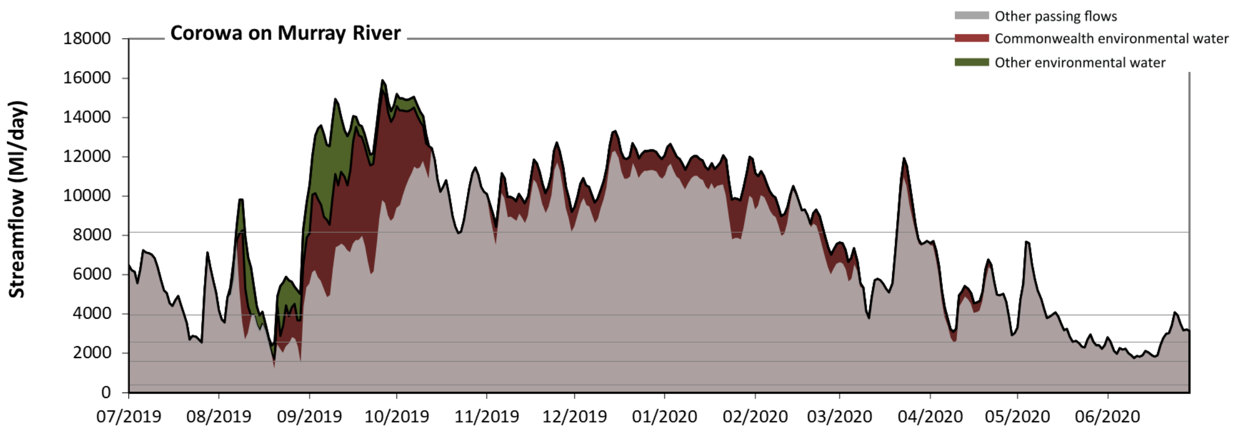


Figure CNM4: Contribution of environmental water delivery at Corowa. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Corowa on Murray River environmental water contributed 15% of the total streamflow volume. Environmental watering actions affected streamflows for 69% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 380 ML/day) compared to an average year in the natural flow regime. Flow regulation does not substantially increase the duration of low flows (i.e. < 1600 ML/day) compared to an average year in the natural flow regime. In the absence of environmental water there would have been at least one low fresh (i.e. > 2600 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the period July to September (from 32 days to 41 days). In the absence of environmental water there would have been at least one medium fresh (i.e. > 4000 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest medium fresh during the period July to September (from 32 days to 41 days). In the absence of environmental water there would have been at least one high fresh in the periods July to September, October to December and January to March. Environmental water increased the duration of the longest high fresh during the periods July to September (from 6 days to 32 days) and January to March (from 23 days to 55 days).

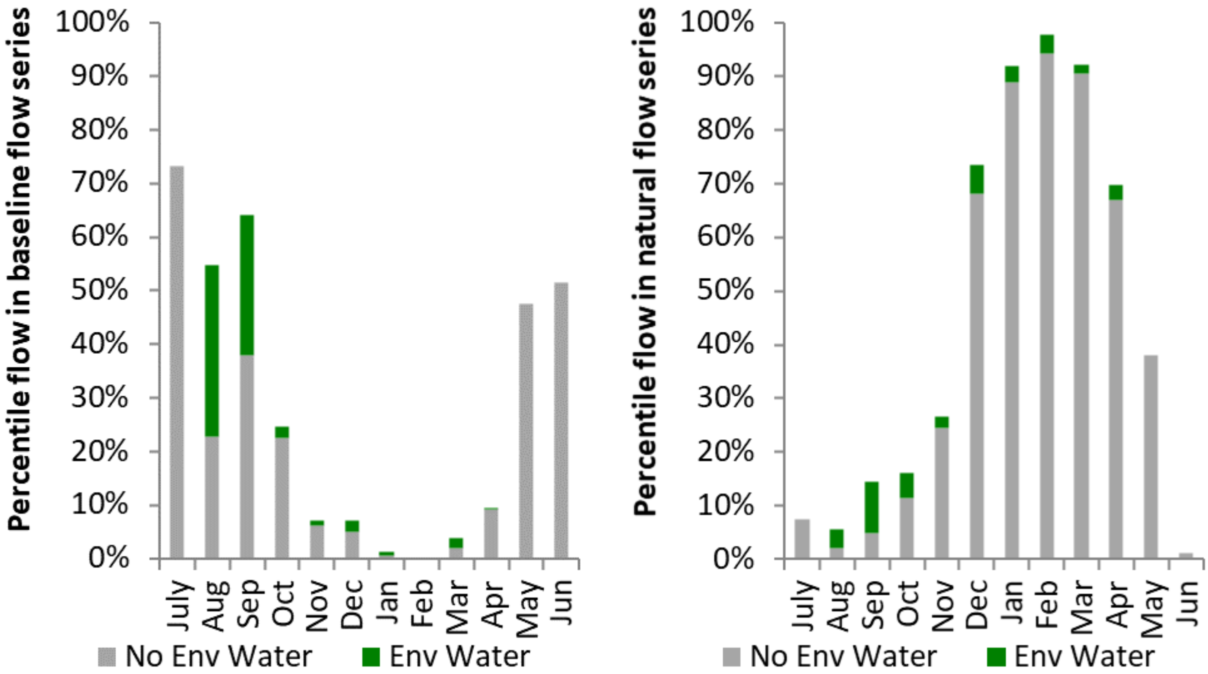


Figure CNM5: Contribution of environmental water delivery at Corowa as percentiles in the natural and baseline flow series.

5.5.3 Yarrawonga

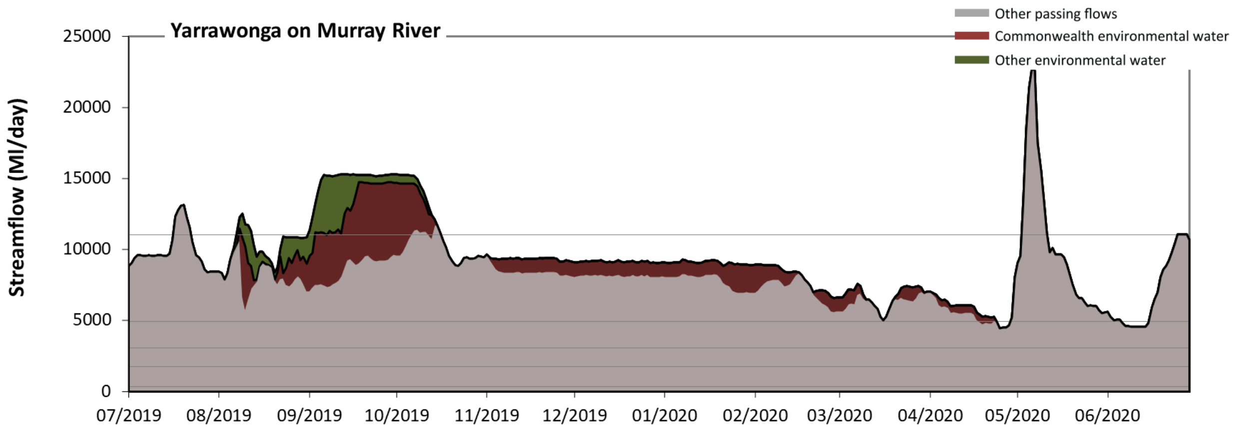


Figure CNM6: Contribution of environmental water delivery at Yarrawonga. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Yarrawonga on Murray River environmental water contributed 13% of the total streamflow volume. Environmental watering actions affected streamflows for 84% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 340 ML/day) compared to an average year in the natural flow regime. Flow regulation does not substantially increase the duration of low flows (i.e. < 1700 ML/day) compared to an average year in the natural flow regime. There was at least one low fresh (i.e. > 3100 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water made no change to the duration of these low freshes. There was at least one medium fresh (i.e. > 4900 ML/day) in the periods July to

September, October to December, January to March and April to June. Environmental water made no change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the periods July to September, October to December and April to June. Environmental water increased the duration of the longest high fresh during the periods July to September (from 6 days to 30 days) and October to December (from 5 days to 16 days).

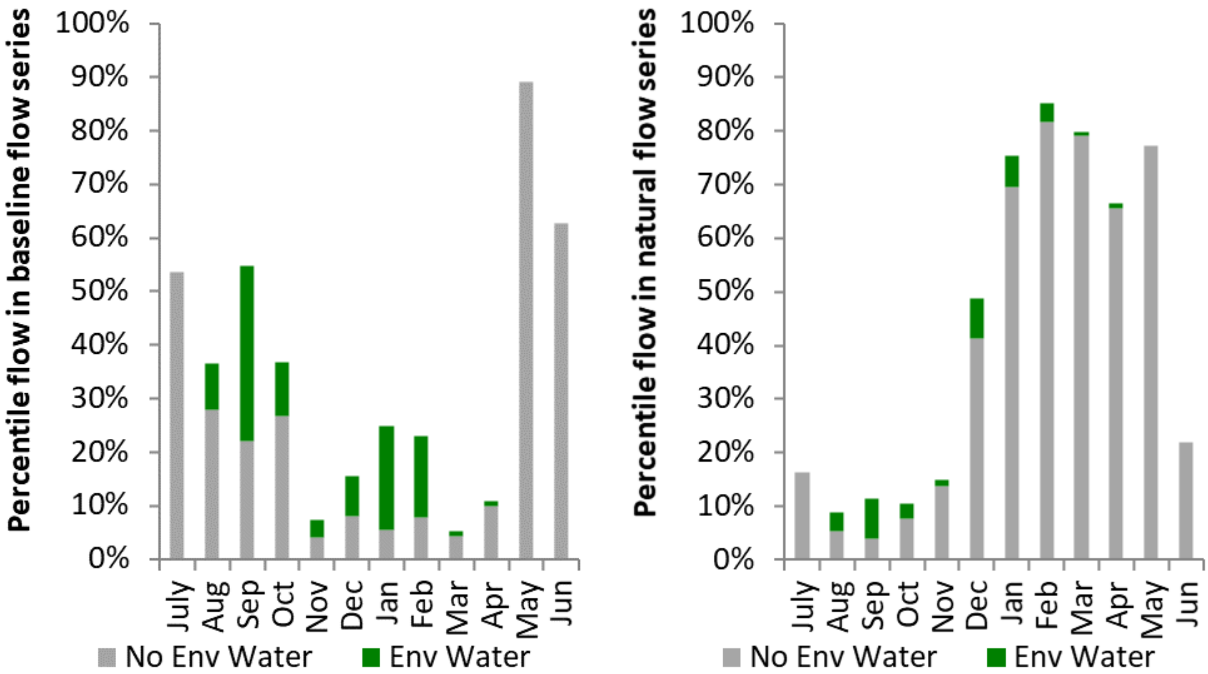


Figure CNM7: Contribution of environmental water delivery at Yarrawonga as percentiles in the natural and baseline flow series.

5.5.4 Tocumwal

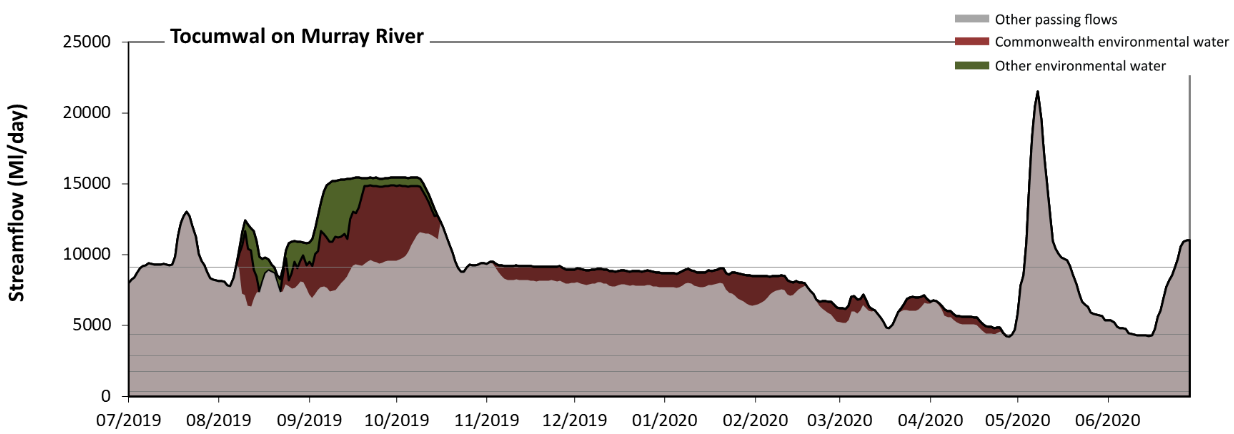
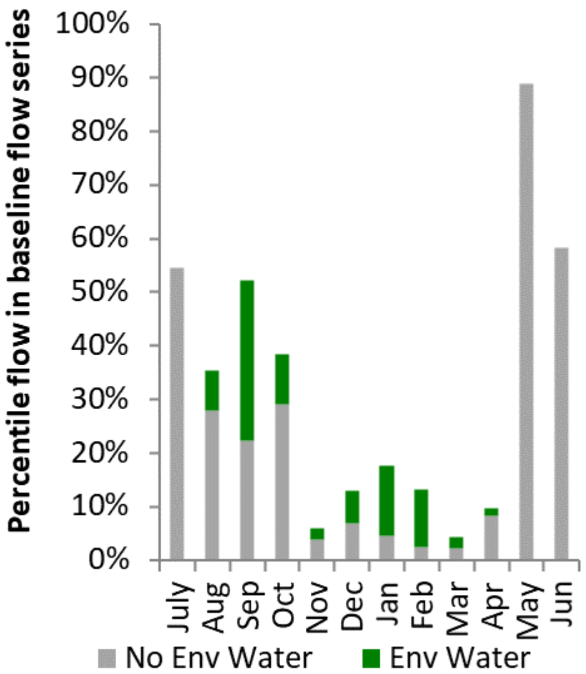


Figure CNM8: Contribution of environmental water delivery at Tocumwal. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Tocumwal on Murray River environmental water contributed 14% of the total streamflow volume. Environmental watering actions affected streamflows for 88% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 340 ML/day) compared to an average year in the natural flow regime. Flow regulation does not substantially increase the duration of low flows (i.e. < 1700 ML/day) compared to an average year in the natural flow regime. There was at least one low fresh (i.e. > 2800 ML/day) in the periods July to September, October to

December, January to March and April to June. Environmental water made no change to the duration of these low freshes. There was at least one medium fresh (i.e. > 4400 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water made no change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the periods July to September, October to December and April to June. Environmental water increased the duration of the longest high fresh during the periods July to September (from 22 days to 38 days) and October to December (from 21 days to 33 days).



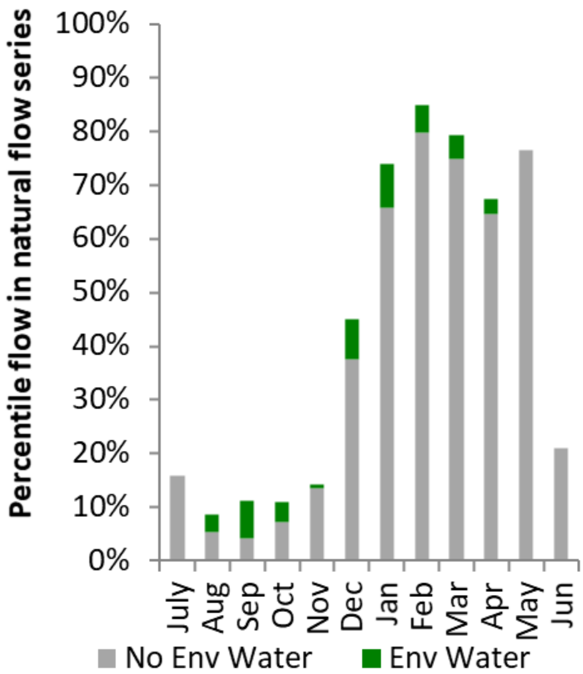


Figure CNM9: Contribution of environmental water delivery at Tocumwal as percentiles in the natural and baseline flow series.

5.5.5 Barmah

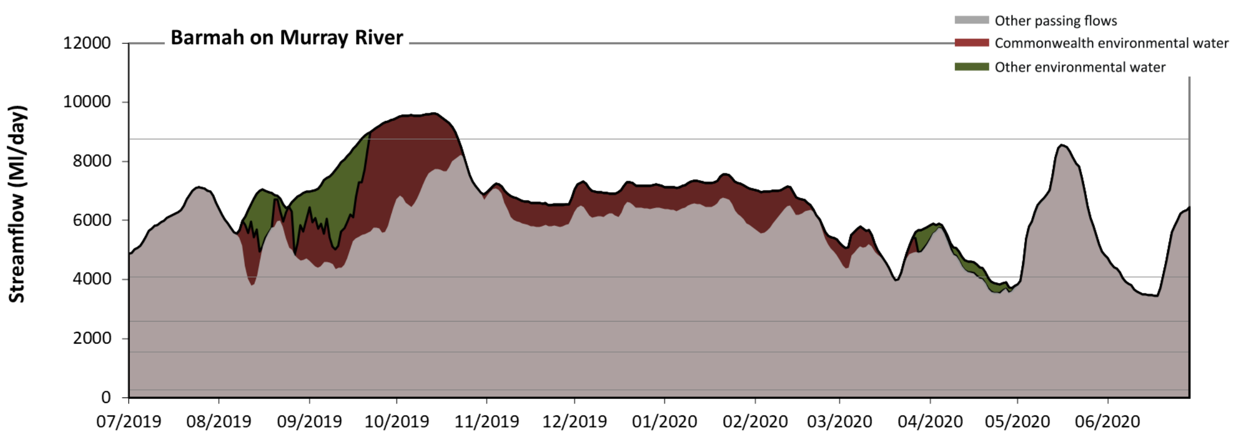


Figure CNM10: Contribution of environmental water delivery at Barmah. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Barmah on Murray River environmental water contributed 12% of the total streamflow volume. Environmental watering actions affected streamflows for 92% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 260 ML/day) compared to an average year in the natural flow regime. Flow regulation does not substantially increase the duration of low flows (i.e. < 1500 ML/day) compared to an average year in the natural flow regime. There was at least one low fresh (i.e. > 2600 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water made little change to the duration of these low freshes. In the absence of environmental water there would have been at least one medium fresh (i.e. > 4100 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest medium fresh during the period July to September (from 48 days to 92 days). In the absence of environmental water there would have been no high freshes. Environmental water increased the duration of the longest high fresh during the periods July to September (from 0 days to 12 days) and October to December (from 0 days to 22 days).

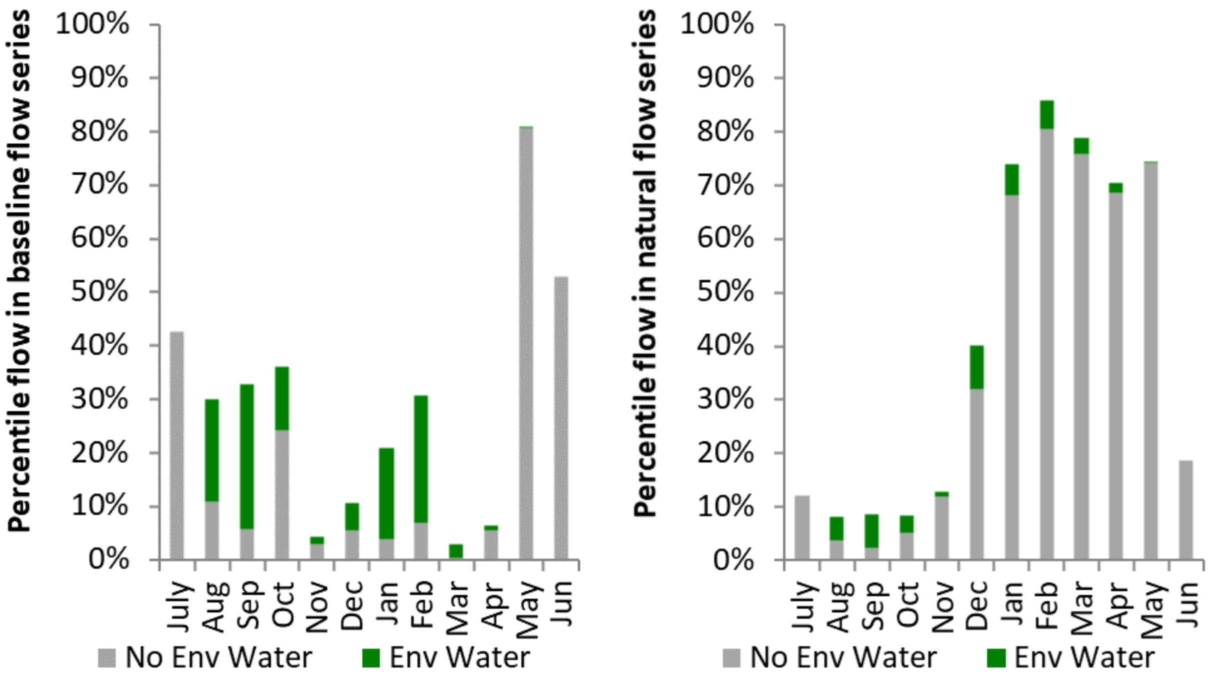


Figure CNM11: Contribution of environmental water delivery at Barmah as percentiles in the natural and baseline flow series.

5.5.6 Torrumbarry

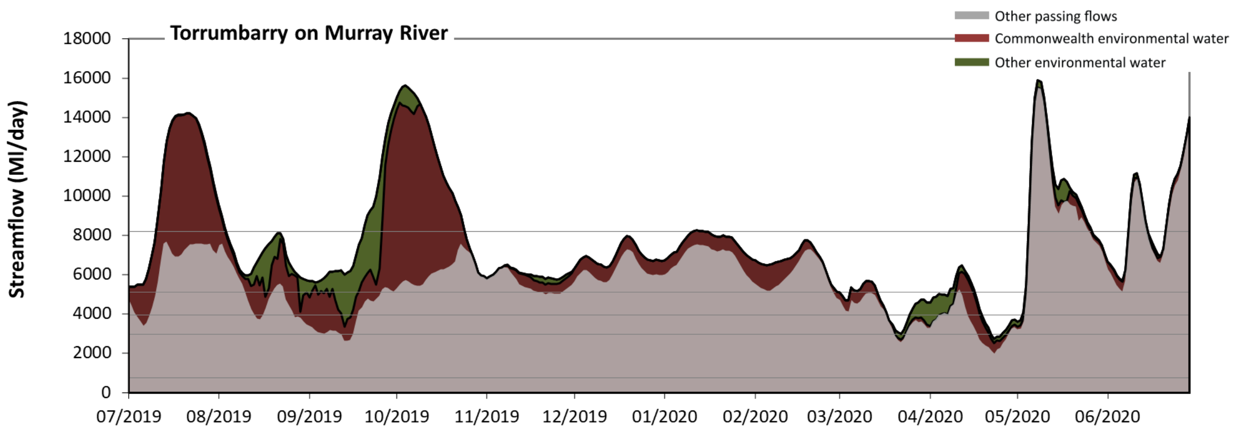


Figure CNM12: Contribution of environmental water delivery at Torrumbarry. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Torrumbarry on Murray River environmental water contributed 23% of the total streamflow volume. Environmental watering actions affected streamflows for 100% of days between 1 July 2019 and 30 June

2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 760 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the duration of low flows (i.e. < 3000 ML/day) in the period July to September would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 5% to 1% of the year, with greatest influence in the periods July to September, January to March and April to June. In the absence of environmental water there would have been at least one low fresh (i.e. > 3900 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the period July to September (from 36 days to 92 days). In the absence of environmental water there would have been at least one medium fresh (i.e. > 5100 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest medium fresh during the periods July to September (from 31 days to 92 days) and October to December (from 50 days to 92 days). In the absence of environmental water there would have been at least one high fresh in the period April to June. Environmental water increased the duration of the longest high fresh during the periods July to September (from 0 days to 24 days), October to December (from 0 days to 24 days) and January to March (from 0 days to 5 days).

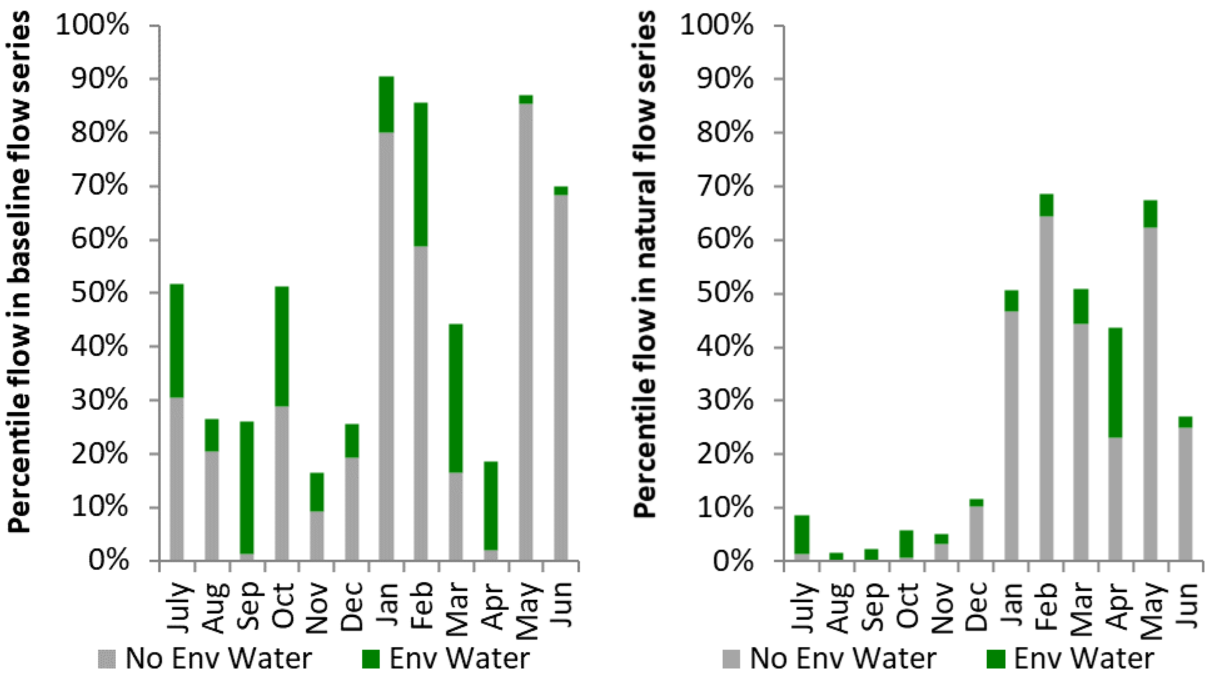


Figure CNM13: Contribution of environmental water delivery at Torrumbarry as percentiles in the natural and baseline flow series.

5.5.7 Swan Hill

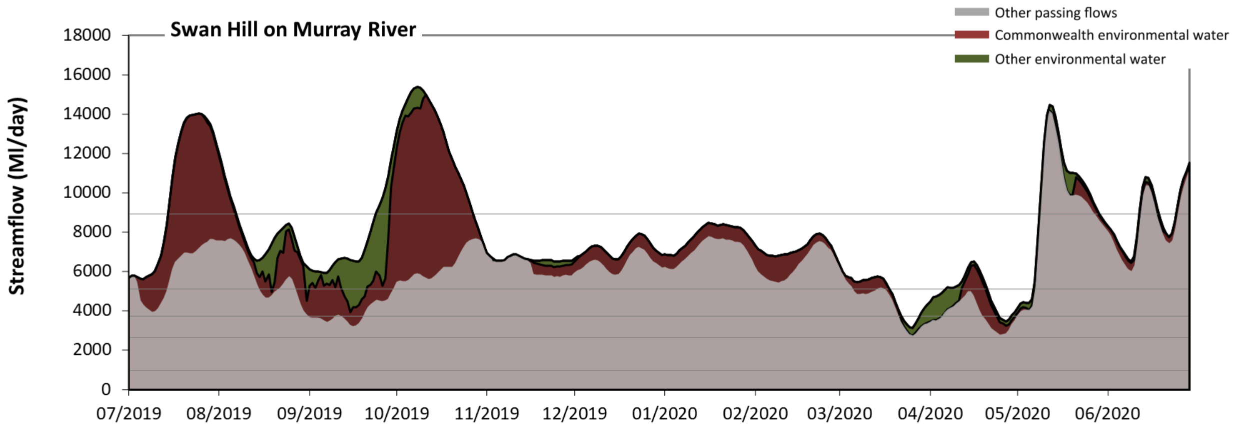


Figure CNM14: Contribution of environmental water delivery at Swan Hill. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Swan Hill on Murray River environmental water contributed 22% of the total streamflow volume. Environmental watering actions affected streamflows for 98% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 980 ML/day) compared to an average year in the natural flow regime. Flow regulation does not substantially increase the duration of low flows (i.e. < 2600 ML/day) compared to an average year in the natural flow regime. In the absence of environmental water there would have been at least one low fresh (i.e. > 3700 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the period July to September (from 62 days to 92 days). In the absence of environmental water there would have been at least one medium fresh (i.e. > 5100 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest medium fresh during the period July to September (from 31 days to 92 days). In the absence of environmental water there would have been at least one high fresh in the period April to June. Environmental water increased the duration of the longest high fresh during the periods July to September (from 0 days to 23 days) and October to December (from 0 days to 27 days).

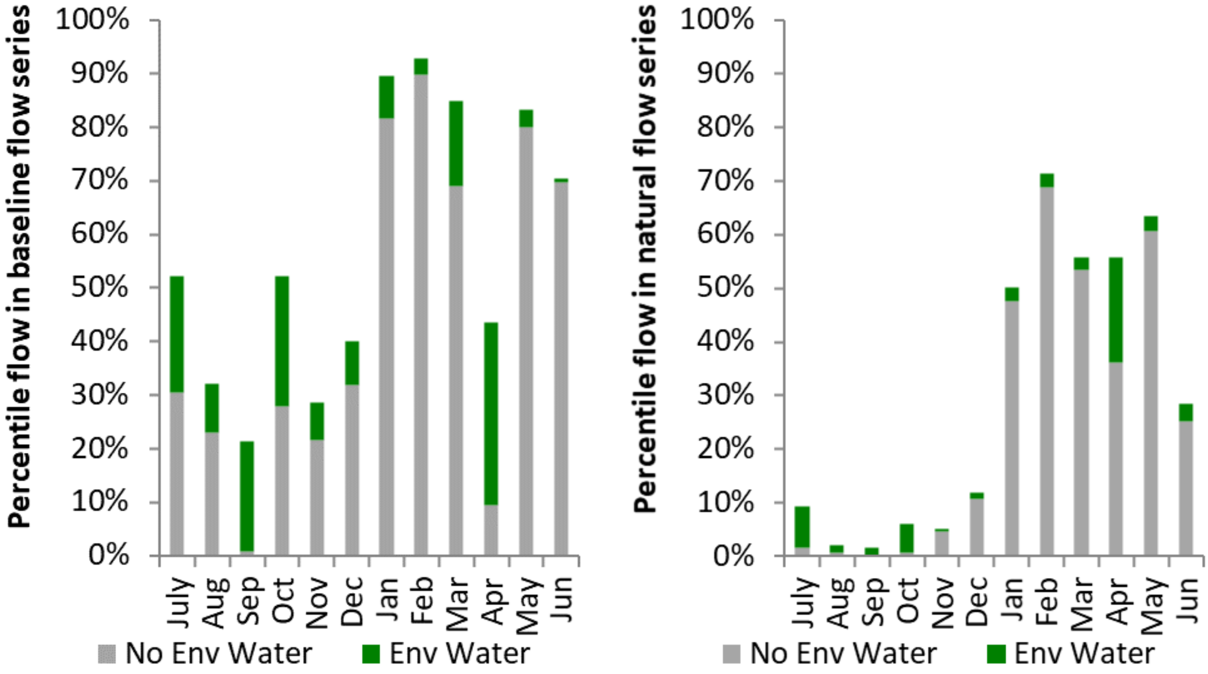


Figure CNM15: Contribution of environmental water delivery at Swan Hill as percentiles in the natural and baseline flow series.

5.5.8 Wakool

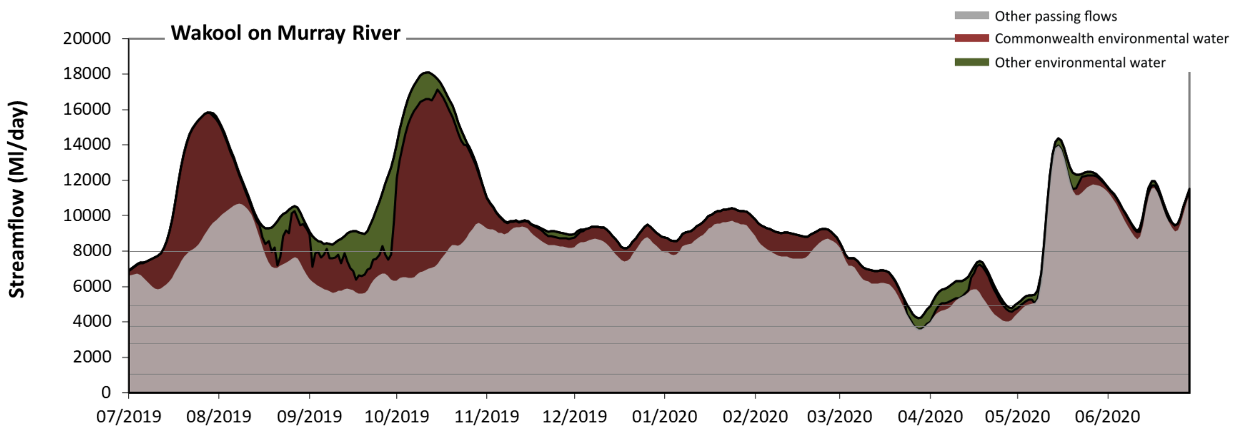


Figure CNM16: Contribution of environmental water delivery at Wakool. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Wakool on Murray River environmental water contributed 20% of the total streamflow volume. Environmental watering actions affected streamflows for 100% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 1000 ML/day) compared to an average year in the natural flow regime. Flow regulation does not substantially increase the duration of low flows (i.e. < 2800 ML/day) compared to an average year in the natural flow regime. There was at least one low fresh (i.e. > 3700 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water made little change to the duration of these low freshes. There was at least one medium fresh (i.e. > 4900 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water made little change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest high fresh during the periods July to September (from 26 days to 80 days), October to December (from 57 days to 92 days) and January to March (from 32 days to 62 days).

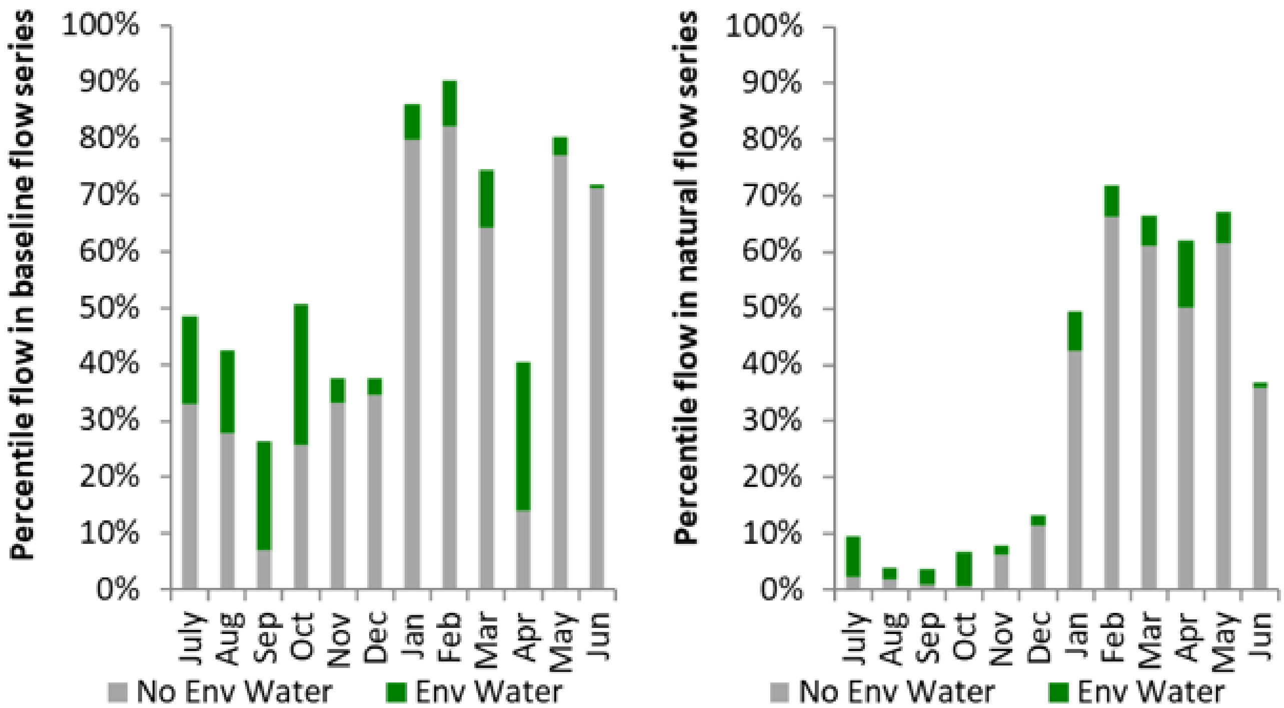


Figure CNM17: Contribution of environmental water delivery at Wakool as percentiles in the natural and baseline flow series.

5.5.9 Euston

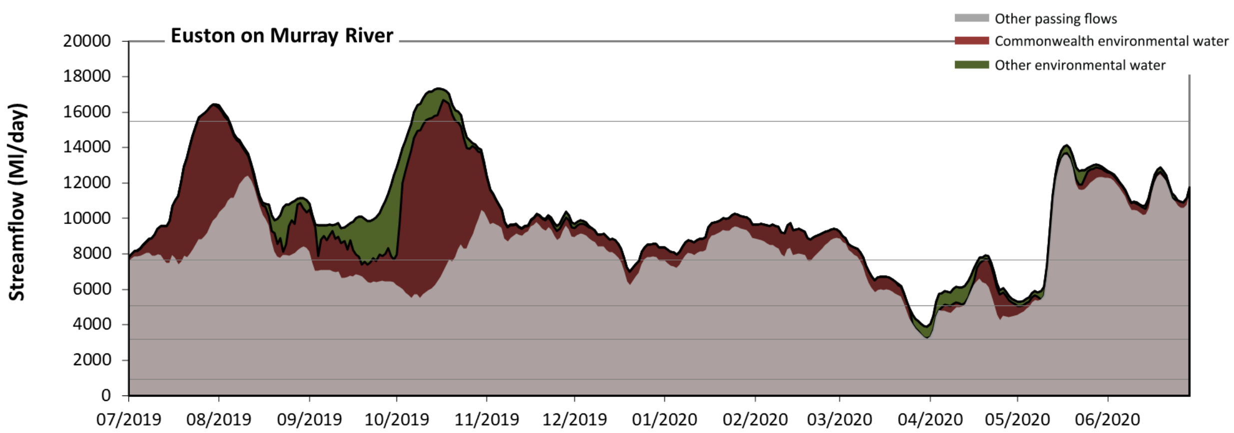


Figure CNM18: Contribution of environmental water delivery at Euston. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Euston on Murray River environmental water contributed 20% of the total streamflow volume. Environmental watering actions affected streamflows for 100% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 910 ML/day) compared to an average year in the natural flow regime. Flow regulation does not substantially increase the duration of low flows (i.e. < 3200 ML/day) compared to an average year in the natural flow regime. In the absence of environmental water there would have been at least one low fresh (i.e. > 5100 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the period April to June (from 55 days to 88 days). In the absence of environmental water there would have been at least one medium fresh (i.e. > 7700

ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest medium fresh during the periods July to September (from 44 days to 92 days), October to December (from 57 days to 79 days) and January to March (from 43 days to 69 days). In the absence of environmental water there would have been no high freshes (i.e. > 15000 ML/day) this year. Environmental water increased the duration of the longest high fresh during the periods July to September (from 0 days to 11 days) and October to December (from 0 days to 17 days).

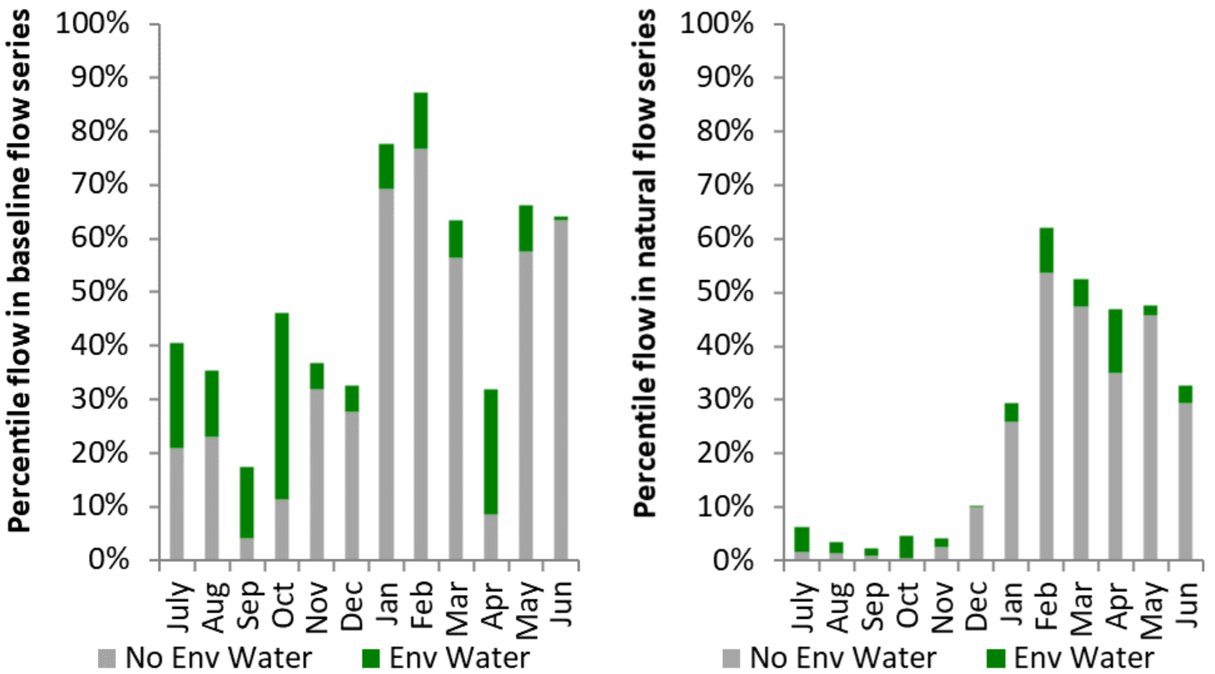


Figure CNM19: Contribution of environmental water delivery at Euston as percentiles in the natural and baseline flow series.

5.5.10 Lock 10

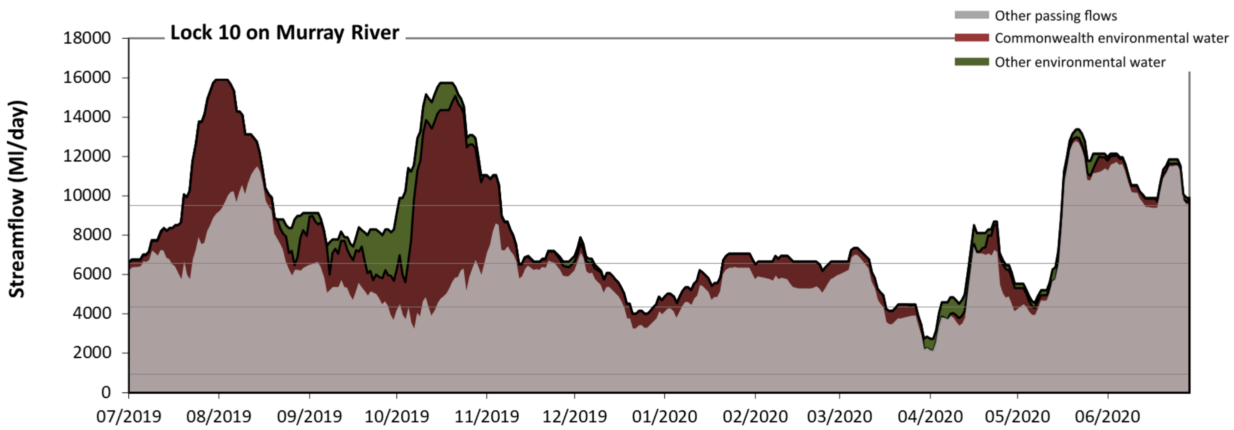


Figure CNM20: Contribution of environmental water delivery at Lock 10. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Lock 10 on Murray River environmental water contributed 23% of the total streamflow volume. Environmental watering actions affected streamflows for 100% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 940 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the durations of low flows (i.e. < 4300 ML/day) in the periods October to December, January to March and April to June would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 18% to 5% of the year, with greatest influence in the periods October to December, January to March and April to June. In the absence of environmental water there would have been at least one low fresh (i.e. > 6600 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the periods July to September (from 33 days to 92 days), October to December (from 12 days to 68 days) and January to March (from 5 days to 21 days). In the absence of environmental water there would have been at least one medium fresh (i.e. > 9500 ML/day) in the periods July to September and April to June. Environmental water increased the duration of the longest medium fresh during the periods July to September (from 15 days to 31 days), October to December (from 0 days to 35 days) and April to June (from 28 days to 44 days). There was no high freshes (i.e. > 18000 ML/day) this year.

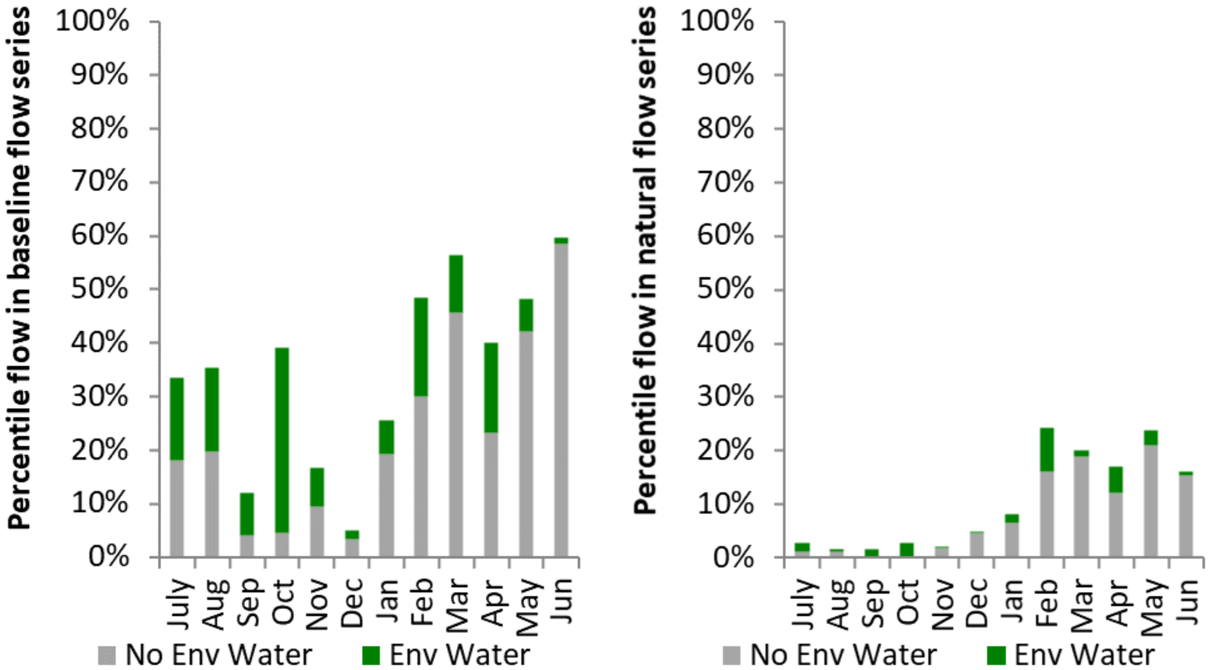


Figure CNM21: Contribution of environmental water delivery at Lock 10 as percentiles in the natural and baseline flow series.

6 Edward/Kolety–Wakool Valley

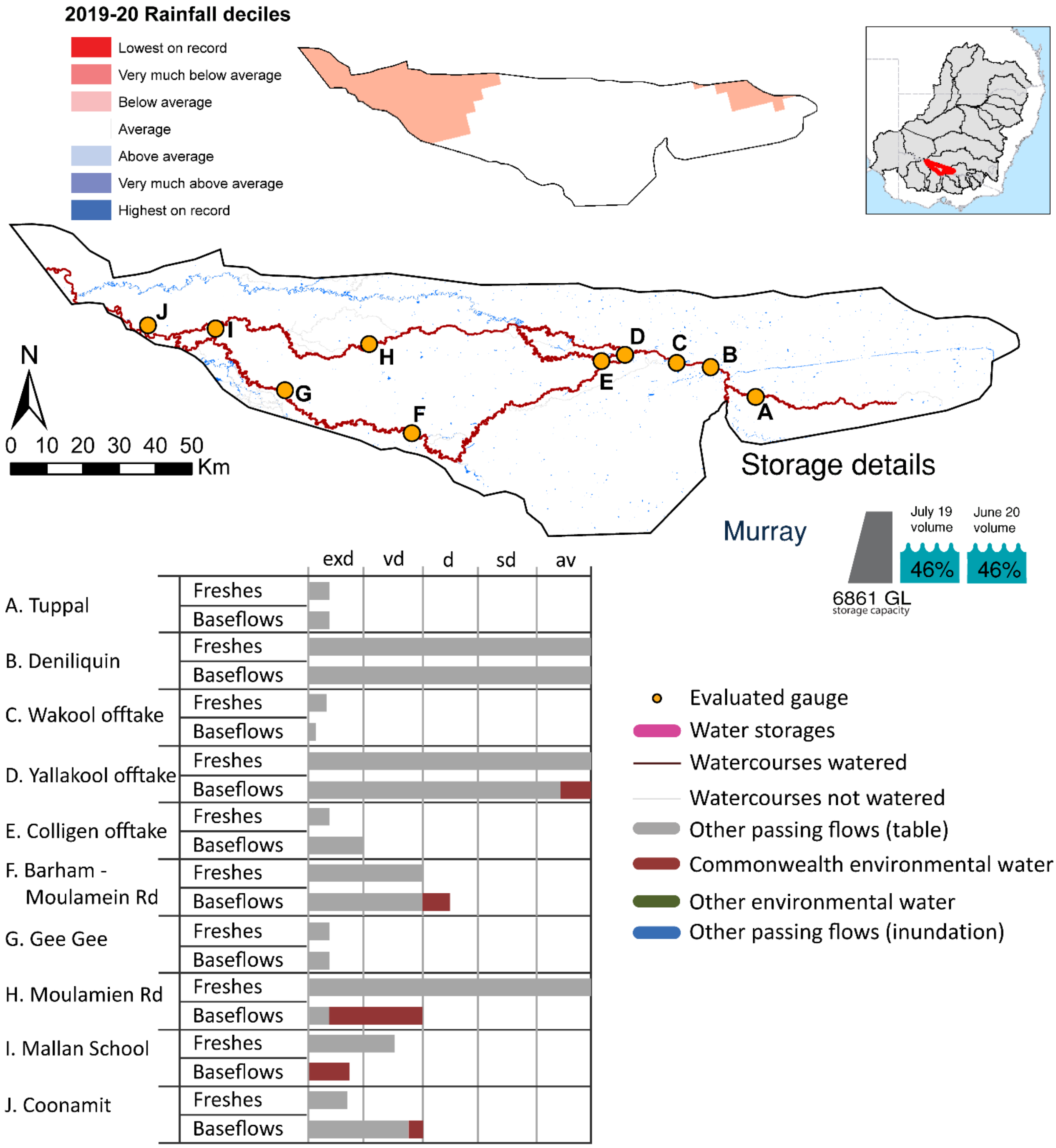


Figure EWK1: Watercourses influenced, areas inundated (where applicable) and gauge stations evaluated in the Edward Wakool valley during the 2019–20 water year. Inset bar graphs report the condition of annual flow regimes by showing the improvements in hydrological condition with the addition of environmental water as well as the hypothetical scenario in 'grey' (if no environmental flow had been delivered). Rainfall conditions (rainfall deciles) and trend in storage levels for the water year are also shown. The classified bands are: exd = extremely dry, vd=very dry, sd=somewhat dry and av=average.

6.1 Summary

The volume of environmental water delivery for the 2019–20 year in the Edward Wakool valley is quantified using data for 10 sites. This evaluation only considers the contribution of held environmental water, which is a primary focus for the Commonwealth. The contributions of planned environmental water (e.g. passing flows), unregulated tributary inflows and clever use of irrigation flows for environmental benefits can all be very important but these are outside the scope of this report. Environmental watering actions lasted on average 122 days over the course of the year. The volume of environmental water at these 10 sites was between 0% and 87% of the total streamflow. Commonwealth environmental water contributed on average 84% of this environmental water. The contribution of environmental water delivery to improved flow regimes is evaluated using data for 10 sites. Ideally, baseflows should be maintained and long periods of excessively low flows avoided. In this valley, the baseflow regime was generally considered to be very dry relative to the pre-development flow regime. In our analysis, a low fresh refers to a period of increased flow, when the water level rises at least one eighth of the way up the river bank (above the low flow level). These low freshes are a regular part of the natural flow regime and support a range of natural processes. In the Edward Wakool valley, in terms of the occurrence and duration of low freshes, the year was assessed as being dry. In our analysis, a medium fresh refers to a period of increased flow, when the water level rises at least one quarter of the way up the river bank. These medium freshes are not as frequent as low freshes but are also a regular and important part of the natural flow regime. In the Edward Wakool valley, in terms of the occurrence of medium freshes, the year was assessed as being very dry. In our analysis, a high fresh refers to a period of increased flow, when the water level rises more than half way up the river. A high fresh may not occur every year but they are still important and long periods without major freshes can have serious consequences for floodplains and their contribution to river ecosystem health. Delivering environmental high in channel flows normally requires that all risks to riparian landholders and infrastructure have been resolved. In the Edward Wakool valley, in terms of the occurrence of high freshes, the year was assessed as being very dry.

6.2 Water delivery context

During the 2019–20 water year, the Commonwealth Environmental Water Holder (CEWH) held water entitlements of up to 805,869 ML for environmental use in the Central Murray and Edward Wakool valley. Each year, water utilities allocate water entitlement holders a percentage of water based on their holding, licence type and carryover (the exact rules vary among Jurisdictions and licence type). In 2019–20, the Central Murray entitlements held by the CEWH were allocated 277,880 ML of water, representing 42% of the Long term average annual yield for the Central Murray valley (665,018 ML). Information and data relating to the portfolio of held Commonwealth environmental water is shown in Table CNM1.

The 2019–20 water allocation (277,880 ML) together with the carryover volume of 246,907 ML of water meant the CEWH had 524,787 ML of water available for delivery. A total of 380,110 ML of Commonwealth environmental water was delivered in the Central Murray valley (which includes the Edward Wakool). A total 144677 ML (28%) of available Commonwealth environmental water was carried over for environmental use into the 2020–21 water year.

6.3 Environmental conditions and resource availability

The water available for environmental delivery combined with the present and antecedent environmental conditions are key inputs used by environmental water managers in planning and implementing watering actions. Post hoc, this information provides important context when evaluating the effectiveness and appropriateness of environmental water use with respect to hydrological outputs.

The rainfall conditions in the Edward Wakool valley were classified as average, based on rainfall percentile data for the entire record held by the Bureau of Meteorology for this valley. The water held in major storages in the Edward Wakool valley is not applicable in this valley over the water year, for example Not applicable dam was NA% full at the beginning of the water year and NA% full by the end of the year (Figure EWK1).

The CEWO calculates resource availability scenarios (RAS) to guide the use and prioritisation of held environmental water. The RAS are progressively calculated over the year as part of the continual adaptive management planning processes. The RAS are based on the availability of held environmental water (including progressive licence acquisitions and allocations) as well as the potential for unregulated or planned environmental flows. The outcome is then used to determine the demand for environmental water across the Basin.

In 2019–20, the resource availability of held Commonwealth environmental water in the Edward Wakool was classified as low to high, whilst the overall demand for environmental water was classified as high to moderate. The physical conditions meant that the CEWO was managing to maintain the ecological health and resilience of most environmental assets.

6.4 Watering actions

A total of 4 watering actions were delivered over the 2019–20 water year, the duration of these actions varied (range of individual actions: 141 - 365 days) and Commonwealth environmental water was delivered for a total of 365 days. The number of water actions commencing in each season included, summer (1), autumn (0), winter (3), spring (0). Similarly, the count of flow component types delivered in the Edward Wakool valley were; (0) baseflow, (3) baseflow-fresh, (0) baseflow-fresh-bankfull, (0) baseflow-fresh-overbank-wetland, (0) fresh, (0) fresh-wetland, (3) bankfull, (0) overbank, (1) wetland and (0) wetland-overbank.

In this Edward Wakool, watering actions were delivered for water quality, connectivity, frogs, fish, vegetation and waterbirds purposes, but water was also delivered for other purposes too. The percentage of watering actions delivered across the nine main themes included fish (20%), vegetation (26.67%), waterbirds (6.67%), frogs (6.67%), other biota (0.0%), connectivity (20%), process (0.0%), resilience (0.0%) and water quality (20%).

6.5 Contribution of Commonwealth environmental water to flow regimes

6.5.1 Deniliquin

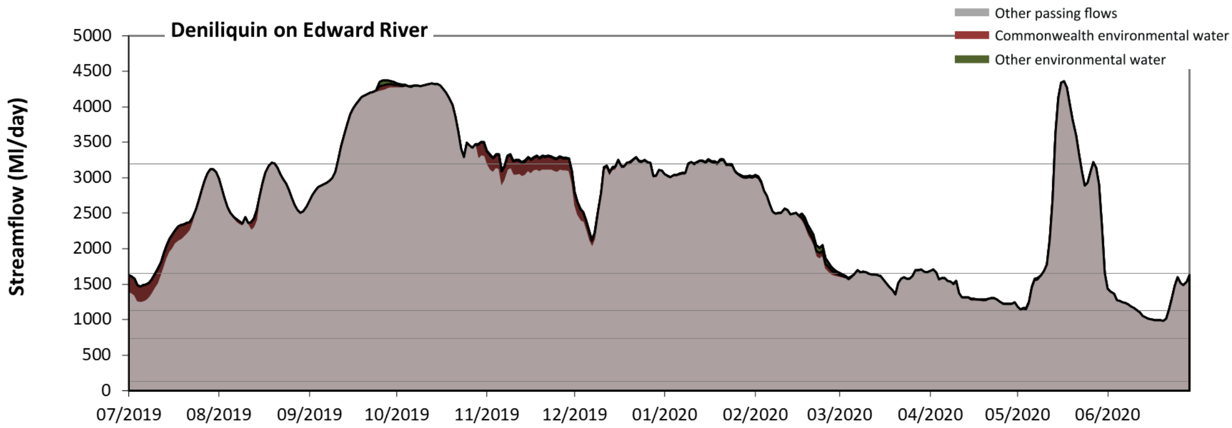


Figure EWK2: Contribution of environmental water delivery at Deniliquin. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Deniliquin on Edward River environmental water contributed 2% of the total streamflow volume (most of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 82% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 130 ML/day) compared to an average year in the natural flow regime. Flow regulation does not substantially increase the duration of low flows (i.e. < 740 ML/day) compared to an average year in the natural flow regime. There was at least one low fresh (i.e. > 1100 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water made little change to the duration of these low freshes. There was at least one medium fresh (i.e. > 1700 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water made little change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest high fresh during the period January to March (from 7 days to 13 days). Commonwealth environmental water equally shared responsibility with other environmental water holders for these increased durations of high freshes.

6.5.2 Tuppal

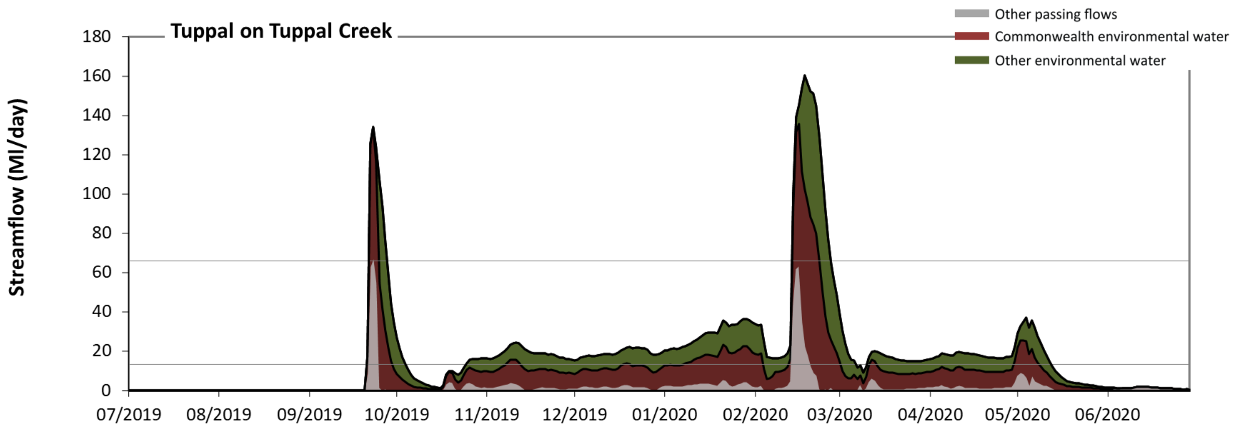


Figure EWK4: Contribution of environmental water delivery at Tuppal. Horizontal lines indicate thresholds for very low flows and low flows (from lowest to highest).

At Tuppal on Tuppal Creek environmental water contributed 87% of the total streamflow volume (with approximately half contributed by Commonwealth environmental water). Environmental watering actions affected streamflows for 71% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 13 ML/day) in the periods July to September, October to December and April to June would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 98% to 42% of the year, with greatest influence in the periods October to December and January to March. Similarly, without environmental water, the durations of low flows (i.e. < 66 ML/day) in the periods July to September, October to December and April to June would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 100% to 95% of the year, with greatest influence in the periods July to September and January to March. Commonwealth environmental water equally shared responsibility with other environmental water holders for these enhancements of environmental baseflows at this site.

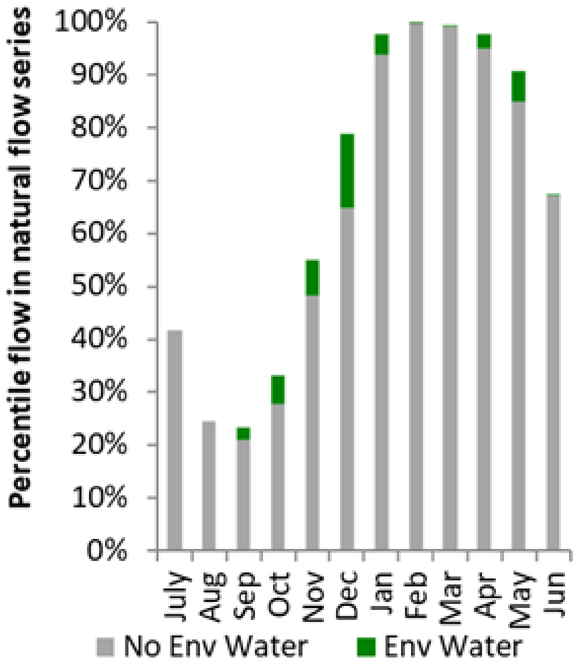


Figure EWK5: Contribution of environmental water delivery at Tuppal as percentiles in the natural flow series.

6.5.3 Yallakool Offtake

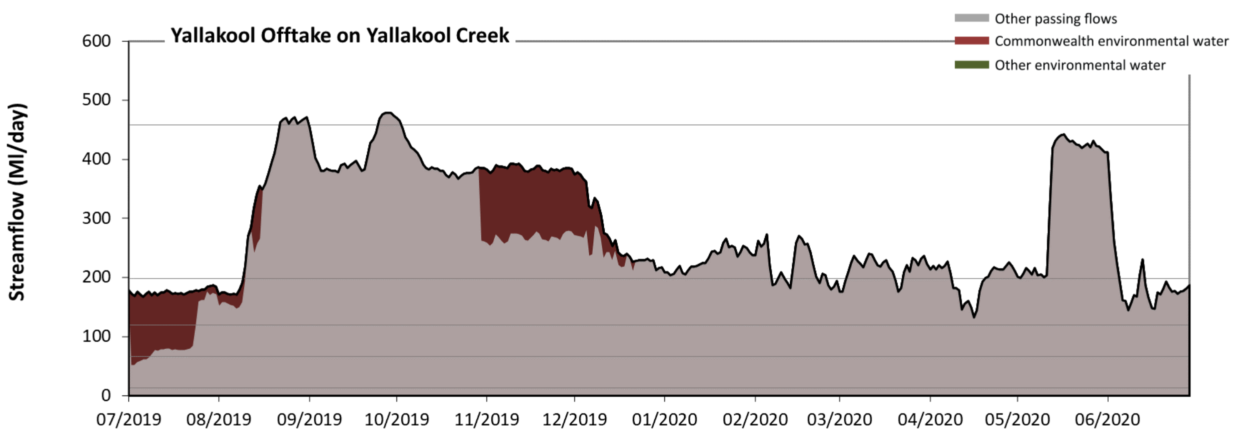


Figure EWK6: Contribution of environmental water delivery at Yallakool Offtake. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Yallakool Offtake on Yallakool Creek environmental water contributed 7% of the total streamflow volume (all of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 27% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 13 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the duration of low flows (i.e. < 66 ML/day) in the period July to September would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 2% to 0% of the year, with greatest influence in the period July to September. In the absence of environmental water there would have been at least one low fresh (i.e. > 120 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the period July to September (from 68 days to 92 days). Commonwealth environmental water was entirely responsible for these increased durations of low freshes.

There was at least one medium fresh (i.e. > 200 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water made little change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the periods July to September and October to December. Environmental water made no change to the duration of these high freshes.

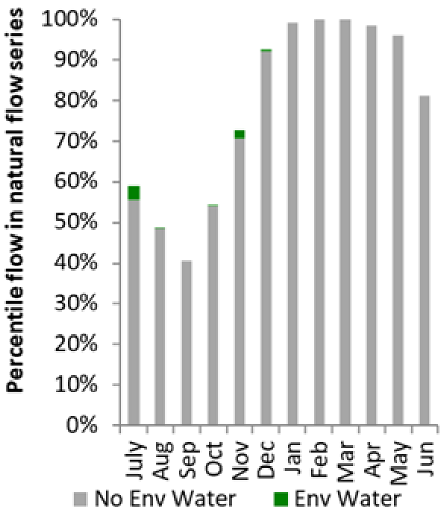


Figure EWK7: Contribution of environmental water delivery at Yallakool Offtake as percentiles in the natural flow series.

6.5.4 Wakool Offtake

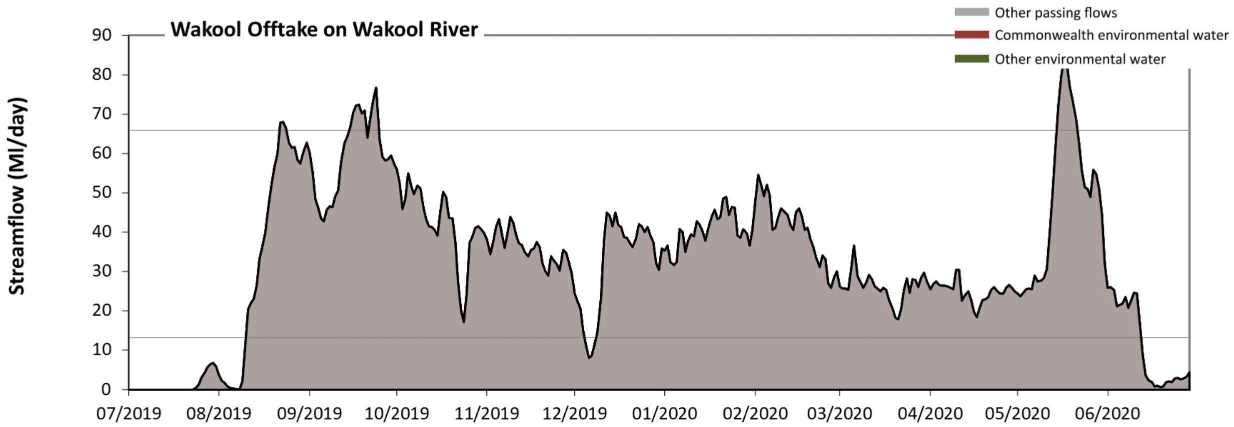


Figure EWK8: Contribution of environmental water delivery at Wakool Offtake. Horizontal lines indicate thresholds for very low flows and low flows (from lowest to highest).

There was no environmental water delivered at Wakool Offtake on Wakool River. Without environmental water, the duration of very low flows (i.e. < 13 ML/day) in the period July to September was substantially in excess of durations expected in an average year in the natural flow regime. Similarly, without environmental water, the durations of low flows (i.e. < 66 ML/day) in the periods July to September and October to December was substantially in excess of durations expected in an average year in the natural flow regime.

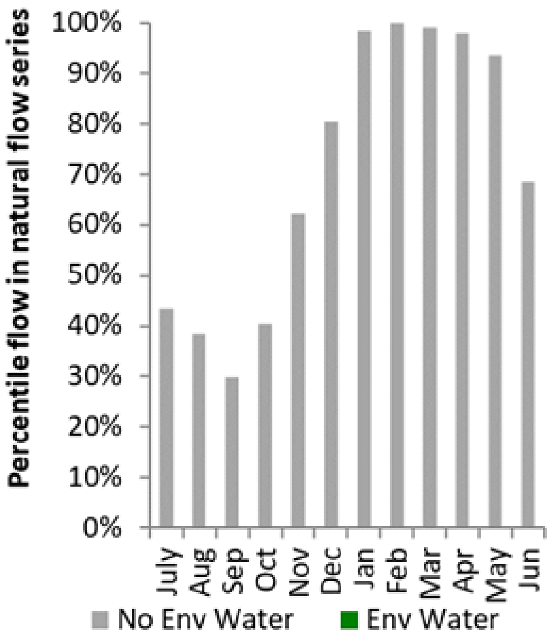


Figure EWK9: Contribution of environmental water delivery at Wakool Offtake as percentiles in the natural flow series.

6.5.5 Barham Moulamien

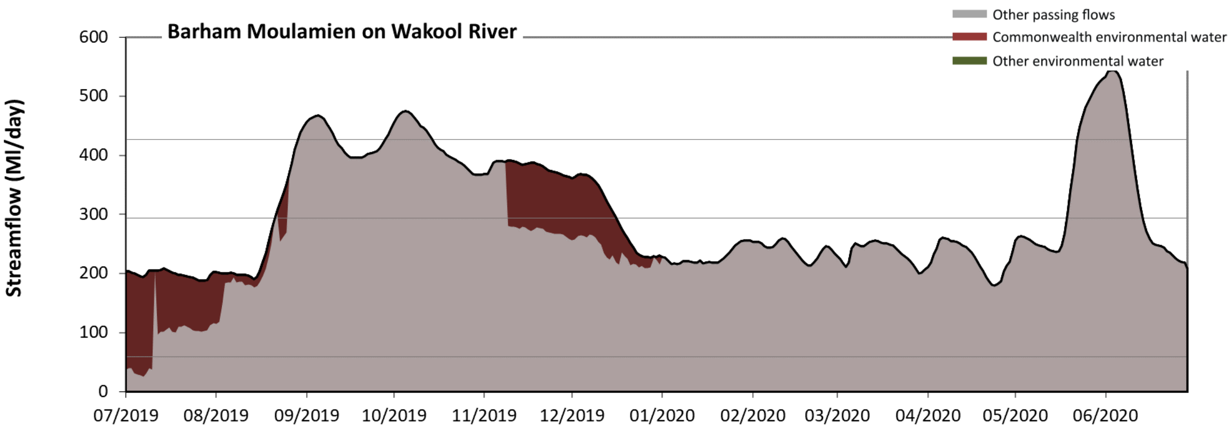


Figure EWK10: Contribution of environmental water delivery at Barham Moulamien. Horizontal lines indicate thresholds for very low flows, low flows and low freshes (from lowest to highest).

At Barham Moulamien on Wakool River environmental water contributed 8% of the total streamflow volume (all of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 30% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 59 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the durations of low flows (i.e. < 290 ML/day) in the periods July to September, October to December and January to March would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 72% to 61% of the year, with greatest influence in the period October to December. Commonwealth environmental water was entirely responsible for these enhancements of environmental baseflows at this site. There was at least one low fresh (i.e. > 430 ML/day) in the periods July to September, October to December and April to June. Environmental water made no change to the duration of these low freshes. There was no medium or high freshes this year.

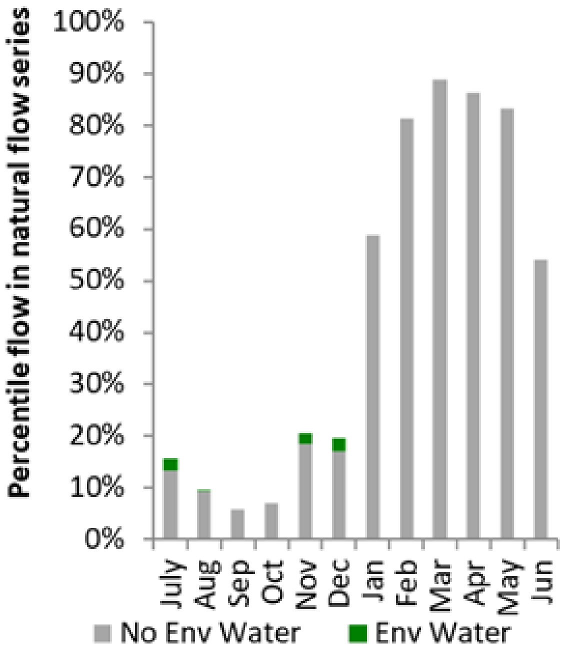


Figure EWK11: Contribution of environmental water delivery at Barham Moulamien as percentiles in the natural flow series.

6.5.6 Gee Gee Bridge

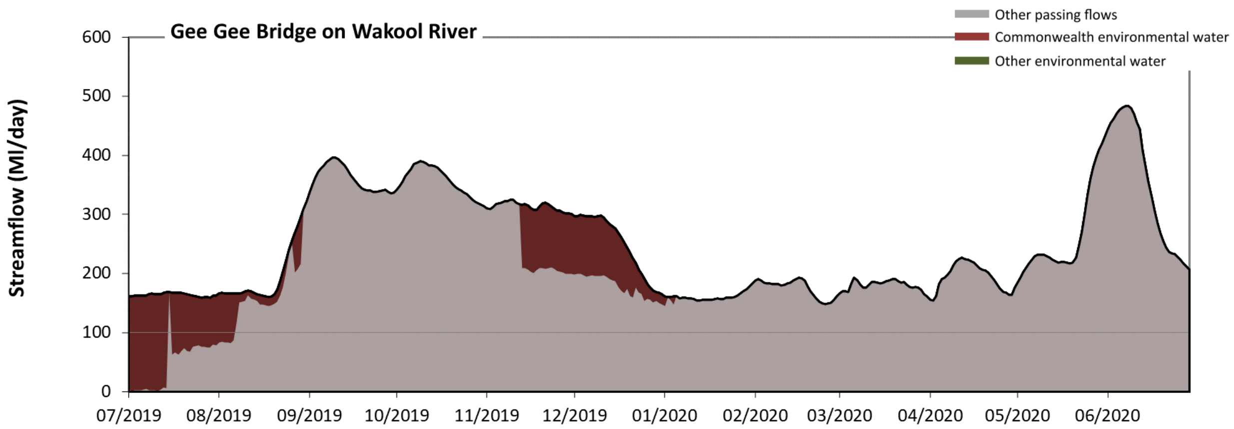


Figure EWK12: Contribution of environmental water delivery at Gee Bridge. Horizontal lines indicate thresholds for very low flows and low flows (from lowest to highest).

At Gee Gee Bridge on Wakool River environmental water contributed 10% of the total streamflow volume (all of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 31% of days between 1 July 2019 and 30 June 2020. Without environmental water, the duration of very low flows (i.e. < 100 ML/day) in the period July to September would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 10% to 0% of the year, with greatest influence in the period July to September. Similarly, without environmental water, the durations of low flows (i.e. < 500 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these low flows, which occurred for 100% of the year. Commonwealth environmental water was entirely responsible for these enhancements of environmental baseflows at this site.

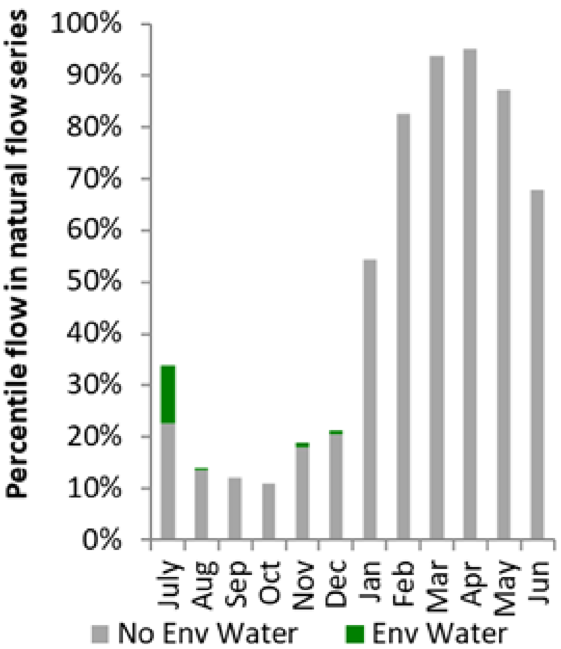


Figure EWK13: Contribution of environmental water delivery at Gee Bridge as percentiles in the natural and baseline flow series.

6.5.7 Coonamit

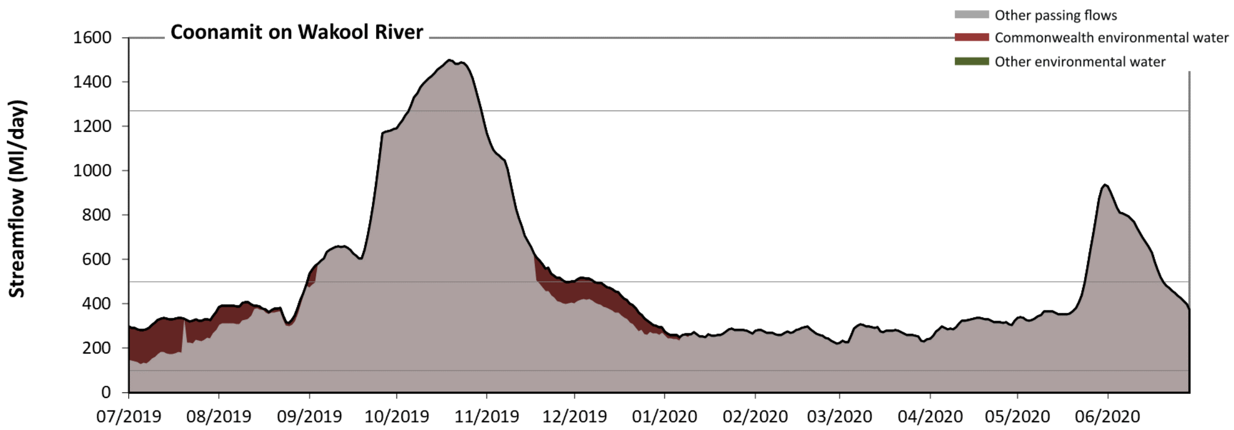


Figure EWK14: Contribution of environmental water delivery at Coonamit. Horizontal lines indicate thresholds for very low flows, low flows and low freshes (from lowest to highest).

At Coonamit on Wakool River environmental water contributed 5% of the total streamflow volume (all of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 32% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 100 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the durations of low flows (i.e. < 500 ML/day) in the periods July to September, October to December and January to March would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 72% to 66% of the year, with greatest influence in the period October to December. Commonwealth environmental water was entirely responsible for these enhancements of environmental baseflows at this site. There was at least one low fresh (i.e. > 1300 ML/day) in the period October to December. Environmental water made no change to the duration of these low freshes. There was no medium or high freshes this year.

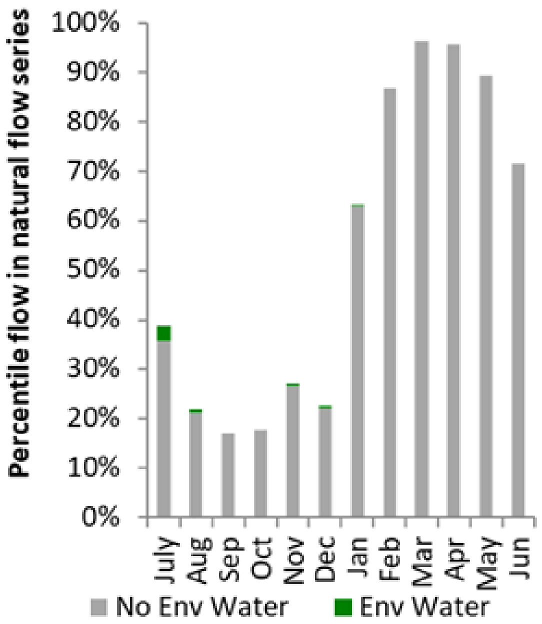


Figure EWK15: Contribution of environmental water delivery at Coonamit as percentiles in the natural flow series.

6.5.8 Colligen Offtake

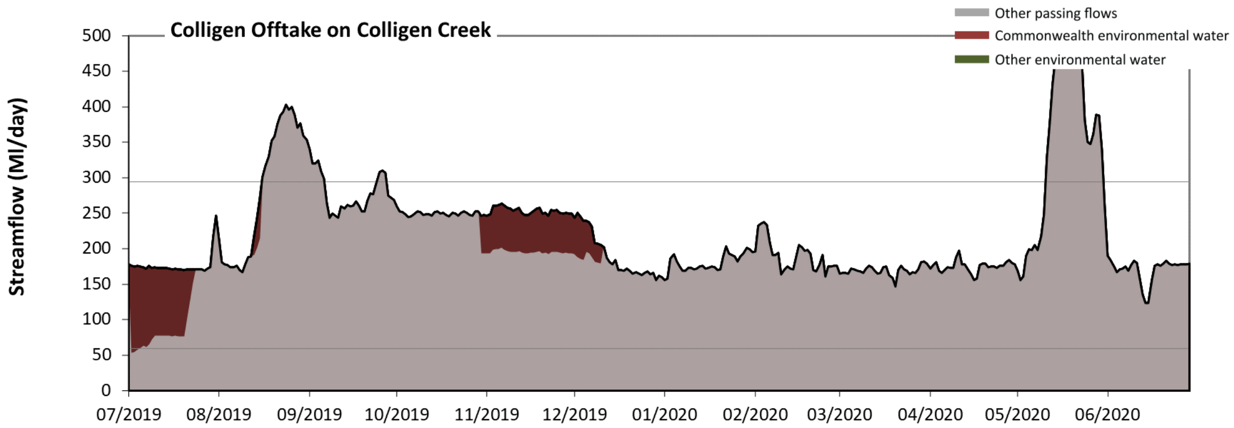


Figure EWK16: Contribution of environmental water delivery at Colligen Offtake. Horizontal lines indicate thresholds for very low flows and low flows (from lowest to highest).

At Colligen Offtake on Colligen Creek environmental water contributed 6% of the total streamflow volume (all of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 18% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 59 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the durations of low flows (i.e. < 290 ML/day) in the periods July to September, October to December and January to March would have substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these low flows, which occurred for 88% of the year.

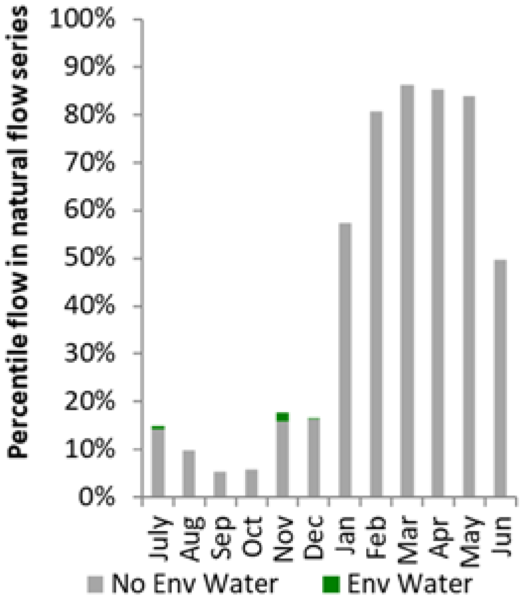


Figure EWK17: Contribution of environmental water delivery at Colligen Offtake as percentiles in the natural flow series.

6.5.9 Moulamien Rd

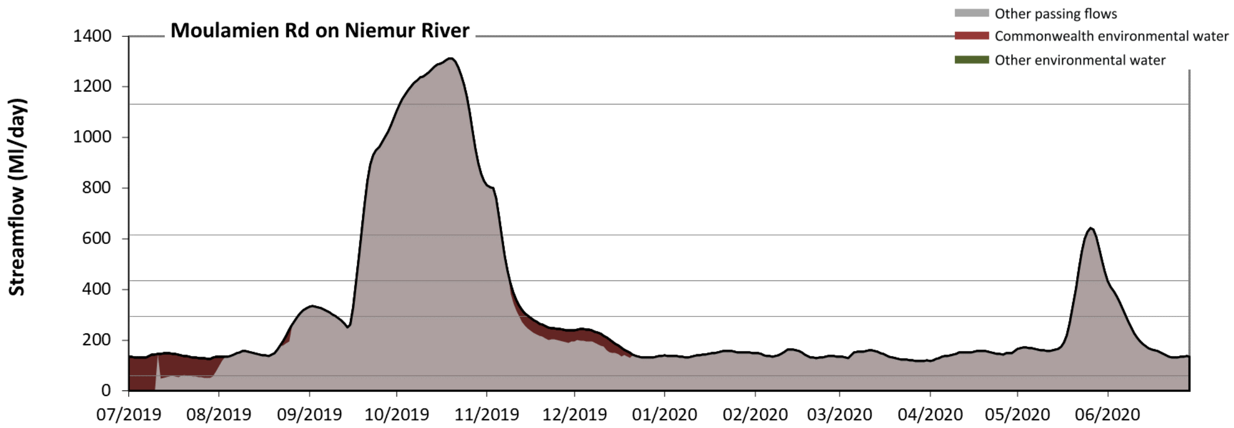


Figure EWK18: Contribution of environmental water delivery at Moulamien Rd. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Moulamien Rd on Niemur River environmental water contributed 4% of the total streamflow volume (all of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 21% of days between 1 July 2019 and 30 June 2020. Without environmental water, the duration of very low flows (i.e. < 59 ML/day) in the period July to September would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 7% to 0% of the year, with greatest influence in the period July to September. Similarly, without environmental water, the durations of low flows (i.e. < 290 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 76% to 75% of the year, with greatest influence in the period October to December. Commonwealth environmental water was entirely responsible for these enhancements of environmental baseflows at this site. There was at least one low fresh (i.e. > 430 ML/day) in the periods July to September, October to

December and April to June. Environmental water made no change to the duration of these low freshes. There was at least one medium fresh (i.e. > 610 ML/day) in the periods July to September, October to December and April to June. Environmental water made no change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the period October to December. Environmental water made no change to the duration of these high freshes.

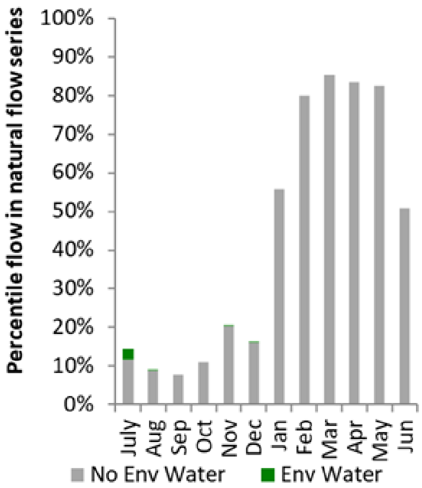


Figure EWK19: Contribution of environmental water delivery at Moulamien Rd as percentiles in the natural flow series.

6.5.10 MallanSchool

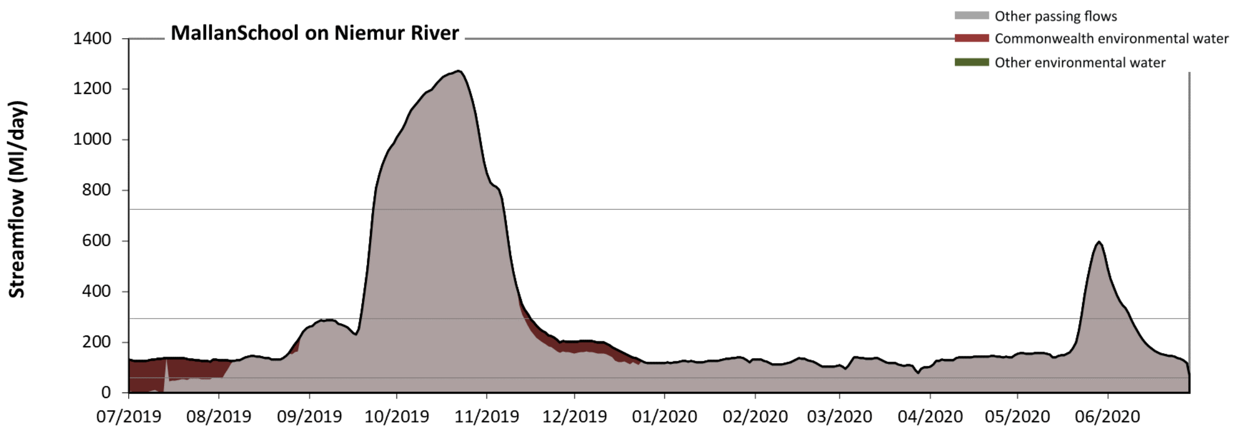


Figure EWK20: Contribution of environmental water delivery at MallanSchool. Horizontal lines indicate thresholds for very low flows, low flows and low freshes (from lowest to highest).

At MallanSchool on Niemur River environmental water contributed 5% of the total streamflow volume (all of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 22% of days between 1 July 2019 and 30 June 2020. Without environmental water, the duration of very low flows (i.e. < 59 ML/day) in the period July to September would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 8% to 0% of the year, with greatest influence in the period July to September. Similarly, without environmental water, the durations of low flows (i.e. < 290 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 80% to 79% of the year, with greatest influence in the period October to December. Commonwealth environmental water was entirely responsible for these enhancements of environmental baseflows at this site. There was at least one low fresh (i.e. > 720 ML/day) in the periods July to September and October to December. Environmental water made no change to the duration of these low freshes. There was no medium or high freshes this year.

7 Lower Murray Valley

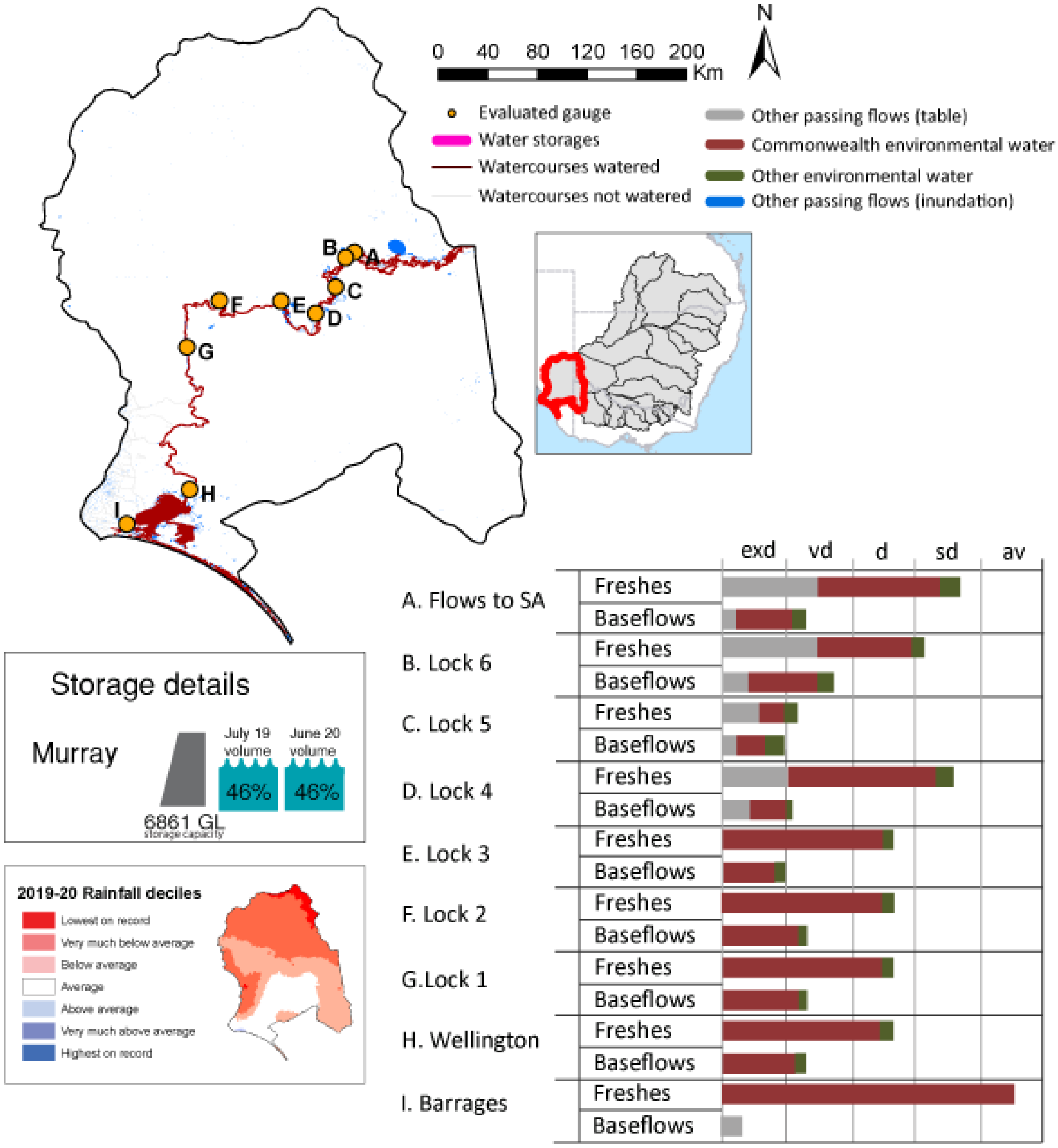


Figure LWM1: Watercourses influenced, areas inundated (where applicable) and gauge stations evaluated in the Lower Murray valley during the 2019–20 water year. Inset bar graphs report the condition of annual flow regimes by showing the improvements in hydrological condition with the addition of environmental water as well as the hypothetical scenario in 'grey' (if no environmental flow had been delivered). Rainfall conditions (rainfall deciles) and trend in storage levels for the water year are also shown. The classified bands are: exd = extremely dry, vd=very dry, sd=somewhat dry and av=average. Locks 7, 8 and 9 are not included in this analysis.

7.1 Summary

The volume of environmental water delivery for the 2019–20 year in the Lower Murray valley is quantified using data for 9 sites. This evaluation only considers the contribution of held environmental water, which is a primary focus for the Commonwealth. The contributions of planned environmental water (e.g. passing flows), unregulated tributary inflows and clever use of irrigation flows for environmental benefits can all be very important but these are outside the scope of this report. Environmental watering actions lasted on average 365 days over the course of the year. The volume of environmental water at these 9 sites was between 31% and 100% of the total streamflow. Commonwealth environmental water contributed on average 85% of this environmental water. The contribution of environmental water delivery to improved flow regimes is evaluated using data for 9 sites. Ideally, baseflows should be maintained and long periods of excessively low flows avoided. In this valley, the baseflow regime was generally considered to be extremely dry relative to the pre-development flow regime. In our analysis, a low fresh refers to a period of increased flow, when the water level rises at least one eighth of the way up the river bank (above the low flow level). These low freshes are a regular part of the natural flow regime and support a range of natural processes. In the Lower Murray valley, in terms of the occurrence and duration of low freshes, the year was assessed as being average. In our analysis, a medium fresh refers to a period of increased flow, when the water level rises at least one quarter of the way up the river bank. These medium freshes are not as frequent as low freshes but are also a regular and important part of the natural flow regime. In the Lower Murray valley, in terms of the occurrence of medium freshes, the year was assessed as being average. In our analysis, a high fresh refers to a period of increased flow, when the water level rises more than half way up the river. A high fresh may not occur every year but they are still important and long periods without major freshes can have serious consequences for floodplains and their contribution to river ecosystem health. Delivering environmental high in channel flows normally requires that all risks to riparian landholders and infrastructure have been resolved. In the Lower Murray valley, in terms of the occurrence of high freshes, the year was assessed as being extremely dry.

7.2 Water delivery context

During the 2019–20 water year, the Commonwealth Environmental Water Holder (CEWH) held water entitlements of up to 162,141 ML for environmental use in the Lower Murray valley. Each year, water utilities allocate water entitlement holders a percentage of water based on their holding, licence type and carryover (the exact rules vary among Jurisdictions and licence type). In 2019–20, the Lower Murray entitlements held by the CEWH were allocated 161,417 ML of water, representing 112% of the Long term average annual yield for the Lower Murray valley (143,868 ML). Information and data relating to the portfolio of held Commonwealth environmental water is shown in Table LWM1.

The 2019–20 water allocation (161,417 ML) together with the carryover volume of 0 ML of water meant the CEWH had 161,417 ML of water available for delivery. A total of 161,417 ML of Commonwealth environmental water was delivered in the Lower Murray valley. No Commonwealth environmental water was carried over for environmental use into the 2020–21 water year.

7.3 Environmental conditions and resource availability

The water available for environmental delivery combined with the present and antecedent environmental conditions are key inputs used by environmental water managers in planning and implementing watering actions. *Post hoc*, this information provides important context when evaluating the effectiveness and appropriateness of environmental water use with respect to hydrological outputs.

The rainfall conditions in the Lower Murray valley were classified as below average, based on rainfall percentile data for the entire record held by the Bureau of Meteorology for this valley. The water held in major storages in the Lower Murray valley increased over the water year, for example Lake Victoria dam was 41.3% full at the beginning of the water year and 88.1% full by the end of the year (Figure LWM1).

The CEWO calculates resource availability scenarios (RAS) to guide the use and prioritisation of held environmental water. The RAS are progressively calculated over the year as part of the continual adaptive management planning processes. The RAS are based on the availability of held environmental water (including progressive licence acquisitions and allocations) as well as the potential for unregulated or planned environmental flows. The outcome is then used to determine the demand for environmental water across the Basin.

In 2019–20, the resource availability of held Commonwealth environmental water in the Lower Murray was classified as low to high, whilst the overall demand for environmental water was classified as high to moderate. The demand for Coorong barrage flows was classified as critical. The physical conditions meant that the CEWO was managing to protect the condition of most environmental assets.

7.4 Watering actions

A total of 48 watering actions were delivered over the 2019–20 water year, the duration of these actions varied (range of individual actions: 8–365 days) and Commonwealth environmental water was delivered for a total of 365 days. The number of water actions commencing in each season included, summer (12), autumn (23), winter (8), spring (5). Similarly, the count of flow component types delivered in the Lower Murray valley were; (3) baseflow, (0) baseflow-fresh, (0) baseflow-fresh-bankfull, (0) baseflow-fresh-overbank-wetland, (2) fresh, (0) fresh-wetland, (0) bankfull, (0) overbank, (43) wetland and (0) wetland-overbank.

In the Lower Murray, watering actions were delivered for water quality, resilience, ecosystem processes, connectivity, biota, frogs fish, vegetation and waterbirds purposes, but water was also delivered for other purposes too. The percentage of watering actions delivered across the nine main themes included fish (7.14%), vegetation (36.73%), waterbirds (17.35%), frogs (15.31%), other biota (3.06%), connectivity (5.1%), process (6.12%), resilience (5.1%) and water quality (4.08%).

Table LWM1. Commonwealth environmental water accounting information for the Lower Murray valley over 2019–20 water year.

Total registered volume (ML)	Allocated volume (ML)	Carry over + allocated volume (ML)	Delivered (ML)	LTAAY (ML)	Carried over to 2020–21
162,141	161,417	161,417	161,417	143,868	0

7.5 Contribution of Commonwealth environmental water to flow regimes

7.5.1 South Australian border

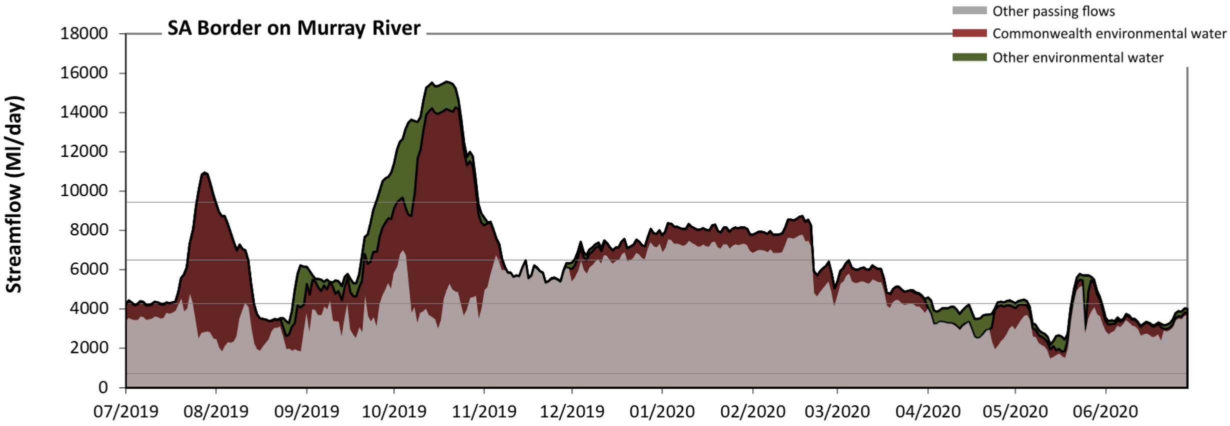


Figure LWM2: Contribution of environmental water delivery at SA Border. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At SA Border on Murray River environmental water contributed 31% of the total streamflow volume. Environmental watering actions affected streamflows for 100% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 700 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the durations of low flows (i.e. < 4000 ML/day) in the periods July to September, October to December and April to June would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 48% to 19% of the year, with greatest influence in the periods July to September and April to June. In the absence of environmental water there would have been at least one low fresh (i.e. > 6100 ML/day) in the periods October to December and January to March. Environmental water increased the duration of the longest low fresh during the periods July to September (from 0 days to 22 days) and October to December (from 25 days to 39 days). In the absence of environmental water there would have been no medium or high freshes this year. Environmental water increased the duration of the longest medium fresh during the periods July to September (from 0 days to 9 days) and October to December (from 0 days to 31 days).

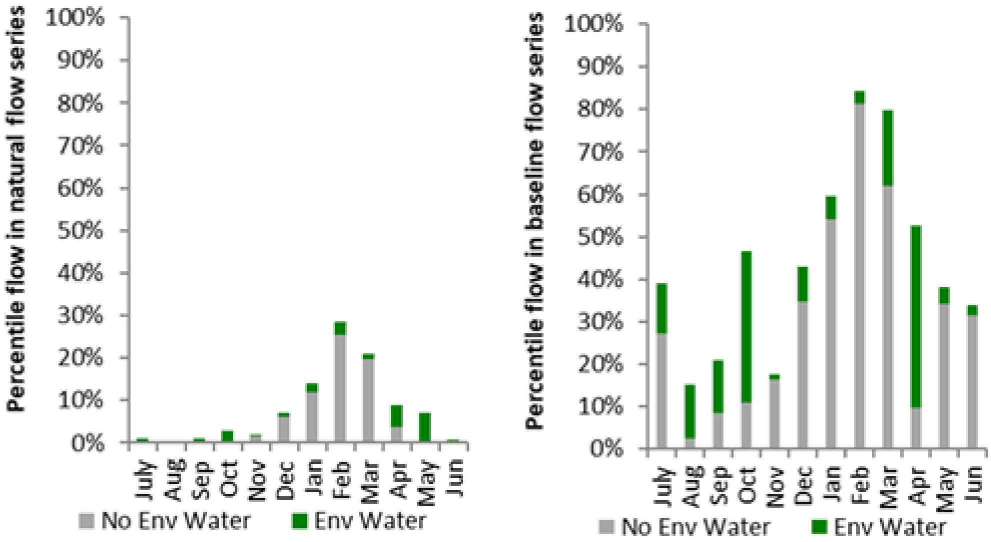


Figure LWM3: Contribution of environmental water delivery at SA Border as percentiles in the natural and baseline flow series.

7.5.2 Lock 6

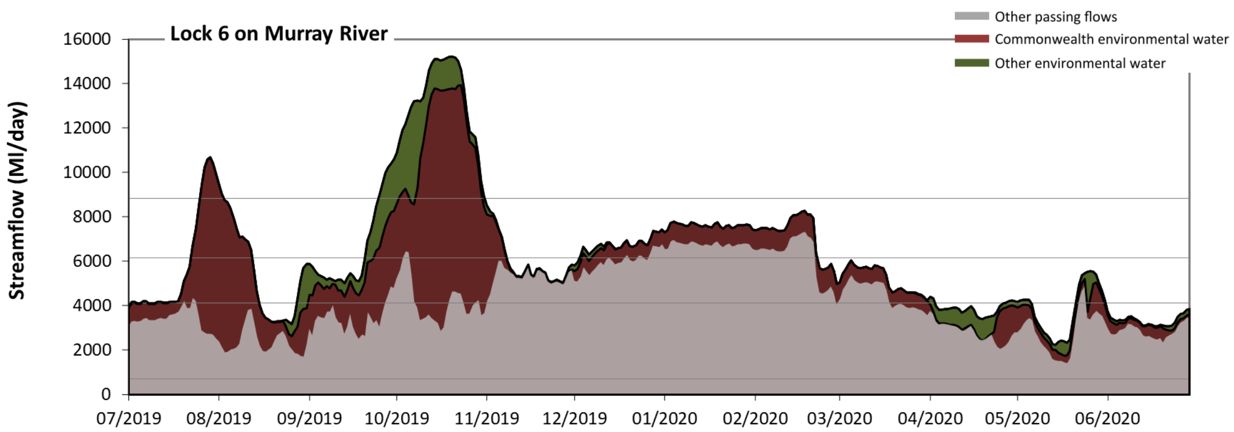


Figure LWM4: Contribution of environmental water delivery at Lock 6. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Lock 6 on Murray River environmental water contributed 32% of the total streamflow volume. Environmental watering actions affected streamflows for 100% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 700 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the durations of low flows (i.e. < 4100 ML/day) in the periods July to September, October to December and April to June would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 55% to 22% of the year, with greatest influence in the period July to September. In the absence of environmental water there would have been at least one low fresh (i.e. > 6100 ML/day) in the periods October to December and January to March. Environmental water increased the duration of the longest low fresh during the periods July to September (from 0 days to 21 days) and October to December (from 5 days to 38 days). In the absence of environmental water there would have been no medium or high freshes this year. Environmental water increased the duration of the longest medium fresh during the periods July to September (from 0 days to 8 days) and October to December (from 0 days to 31 days).

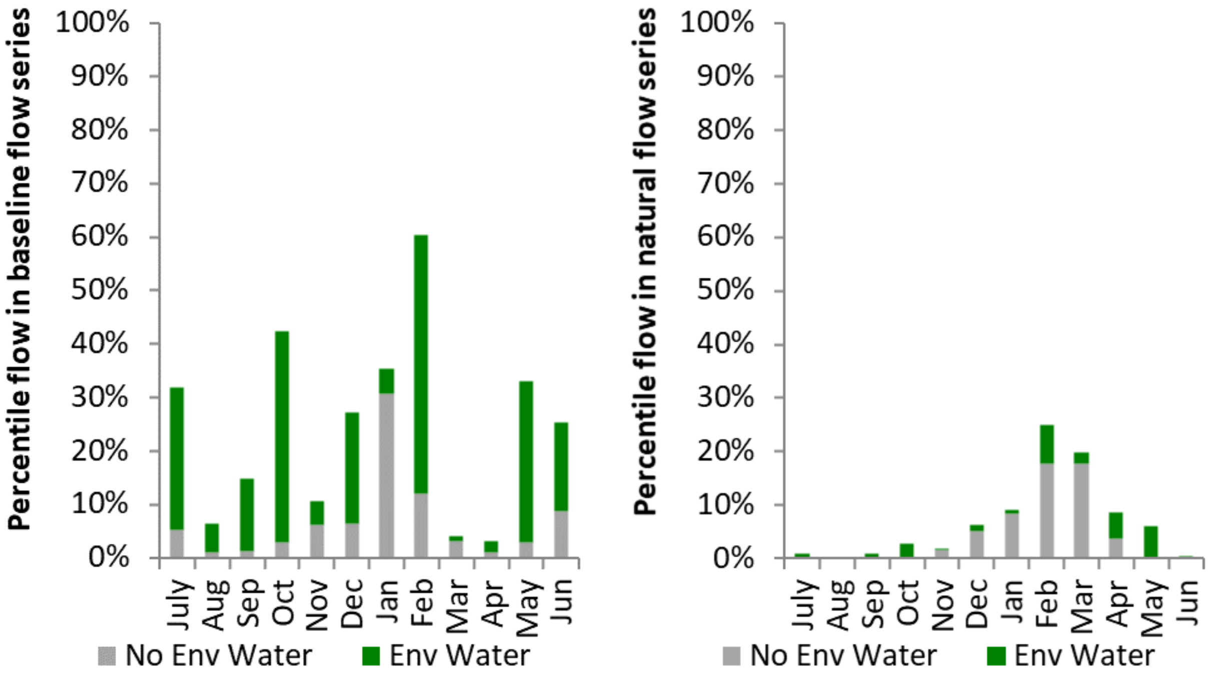


Figure LWM5: Contribution of environmental water delivery at Lock 6 as percentiles in the natural and baseline flow series.

7.5.3 Lock 5

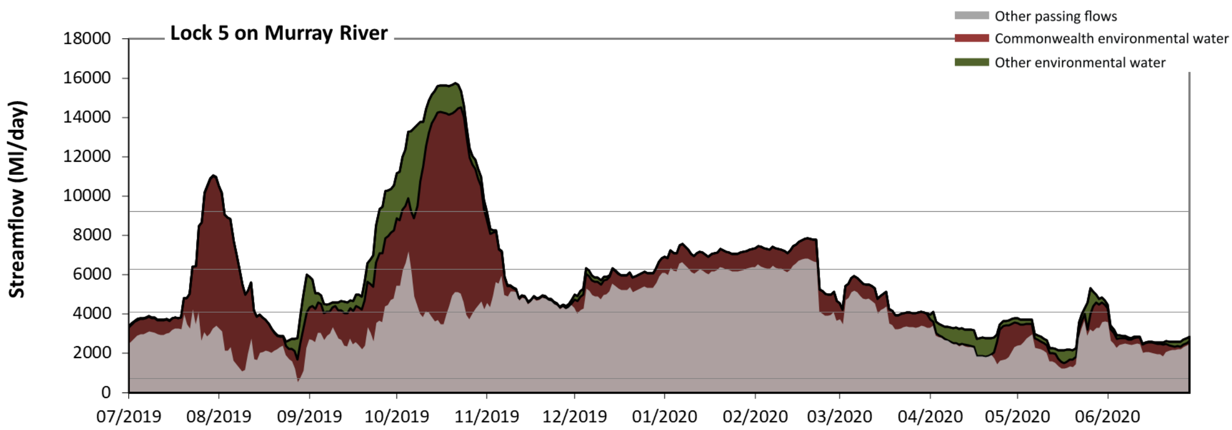


Figure LWM6: Contribution of environmental water delivery at Lock 5. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Lock 5 on Murray River environmental water contributed 35% of the total streamflow volume. Environmental watering actions affected streamflows for 100% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 700 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the durations of low flows (i.e. < 4100 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 58% to 35% of the year, with greatest influence in the period July to September. In the absence of environmental water there would have been at least one low fresh (i.e. > 6300 ML/day) in the periods October to December and January to March. Environmental water increased the duration of the longest low fresh during the periods July to September (from 0 days to 16 days), October to December (from 2 days to 37 days) and January to March (from 13 days to 53 days). In the absence of environmental water there would have been no medium or high freshes this year. Environmental water increased the duration of the longest medium fresh during the periods July to September (from 0 days to 7 days) and October to December (from 0 days to 32 days).

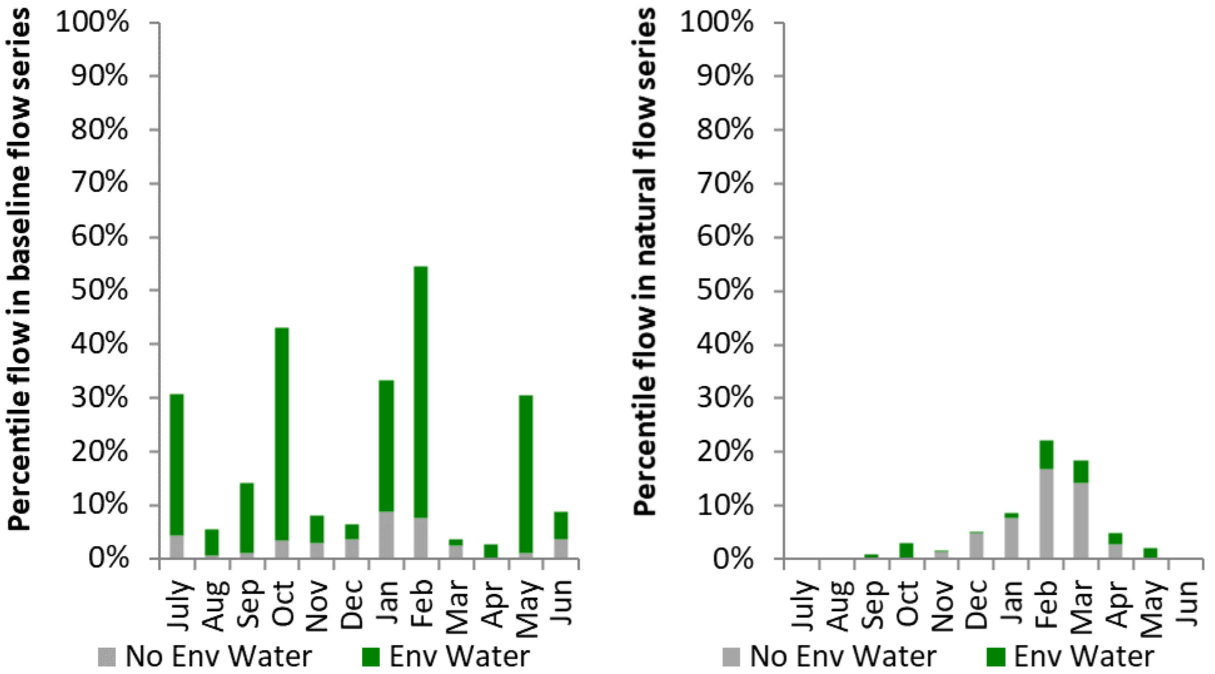


Figure LWM7: Contribution of environmental water delivery at Lock 5 as percentiles in the natural and baseline flow series.

7.5.4 Lock 4

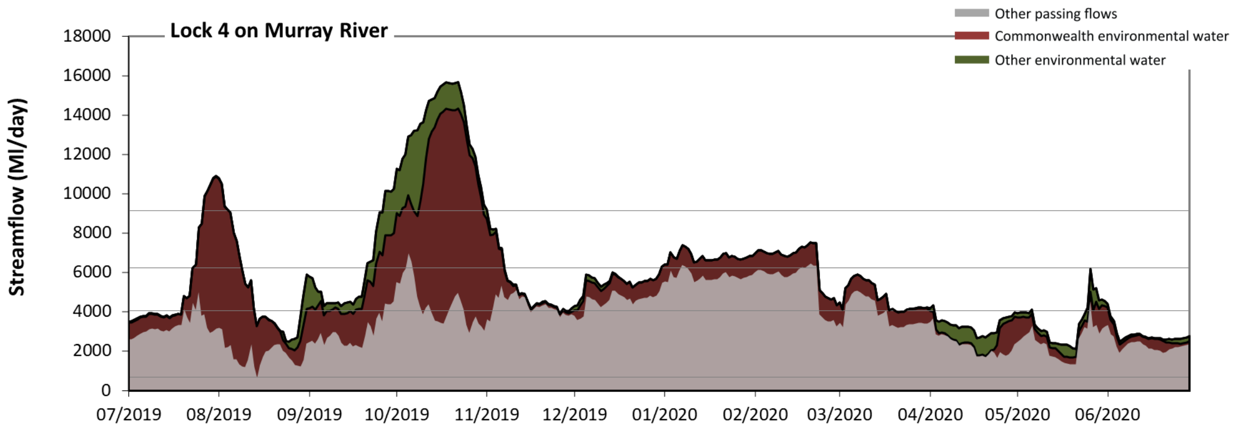


Figure LWM8: Contribution of environmental water delivery at Lock 4. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Lock 4 on Murray River environmental water contributed 37% of the total streamflow volume. Environmental watering actions affected streamflows for 100% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 700 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the durations of low flows (i.e. < 4100 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 62% to 33% of the year, with greatest influence in the period July to September. In the absence of environmental water there would have been at least one low fresh (i.e. > 6200 ML/day) in the periods October to December and January to March. Environmental water increased the duration of the longest low fresh during the periods July to September (from 0 days to 16 days), October to December (from 2 days to 37 days) and January to March (from 6 days to 53 days). In the absence of environmental water there would have been no medium or high freshes this year. Environmental water increased the duration of the longest medium fresh during the periods July to September (from 0 days to 9 days) and October to December (from 0 days to 32 days).

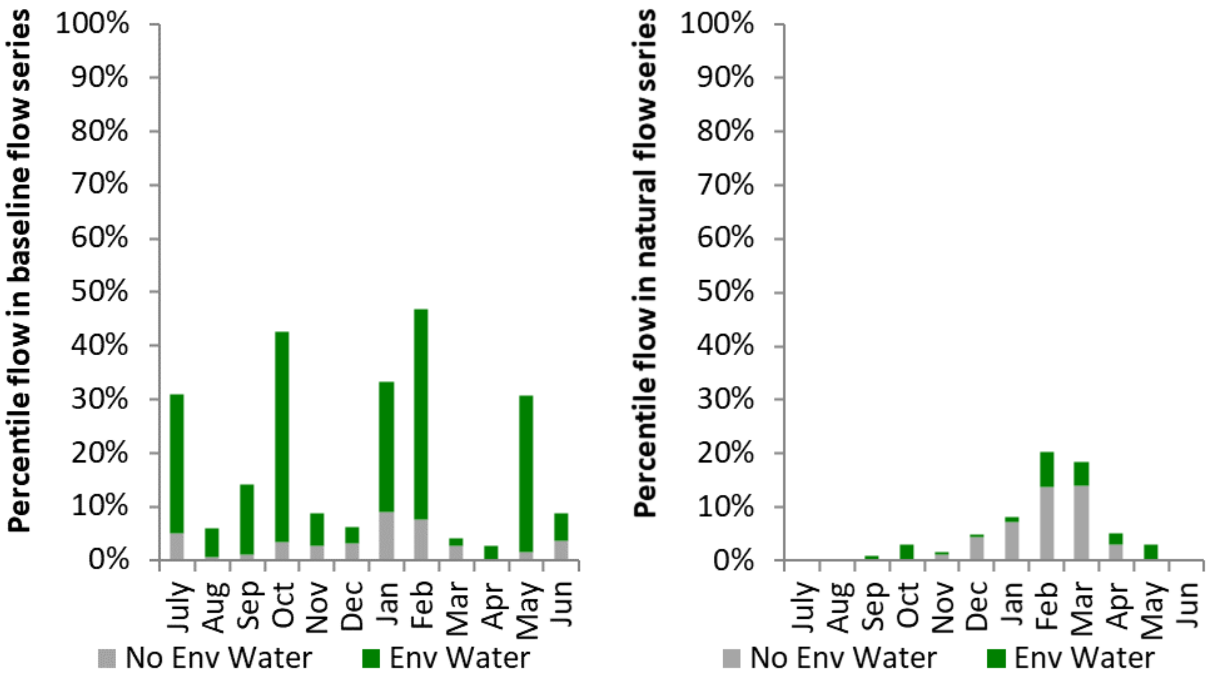


Figure LWM9: Contribution of environmental water delivery at Lock 4 as percentiles in the natural and baseline flow series.

7.5.5 Lock 3

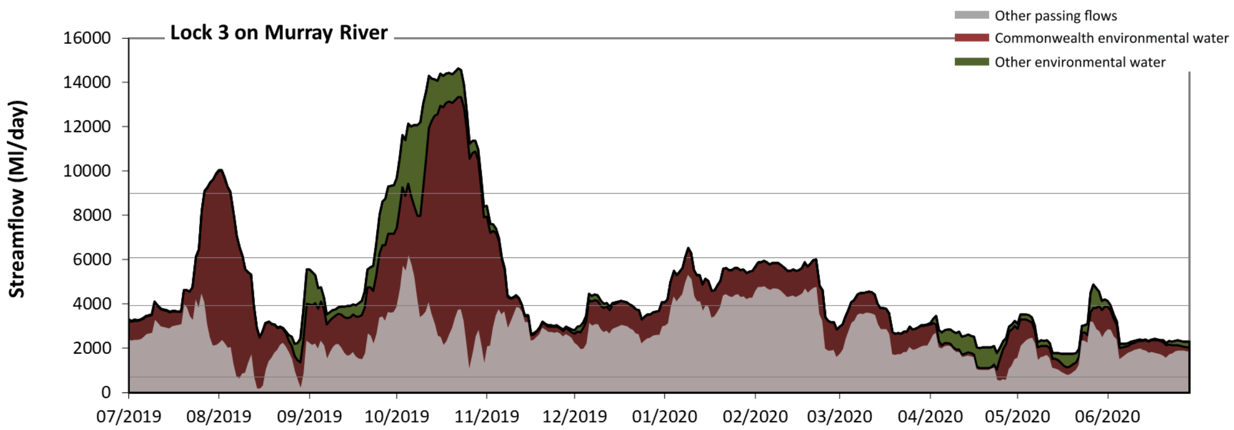


Figure LWM10: Contribution of environmental water delivery at Lock 3. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Lock 3 on Murray River environmental water contributed 45% of the total streamflow volume. Environmental watering actions affected streamflows for 100% of days between 1 July 2019 and 30 June 2020. Without environmental water, the duration of very low flows (i.e. < 690 ML/day) in the period July to September would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 3% to 0% of the year, with greatest influence in the periods July to September and April to June. Similarly, without environmental water, the durations of low flows (i.e. < 3900 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 85% to 51% of the year, with greatest influence in the periods July to September and October to December. In the absence of environmental water there would have been at least one low fresh (i.e. > 6100 ML/day) in the period October to December. Environmental water increased the duration of the longest low fresh during the periods July to September (from 0 days to 17 days), October to December (from 1 days to 37 days) and January to March (from 0 days to 3 days). In the absence of environmental water there would have been no medium or high freshes this year. Environmental water increased the duration of the longest medium fresh during the periods July to September (from 0 days to 10 days) and October to December (from 0 days to 30 days).

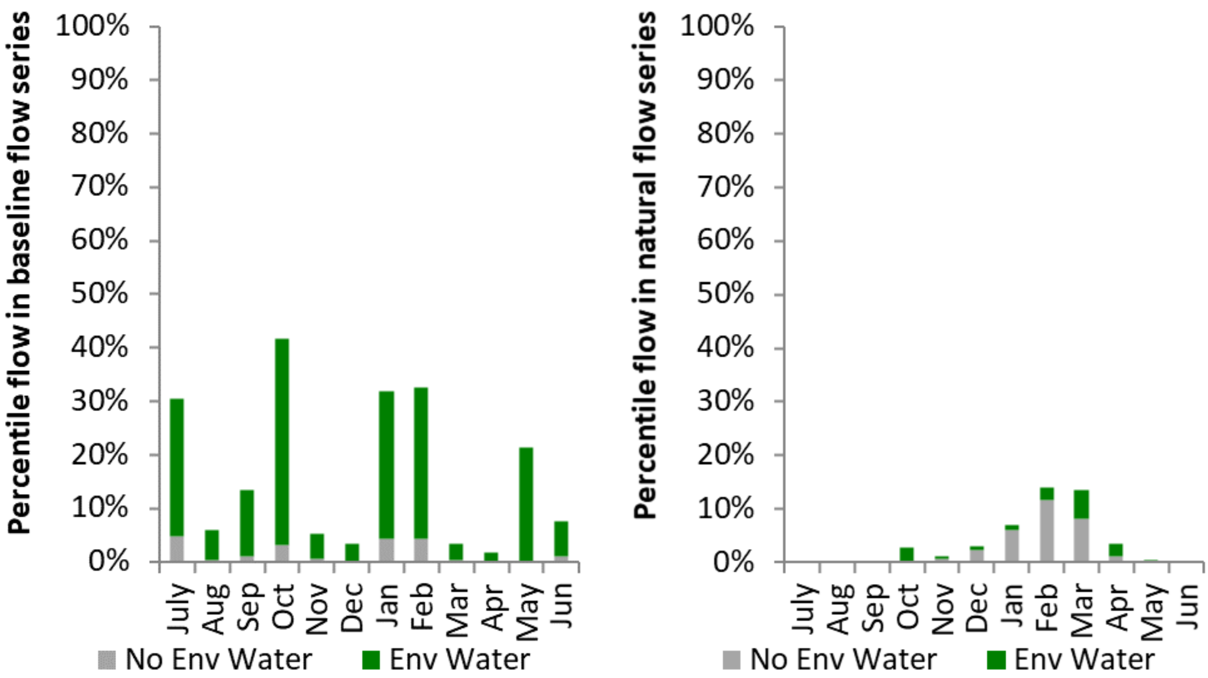


Figure LWM11: Contribution of environmental water delivery at Lock 3 as percentiles in the natural and baseline flow series.

7.5.6 Lock 2

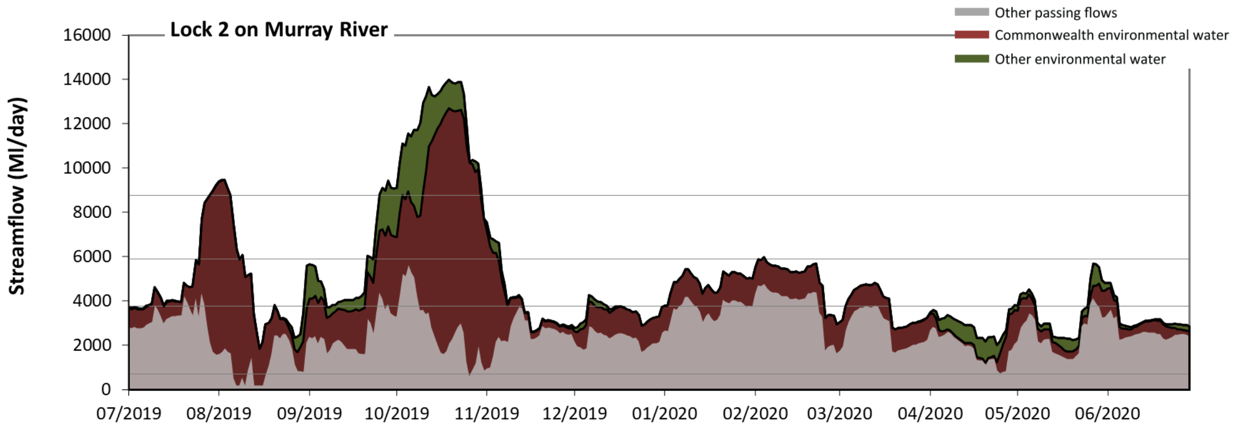


Figure LWM12: Contribution of environmental water delivery at Lock 2. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Lock 2 on Murray River environmental water contributed 46% of the total streamflow volume. Environmental watering actions affected streamflows for 100% of days between 1 July 2019 and 30 June 2020. Without environmental water, the duration of very low flows (i.e. < 690 ML/day) in the period July to September would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 3% to 0% of the year, with greatest influence in the period July to September. Similarly, without environmental water, the durations of low flows (i.e. < 3800 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 85% to 44% of the year, with greatest influence in the periods July to September and October to December. Environmental water increased the duration of the longest low fresh during the periods July to September (from 0 days to 13 days), October to December (from 0 days to 36 days) and January to March (from 0 days to 1 days). Environmental water increased the duration of the longest medium fresh during the periods July to September (from 0 days to 8 days) and October to December (from 0 days to 30 days).

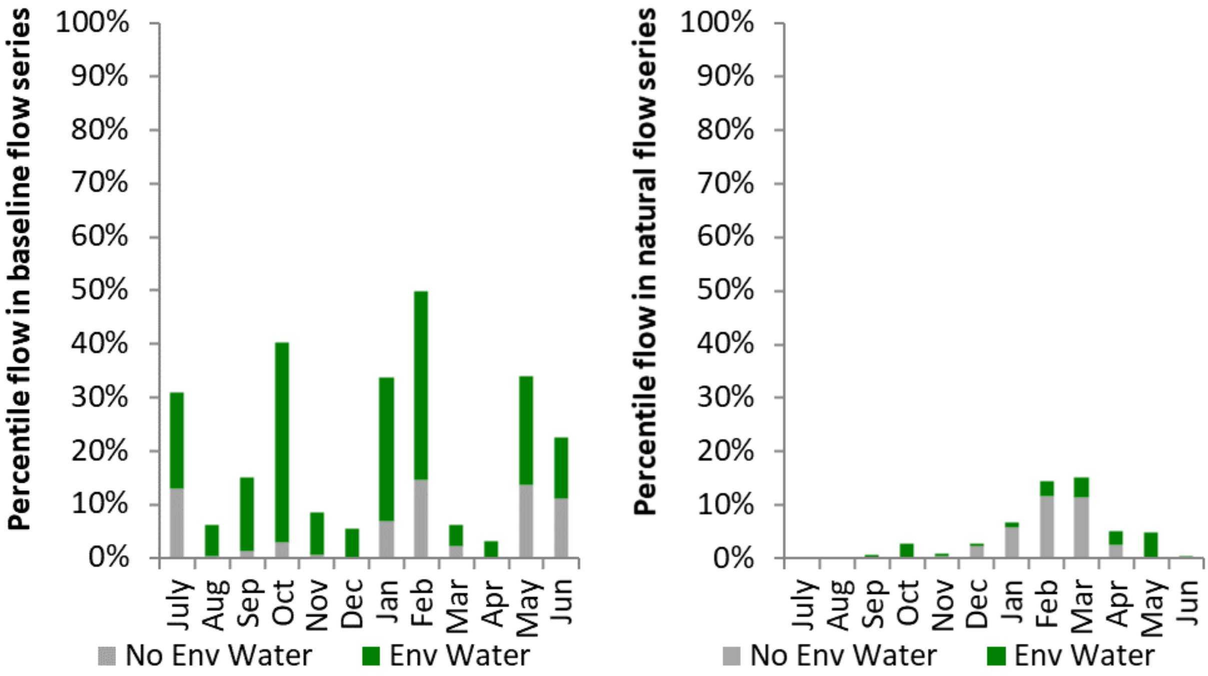


Figure LWM13: Contribution of environmental water delivery at Lock 2 as percentiles in the natural and baseline flow series.

7.5.7 Lock 1

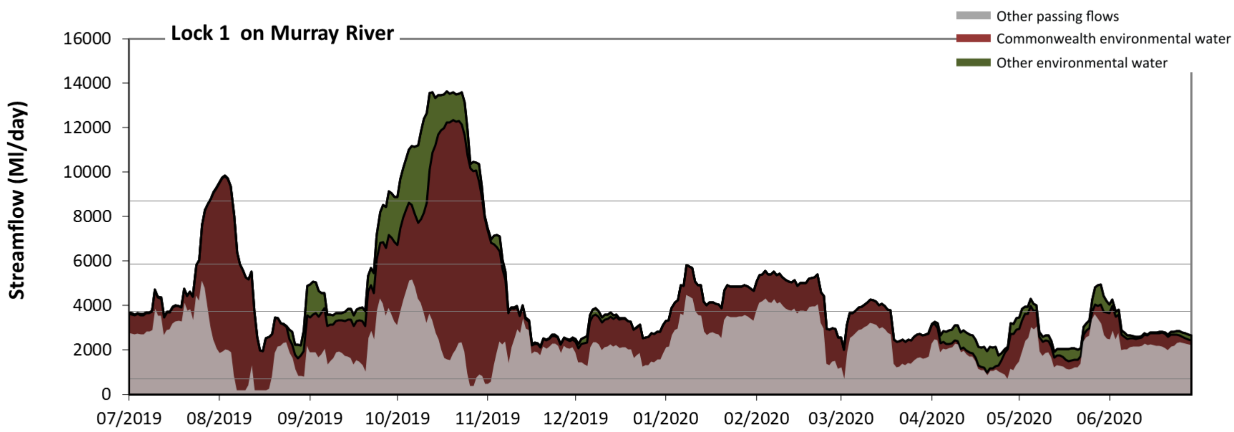


Figure LWM14: Contribution of environmental water delivery at Lock 1. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Lock 1 on Murray River environmental water contributed 49% of the total streamflow volume. Environmental watering actions affected streamflows for 100% of days between 1 July 2019 and 30 June 2020. Without environmental water, the duration of very low flows (i.e. < 690 ML/day) in the period July to September would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 4% to 0% of the year, with greatest influence in the periods July to September and October to December. Similarly, without environmental water, the durations of low flows (i.e. < 3700 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 88% to 50% of the year, with greatest influence in the periods July to September, October to December and January to March. Environmental water increased the duration of the longest low fresh during the periods July to

September (from 0 days to 14 days) and October to December (from 0 days to 37 days). Environmental water increased the duration of the longest medium fresh during the periods July to September (from 0 days to 8 days) and October to December (from 0 days to 30 days).

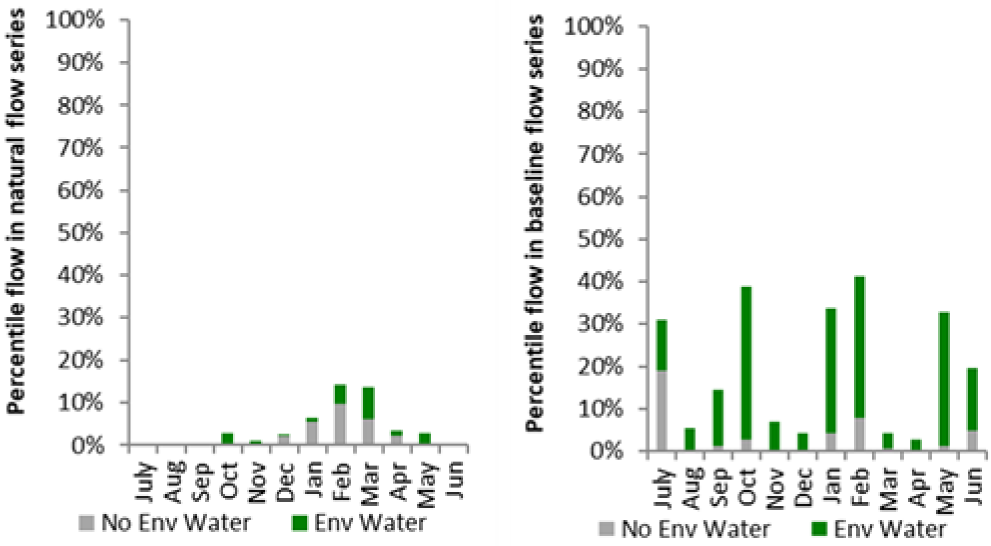


Figure LWM15: Contribution of environmental water delivery at Lock 1 as percentiles in the natural and baseline flow series.

7.5.8 Wellington

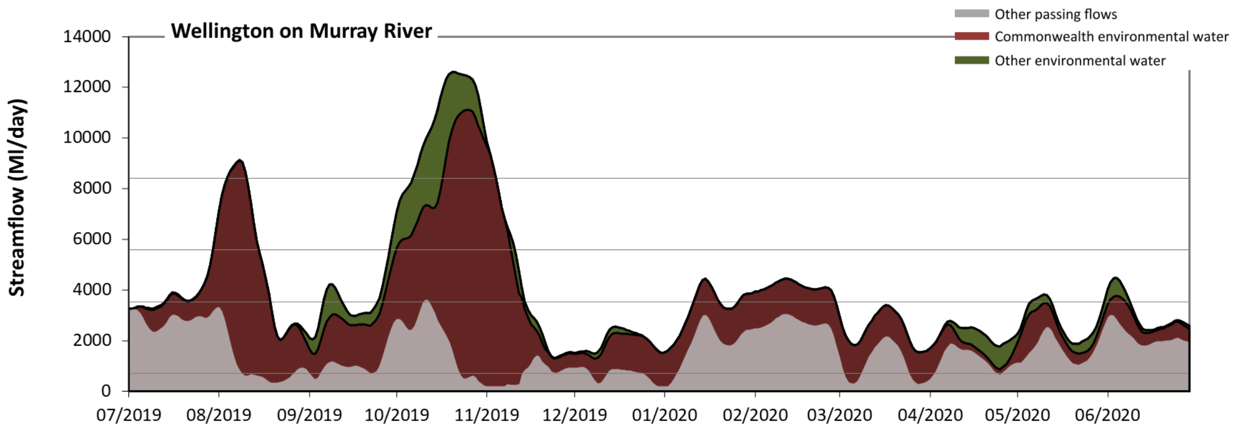


Figure LWM16: Contribution of environmental water delivery at Wellington. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Wellington on Murray River environmental water contributed 60% of the total streamflow volume. Environmental watering actions affected streamflows for 100% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 690 ML/day) in the periods July to September, October to December and January to March would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 20% to 0% of the year, with greatest influence in the periods July to September and October to December. Similarly, without environmental water, the durations of low flows (i.e. < 3500 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 99% to 58% of the year, with greatest influence in the periods July to September, October to December and January to March. Environmental water increased the duration of the longest low fresh during the periods July to September (from 0 days to 16 days) and October to December (from 0 days to 41 days). Environmental water increased the duration of the longest medium fresh during the periods July to September (from 0 days to 7 days) and October to December (from 0 days to 28 days).

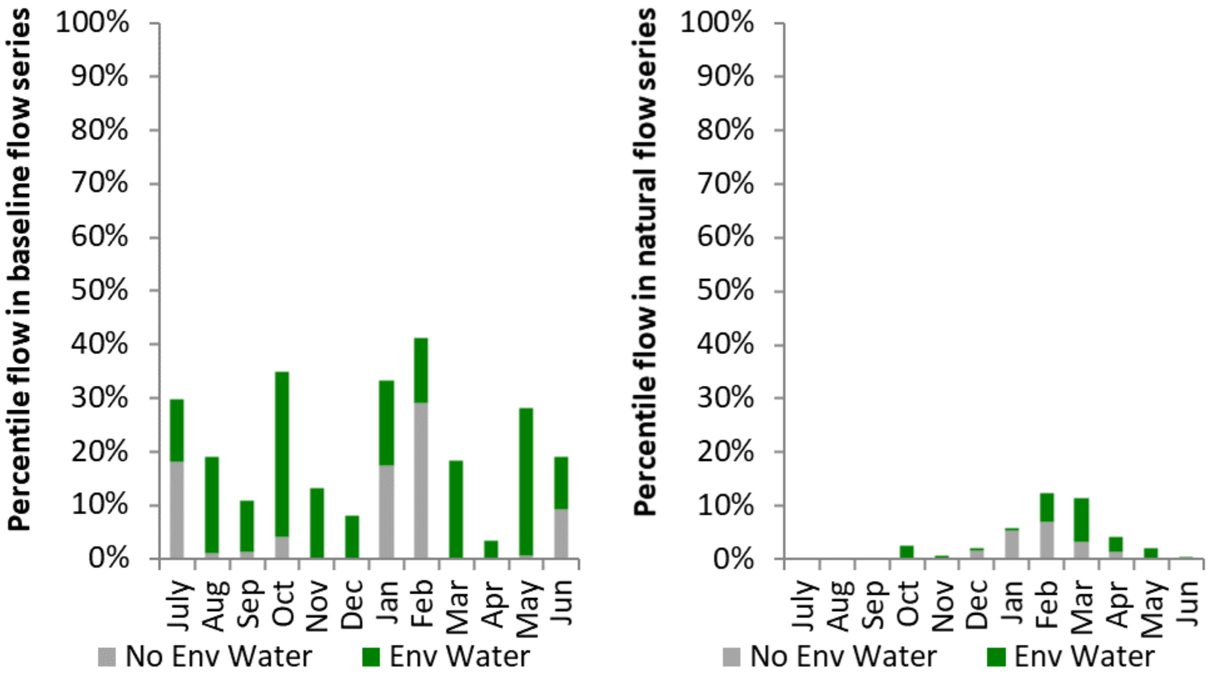


Figure LWM17: Contribution of environmental water delivery at Wellington as percentiles in the natural and baseline flow series.

7.5.9 Barrages

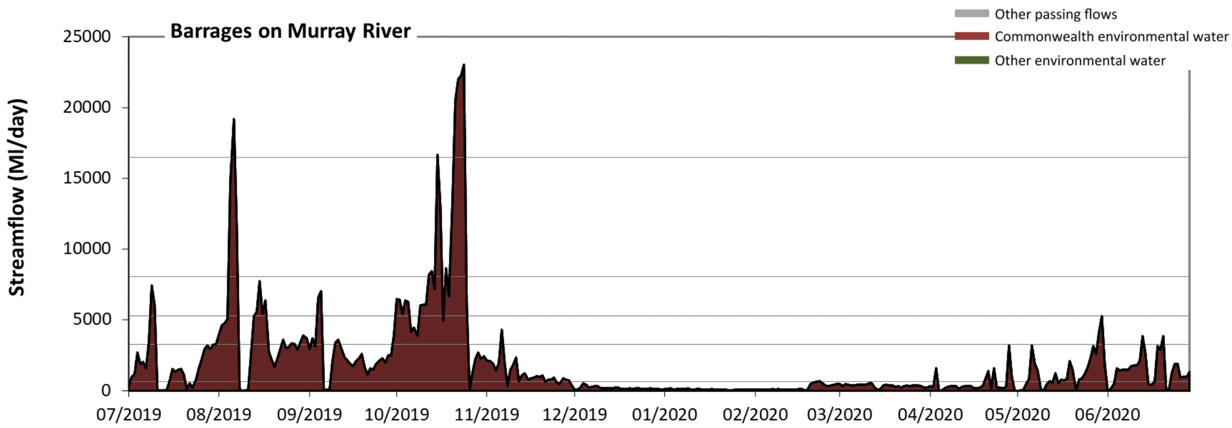


Figure LWM18: Contribution of environmental water delivery at Barrages. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Barrages on Murray River environmental water contributed 100% of the total streamflow volume. Environmental watering actions affected streamflows for 99% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 650 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 100% to 50% of the year, with greatest influence in the periods July to September, October to December and April to June. Similarly, without environmental water, the durations of low flows (i.e. < 3300 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 100% to 84% of the year, with greatest influence in the periods July to September and October to December. Environmental water increased the duration of the longest low fresh during the periods July to September (from 0 days to 4 days) and October to December (from 0 days to 8 days). Environmental water increased the duration of the longest medium fresh during the periods July to September (from 0 days to 3 days) and October to December (from 0 days to 5 days). Environmental water increased the duration of the longest medium fresh during the periods July to September (from 0 days to 1 days) and October to December (from 0 days to 4 days).

8 Barwon-Darling Valley

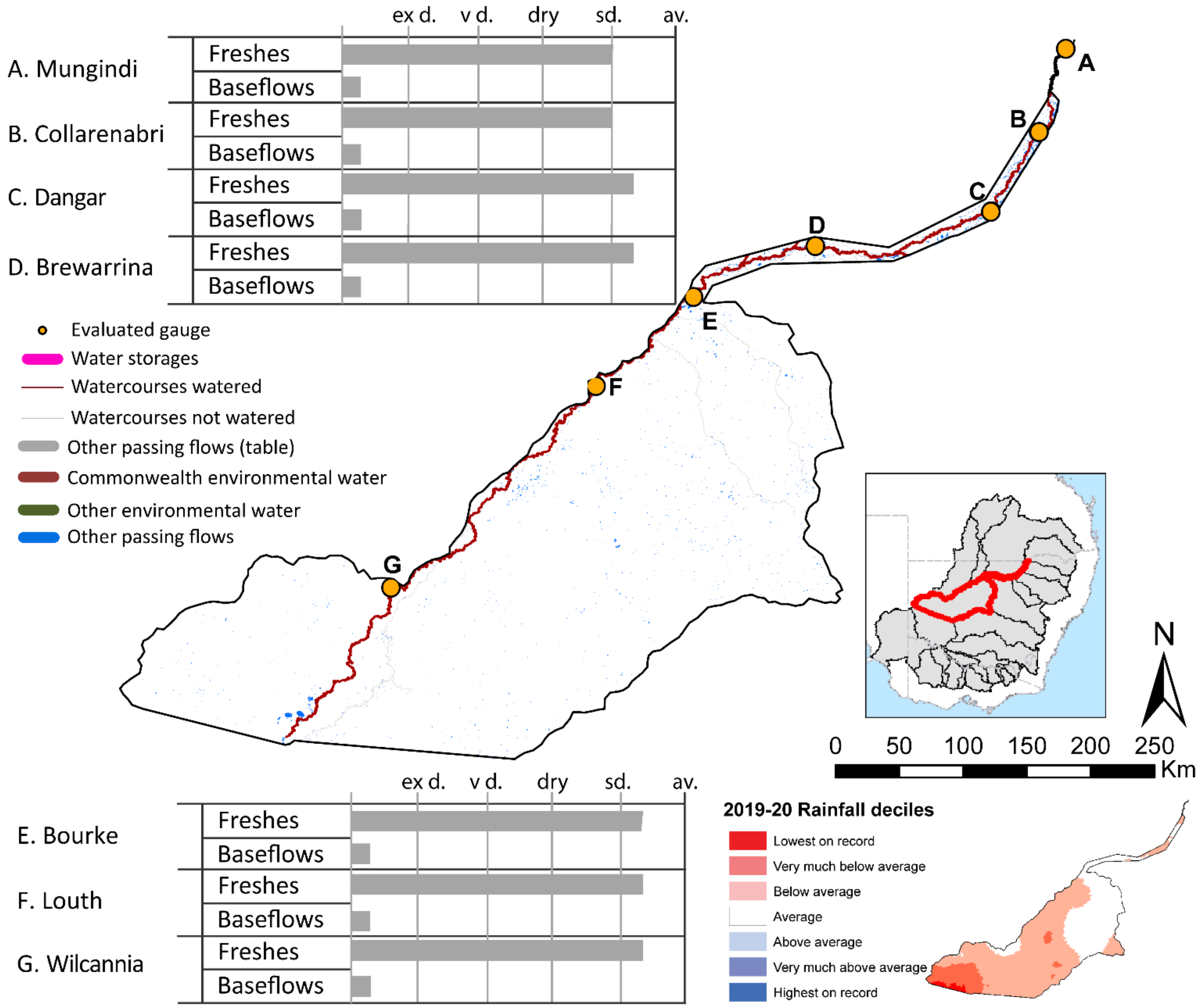


Figure BDL1: Watercourses influenced, areas inundated (where applicable) and gauge stations evaluated in the Barwon Darling valley during the 2019–20 water year. Inset bar graphs report the condition of annual flow regimes by showing the improvements in hydrological condition with the addition of environmental water as well as the hypothetical scenario in 'grey' (if no environmental flow had been delivered). Rainfall conditions (rainfall deciles) and trend in storage levels for the water year are also shown. The classified bands are: exd = extremely dry, vd=very dry, sd=somewhat dry and av=average.

8.1 Summary

The volume of environmental water delivery for the 2019–20 year in the Barwon Darling valley is quantified using data for 7 sites. This evaluation only considers the contribution of held environmental water, which is a primary focus for the Commonwealth. The contributions of planned environmental water (e.g. passing flows), unregulated tributary inflows and clever use of irrigation flows for environmental benefits can all be very important but these are outside the scope of this report. Environmental watering actions lasted on average 11 days over the course of the year. The volume of environmental water at these 7 sites was between 0% and 7% of the total streamflow. Commonwealth environmental water contributed on average 43% of this environmental water. The contribution of environmental water delivery to improved flow regimes is evaluated using data for 7 sites. Ideally, baseflows should be maintained and long periods of excessively low flows avoided. In this valley, the baseflow regime was generally considered to be extremely dry relative to the pre-development flow regime. In our analysis, a low fresh refers to a period of increased flow, when the water level rises at least one eighth of the way up the river bank (above the low flow level). These low freshes are a regular part of the natural flow regime and support a range of natural processes. In the Barwon Darling valley, in terms of the occurrence and duration of low freshes, the year was assessed as being somewhat dry. In our analysis, a medium fresh refers to a period of increased flow, when the water level rises at least one quarter of the way up the river bank. These medium freshes are not as frequent as low freshes but are also a regular and important part of the natural flow regime. In the Barwon Darling valley, in terms of the occurrence of medium freshes, the year was assessed as being average. In our analysis, a high fresh refers to a period of increased flow, when the water level rises more than half way up the river. A high fresh may not occur every year but they are still important and long periods without major freshes can have serious consequences for floodplains and their contribution to river ecosystem health. Delivering environmental high in channel flows normally requires that all risks to riparian landholders and infrastructure have been resolved. In the Barwon Darling valley, in terms of the occurrence of high freshes, the year was assessed as being average.

8.2 Water delivery context

During the 2019–20 water year, the Commonwealth Environmental Water Holder (CEWH) held water entitlements of up to 28,631 ML for environmental use in the Barwon Darling valley. Each year, water utilities allocate water entitlement holders a percentage of water based on their holding, licence type and carryover (the exact rules vary among Jurisdictions and licence type). In 2019–20, the Barwon Darling entitlements triggered 28.631 ML of water use. Information and data relating to the portfolio of held Commonwealth environmental water is shown in Table BDL1.

8.3 Environmental conditions and resource availability

The rainfall conditions in the Barwon Darling valley were classified as below average, based on rainfall percentile data for the entire record held by the Bureau of Meteorology for this valley.

The CEWO calculates resource availability scenarios (RAS) to guide the use and prioritisation of held environmental water. The RAS are progressively calculated over the year as part of the continual adaptive management planning processes. The RAS are based on the availability of held environmental water (including progressive licence acquisitions and allocations) as well as the potential for unregulated or planned environmental flows. The outcome is then used to determine the demand for environmental water across the Basin.

In 2019–20, the resource availability of held Commonwealth environmental water in the Barwon Darling was classified as very low to low, whilst the overall demand for environmental water was classified as critical to high. The physical conditions meant that the CEWO was managing to avoid damage and protect aquatic ecosystems and native fish habitat in the Barwon and Darling rivers.

8.4 Watering actions

A total of 1 watering actions were delivered over the 2019–20 water year, the duration of these actions varied (range of individual actions: 167 - 167 days) and Commonwealth environmental water was delivered for a total of 167 days. The number of water actions commencing in each season included, summer (0), autumn (0), winter (1), spring (0). Similarly, the count of flow component types delivered in the Barwon Darling valley were; (0) baseflow, (1) baseflow-fresh, (0) baseflow-fresh-bankfull, (0) baseflow-fresh-overbank-wetland, (0) fresh, (0) fresh-wetland, (1) bankfull, (0) overbank, (0) wetland and (0) wetland-overbank.

In the Barwon Darling, watering actions were delivered for resilience and Fish purposes, but water was also delivered for other purposes too. The percentage of watering actions delivered across the nine main themes included fish (50%), vegetation (0.0%), waterbirds (0.0%), frogs (0.0%), other biota (0.0%), connectivity (0.0%), process (0.0%), resilience (50%) and water quality (0.0%).

Table BDL1. Commonwealth environmental water accounting information for the Barwon Darling valley over 2019–20 water year.

Total registered volume (ML)	Allocated volume (ML)	Carry over + allocated volume (ML)	Delivered (ML)	LTAAY (ML)	Carried over to 2020–21
28,631	28,631	0	28,631	28,631	0

8.5 Contribution of Commonwealth environmental water to flow regimes

8.5.1 Mungindi

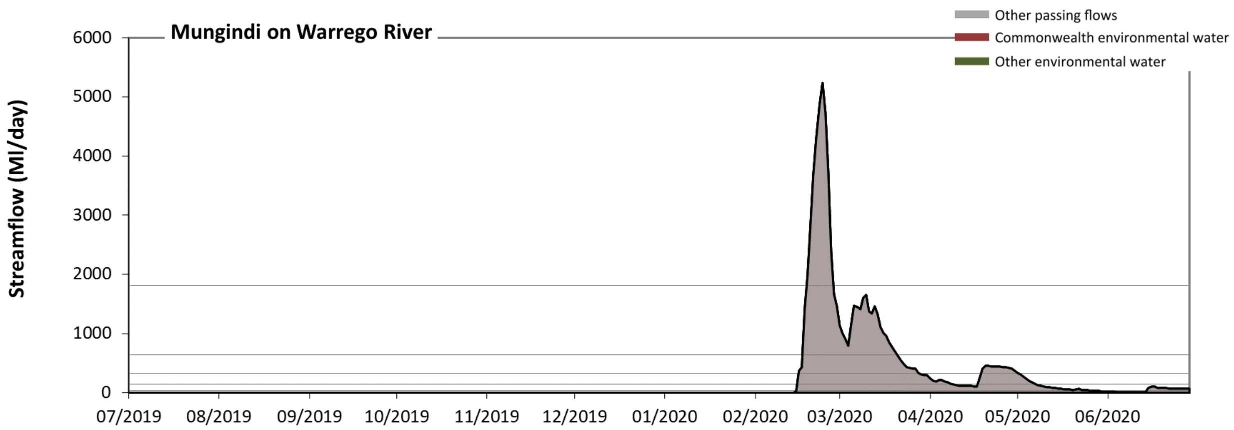


Figure BDL2: Contribution of environmental water delivery at Mungindi. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

There was no environmental water delivered at Mungindi on Warrego River. Without environmental water, the durations of very low flows (i.e. < 28 ML/day) in the periods July to September, October to December and January to March was substantially in excess of durations expected in an average year in the natural flow regime. Similarly, without environmental water, the durations of low flows (i.e. < 140 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. There was at least one low fresh (i.e. > 320 ML/day) in the periods January to March and April to June. There was at least one medium fresh (i.e. > 630 ML/day) in the period January to March. In the absence of environmental water there was at least one high fresh in the period January to March.

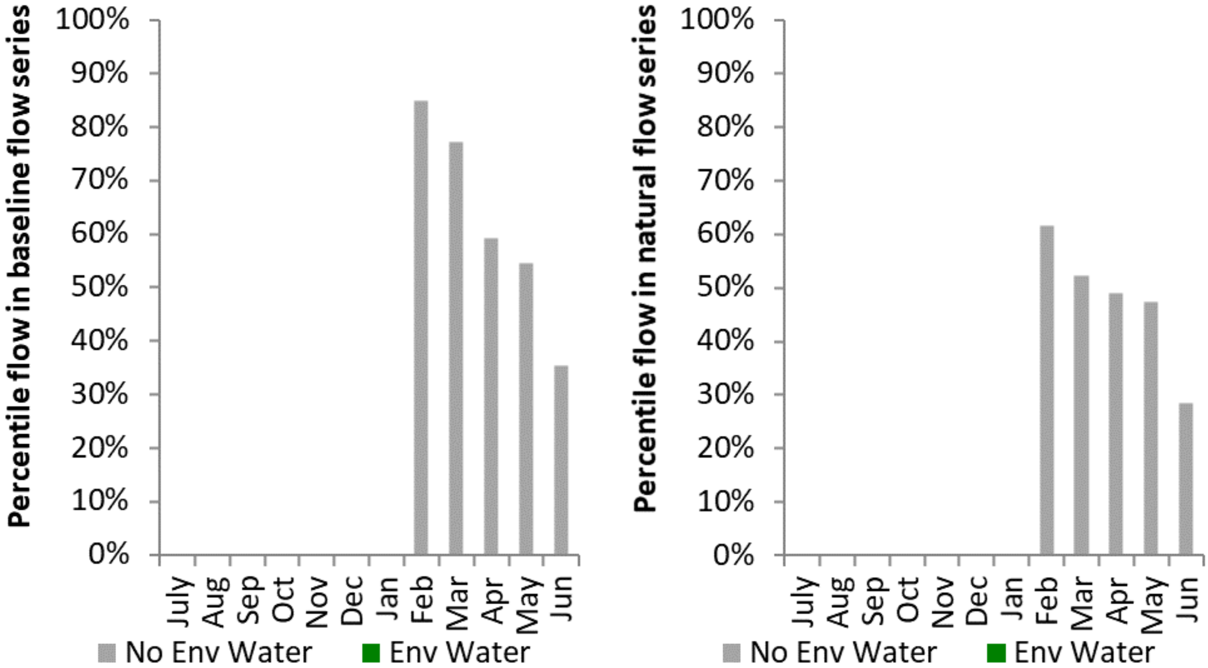


Figure BDL3: Contribution of environmental water delivery at Mungindi as percentiles in the natural and baseline flow series.

8.5.2 Collarenebri

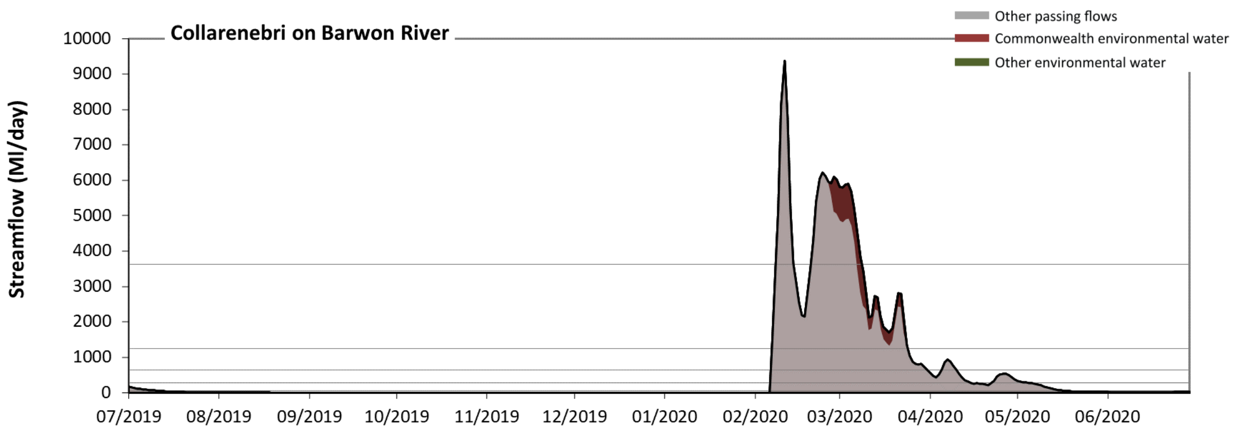


Figure BDL4: Contribution of environmental water delivery at Collarenebri. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Collarenebri on Barwon River environmental water contributed 7% of the total streamflow volume (all of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 7% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 55 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these very low flows, which occurred for 70% of the year. Similarly, without environmental water, the durations of low flows (i.e. < 270 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these low flows, which occurred for 78% of the year. There was at least one low fresh (i.e. > 640 ML/day) in the periods January to March and April to June. Environmental water made no change to the duration of these low freshes. There was at least one medium fresh (i.e. > 1300 ML/day) in the period January to March. Environmental water made no change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the period January to March. Environmental water made little change to the duration of these high freshes.

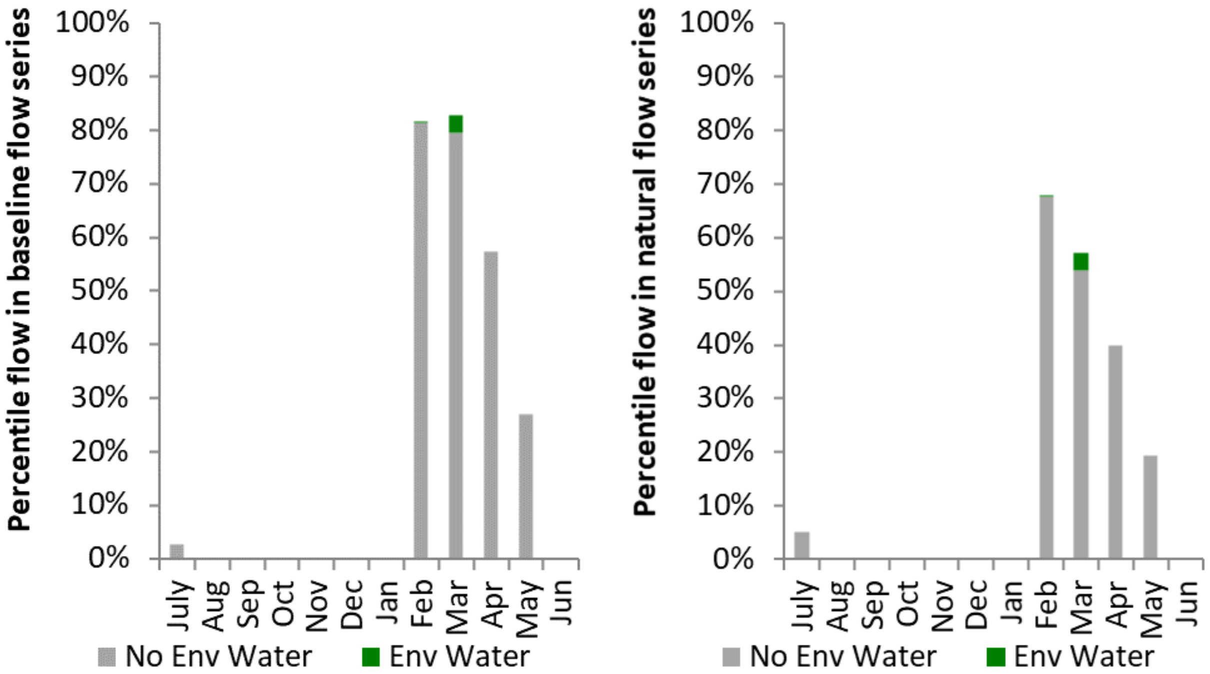


Figure BDL5: Contribution of environmental water delivery at Collarenebri as percentiles in the natural and baseline flow series.

8.5.3 Dangar

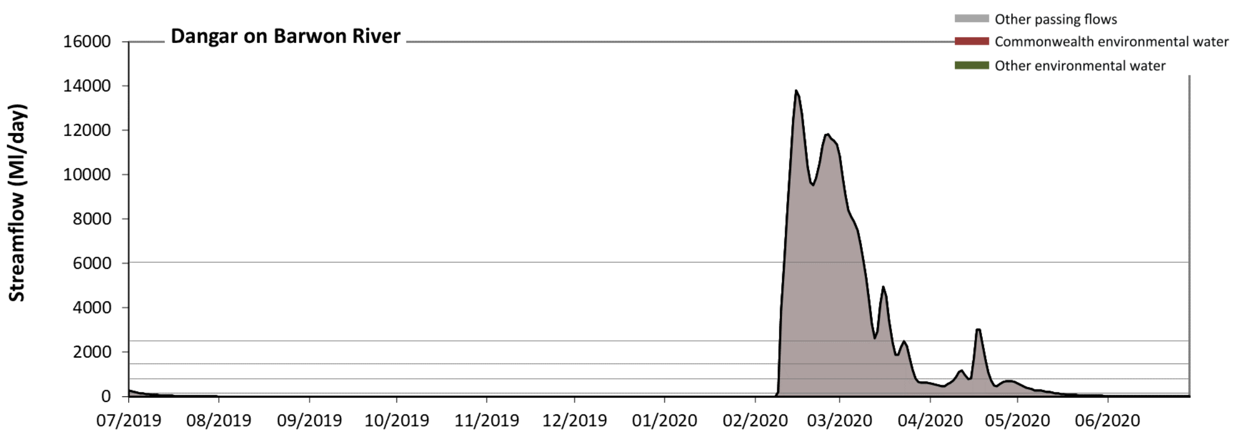


Figure BDL6: Contribution of environmental water delivery at Dangar. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

There was no environmental water delivered at Dangar on Barwon River. Without environmental water, the durations of very low flows (i.e. < 160 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. Similarly, without environmental water, the durations of low flows (i.e. < 780 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. There was at least one low fresh (i.e. > 1500 ML/day) in the periods January to March and April to June. There was at least one medium fresh (i.e. > 2500 ML/day) in the periods January to March and April to June. In the absence of environmental water there was at least one high fresh in the period January to March.

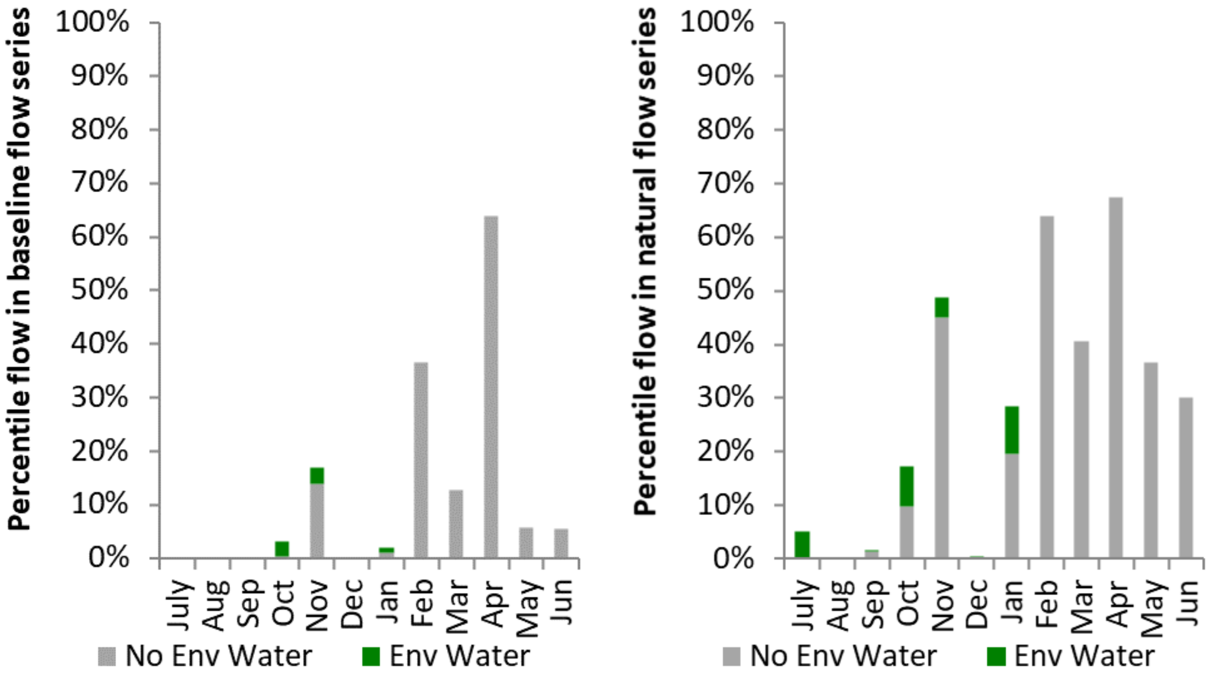


Figure BDL7: Contribution of environmental water delivery at Dangar as percentiles in the natural and baseline flow series.

8.5.4 Brewarrina

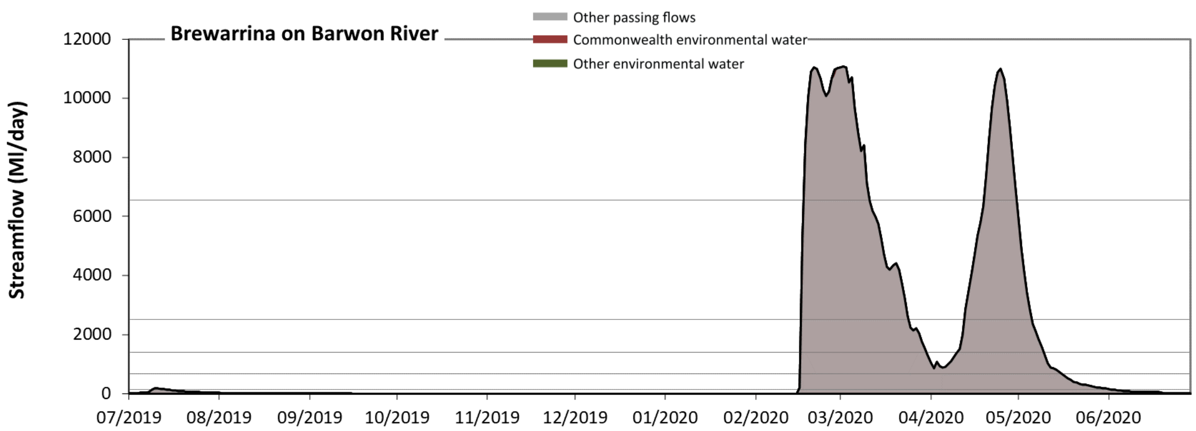


Figure BDL8: Contribution of environmental water delivery at Brewarrina. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Brewarrina on Barwon River environmental water contributed 0% of the total streamflow volume (all of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 1% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 140 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these very low flows, which occurred for 69% of the year. Similarly, without environmental water, the durations of low flows (i.e. < 680 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these low flows, which occurred for 76% of the year. There was at least one low fresh (i.e. > 1400 ML/day) in the periods January to March and April to June. Environmental water made no change to the duration of these low freshes. There was at least one medium fresh (i.e. > 2500 ML/day) in the periods January to March and April to June. Environmental water made no change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the periods January to March and April to June. Environmental water made no change to the duration of these high freshes.

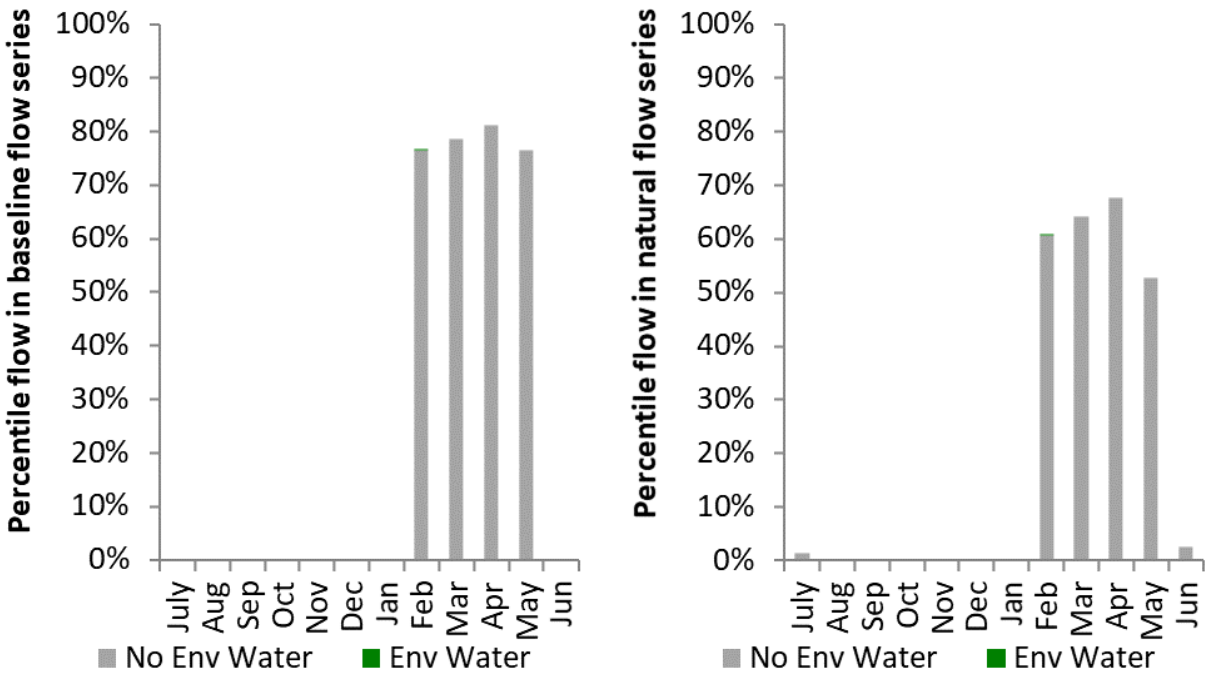


Figure BDL9: Contribution of environmental water delivery at Brewarrina as percentiles in the natural and baseline flow series.

8.5.5 Bourke

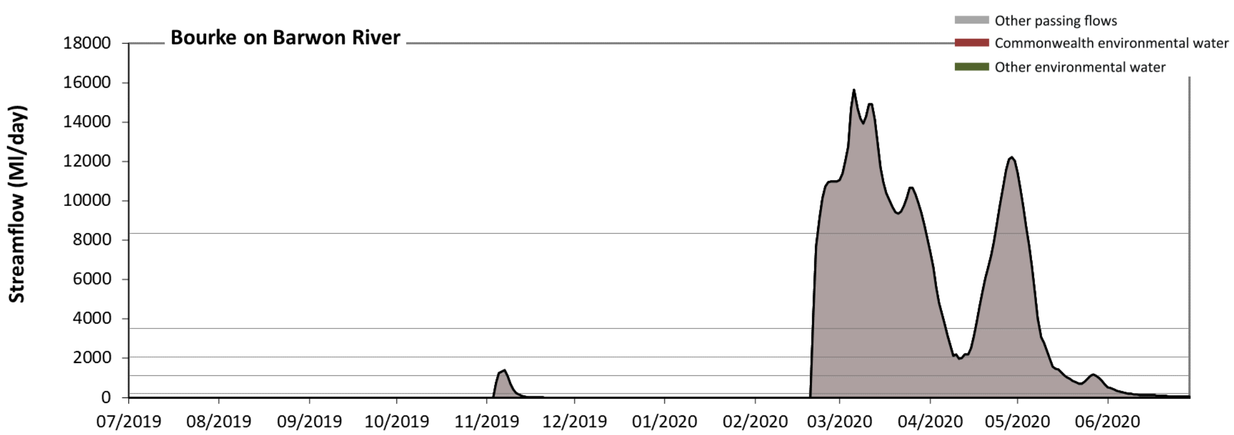


Figure BDL10: Contribution of environmental water delivery at Bourke. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

There was no environmental water delivered at Bourke on Barwon River. Without environmental water, the durations of very low flows (i.e. < 220 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. Similarly, without environmental water, the durations of low flows (i.e. < 1100

ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. There was at least one low fresh (i.e. > 2100 ML/day) in the periods January to March and April to June. There was at least one medium fresh (i.e. > 3500 ML/day) in the periods January to March and April to June. In the absence of environmental water there was at least one high fresh in the periods January to March and April to June.

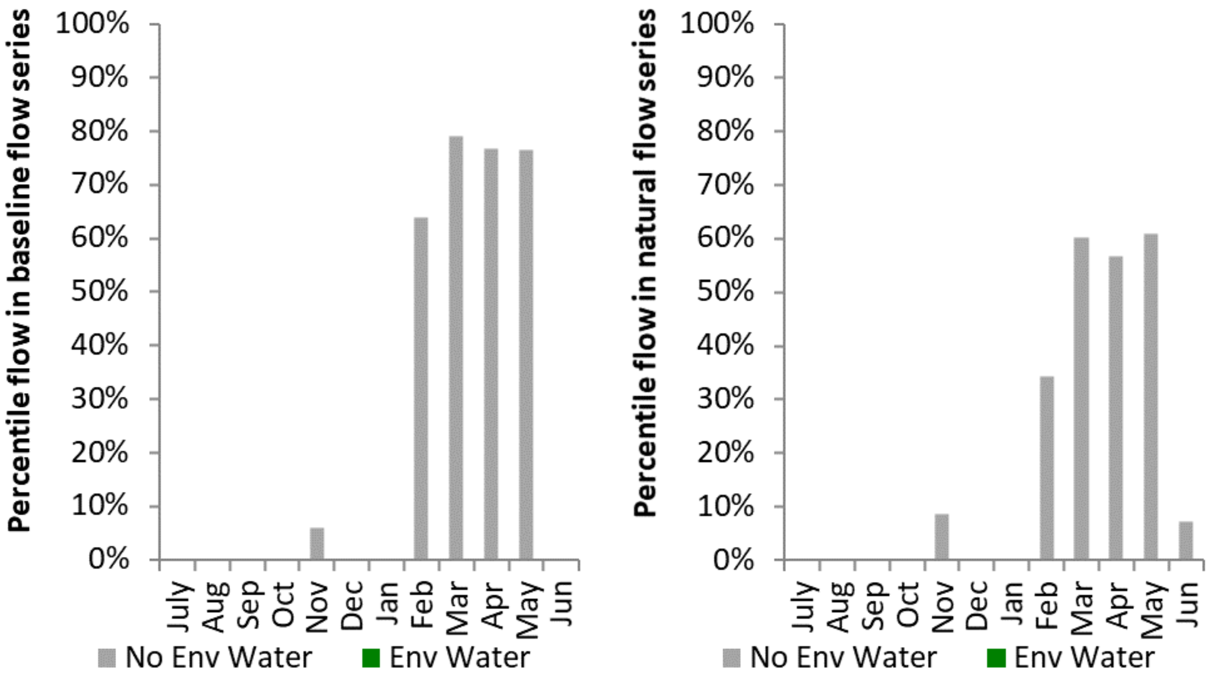


Figure BDL11: Contribution of environmental water delivery at Bourke as percentiles in the natural and baseline flow series.

8.5.6 Louth

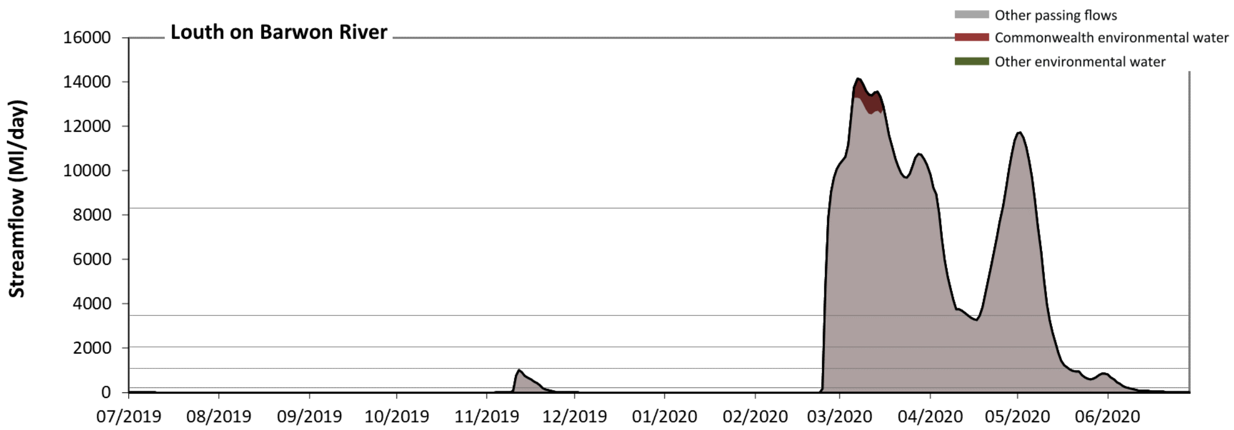


Figure BDL12: Contribution of environmental water delivery at Louth. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Louth on Barwon River environmental water contributed 1% of the total streamflow volume (all of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 12% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 220 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these very low flows, which occurred for 69% of the year. Similarly, without environmental water, the durations of low flows (i.e. < 1100 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these low flows, which occurred for 77% of the year. There was at least one low fresh (i.e. > 2000 ML/day) in the periods January to March and April to June. Environmental water made no change to the duration of these low freshes. There was at least one medium fresh (i.e. > 3500 ML/day) in the periods January to March and April to June. Environmental water made no change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the periods January to March and April to June. Environmental water made no change to the duration of these high freshes.

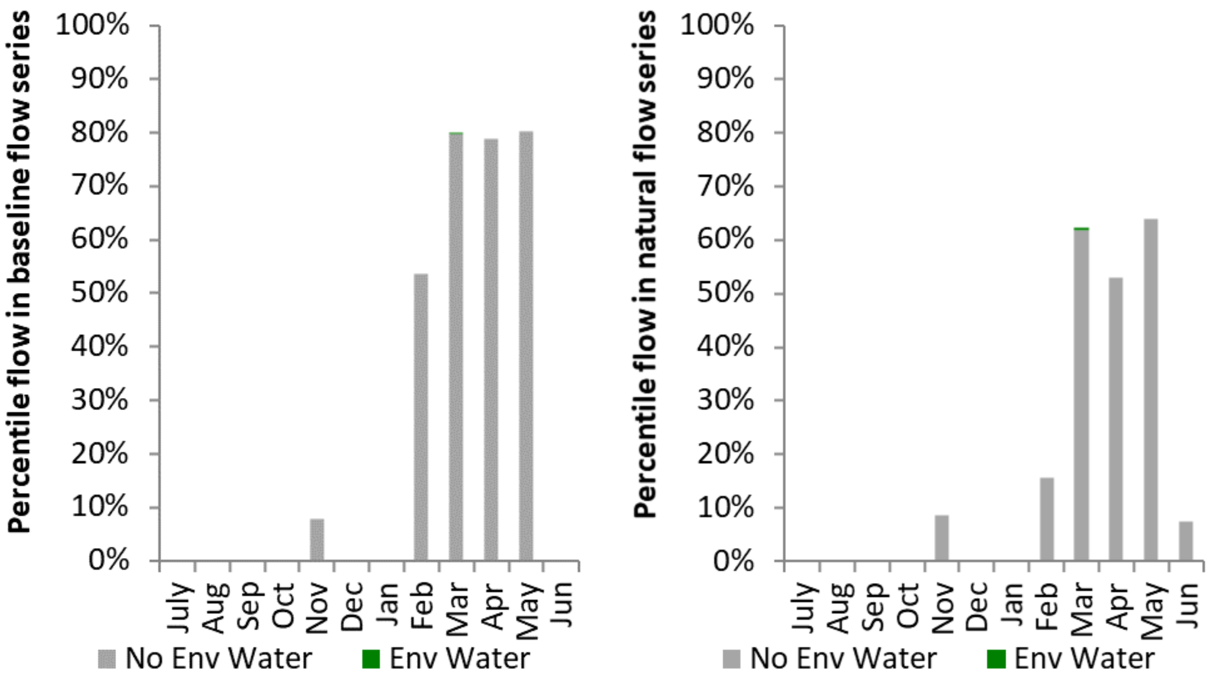


Figure BDL13: Contribution of environmental water delivery at Louth as percentiles in the natural and baseline flow series.

8.5.7 Wilcannia

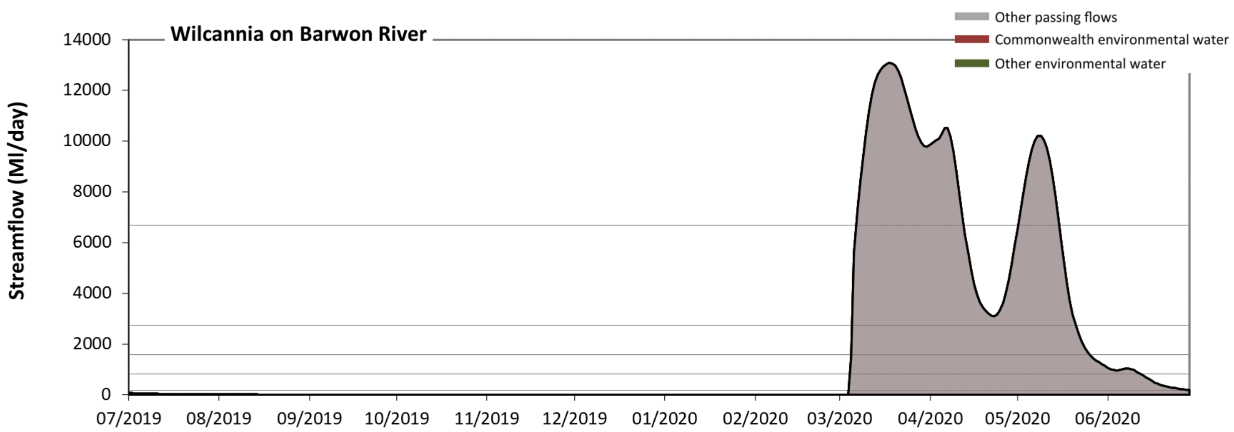


Figure BDL14: Contribution of environmental water delivery at Wilcannia. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

There was no environmental water delivered at Wilcannia on Barwon River. Without environmental water, the durations of very low flows (i.e. < 160 ML/day) in the periods July to September, October to December and January to March was substantially in excess of durations expected in an average year in the natural flow regime. Similarly, without environmental water, the durations of low flows (i.e. < 810 ML/day) in the periods July to September, October to December and January to March was substantially in excess of durations expected in an average year in the natural flow regime. There was at least one low fresh (i.e. > 1600 ML/day) in the periods January to March and April to June. There was at least one medium fresh (i.e. > 2700 ML/day) in the periods January to March and April to June. In the absence of environmental water there was at least one high fresh in the periods January to March and April to June.

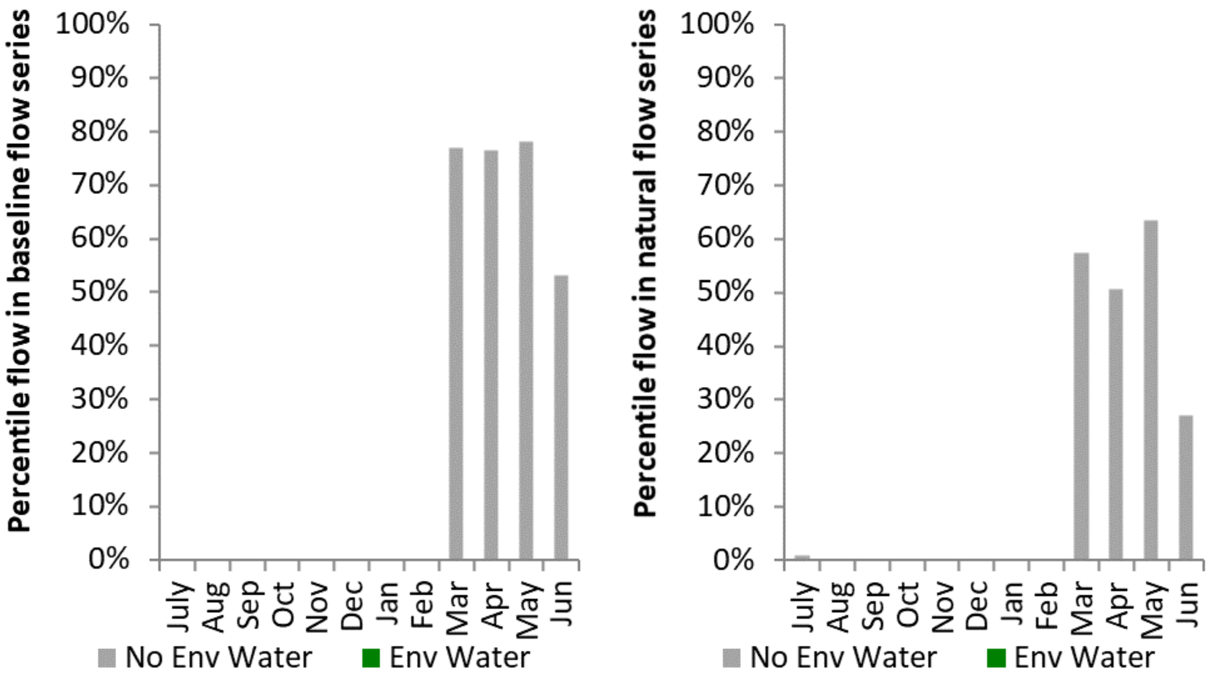


Figure BDL15: Contribution of environmental water delivery at Wilcannia as percentiles in the natural and baseline flow series.

9 Macquarie Valley

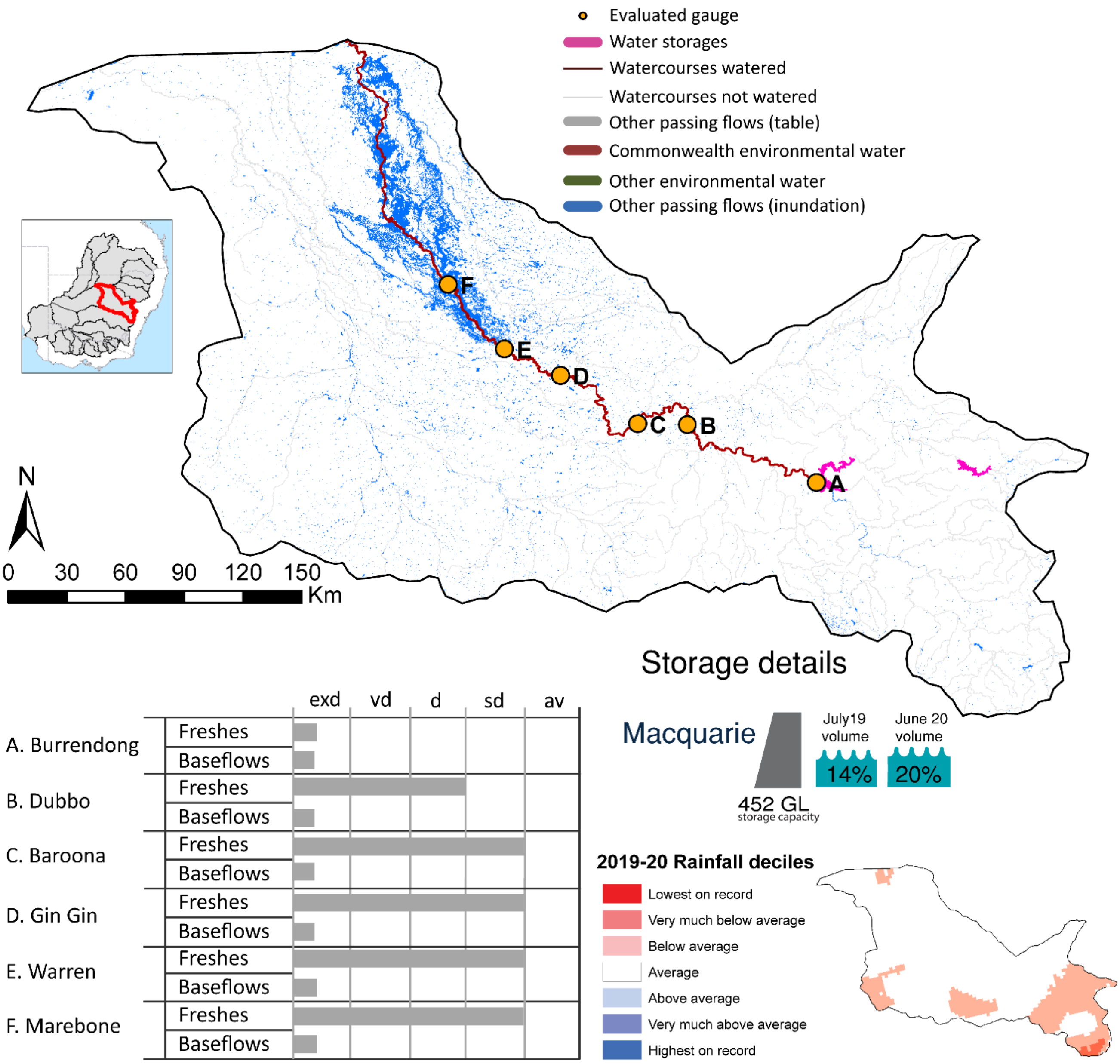


Figure MCQ1: Watercourses influenced, areas inundated (where applicable) and gauge stations evaluated in the Macquarie valley during the 2019–20 water year. Inset bar graphs report the condition of annual flow regimes by showing the improvements in hydrological condition with the addition of environmental water as well as the hypothetical scenario in 'grey' (if no environmental flow had been delivered). Rainfall conditions (rainfall deciles) and trend in storage levels for the water year are also shown. The classified bands are: exd = extremely dry, vd=very dry, sd=somewhat dry and av=average.

9.1 Summary

The volume of environmental water delivery for the 2019–20 year in the Macquarie valley is quantified using data for 6 sites. This evaluation only considers the contribution of held environmental water, which is a primary focus for the Commonwealth. The contributions of planned environmental water (e.g. passing flows), unregulated tributary inflows and clever use of irrigation flows for environmental benefits can all be very important but these are outside the scope of this report. Environmental watering actions lasted on average 8 days over the course of the year. The volume of environmental water at these 6 sites was between 0% and 3% of the total streamflow. Commonwealth environmental water contributed on average 46% of this environmental water. The contribution of environmental water delivery to improved flow regimes is evaluated using data for 6 sites. Ideally, baseflows should be maintained and long periods of excessively low flows avoided. In this valley, the baseflow regime was generally considered to be extremely dry relative to the pre-development flow regime. In our analysis, a low fresh refers to a period of increased flow, when the water level rises at least one eighth of the way up the river bank (above the low flow level). These low freshes are a regular part of the natural flow regime and support a range of natural processes. In the Macquarie valley, in terms of the occurrence and duration of low freshes, the year was assessed as being dry. In our analysis, a medium fresh refers to a period of increased flow, when the water level rises at least one quarter of the way up the river bank. These medium freshes are not as frequent as low freshes but are also a regular and important part of the natural flow regime. In the Macquarie valley, in terms of the occurrence of medium freshes, the year was assessed as being average. In our analysis, a high fresh refers to a period of increased flow, when the water level rises more than half way up the river. A high fresh may not occur every year but they are still important and long periods without major freshes can have serious consequences for floodplains and their contribution to river ecosystem health. Delivering environmental high in channel flows normally requires that all risks to riparian landholders and infrastructure have been resolved. In the Macquarie valley, in terms of the occurrence of high freshes, the year was assessed as being average.

9.2 Water delivery context

During the 2019–20 water year, the Commonwealth Environmental Water Holder (CEWH) held water entitlements of up to 134,516 ML (includes: 126, 224 ML of General security and 8,292 ML of Supplementary) for environmental use in the Macquarie valley. Each year, water utilities allocate water entitlement holders a percentage of water based on their holding, licence type and carryover (the exact rules vary among Jurisdictions and licence type). In 2019–20, the Macquarie general security entitlements held by the CEWH were allocated 0 ML of water, representing 0% of the Long term average annual yield for the Macquarie valley (70,008 ML). The Commonwealth also holds supplementary licences in the Macquarie, which are triggered when in-channel flows meet criteria set by the water utility. In this valley, the CEWH held 9,292.4 ML which was 100% of supplementary entitled water. Information and data relating to the portfolio of held Commonwealth environmental water is shown in Table MCQ1.

The 2019–20 water allocation (0 ML) together with the carryover volume of 22,663 ML of water meant the CEWH had 22,663 ML of water available for delivery. However, due to the extreme drought water was held in quarantine and was not available for use. A total of 3,895 ML of Commonwealth environmental water was delivered in the Macquarie valley (all of which was sourced from supplementary entitlements). A total of 22,663 ML (100%) of available Commonwealth environmental water was carried over for environmental use into the 2020–21 water year.

9.3 Environmental conditions and resource availability

The water available for environmental delivery combined with the present and antecedent environmental conditions are key inputs used by environmental water managers in planning and implementing watering actions. *Post hoc*, this information provides important context when evaluating the effectiveness and appropriateness of environmental water use with respect to hydrological outputs.

The rainfall conditions in the Macquarie valley were classified as average, based on rainfall percentile data for the entire record held by the Bureau of Meteorology for this valley. The water held in major storages in the Macquarie valley decreased over the water year, for example Burrendong dam was 13.7% full at the beginning of the water year and 19.7% full by the end of the year (Figure MCQ1).

The CEWO calculates resource availability scenarios (RAS) to guide the use and prioritisation of held environmental water. The RAS are progressively calculated over the year as part of the continual adaptive management planning processes. The RAS are based on the availability of held environmental water (including progressive licence acquisitions and allocations) as well as the potential for unregulated or planned environmental flows. The outcome is then used to determine the demand for environmental water across the Basin.

In 2019–20, the resource availability of held Commonwealth environmental water in the Macquarie was classified as very low to low, whilst the overall demand for environmental water was classified as critical to high. The physical conditions meant that the CEWO was managing to avoid damage through the provision of critical refuge habitat at key sites and protect or maintain the condition of environmental assets.

9.4 Watering actions

A total of 3 watering actions were delivered over the 2019–20 water year, the duration of these actions varied (range of individual actions: 3 days) and Commonwealth environmental water was delivered for a total of 9 days. The number of water actions commencing in each season included, summer (1), autumn (2), winter (0), spring (0). Similarly, the count of flow component types delivered in the Macquarie valley were; (0) baseflow, (0) baseflow-fresh, (0) baseflow-fresh-bankfull, (0) baseflow-fresh-overbank-wetland, (0) fresh, (3) fresh-wetland, (0) bankfull, (0) overbank, (0) wetland and (0) wetland-overbank.

In the Macquarie, watering actions were delivered for resilience, connectivity, fish, vegetation and waterbirds purposes, but water was also delivered for other purposes too. The percentage of watering actions delivered across the nine main themes included fish (20%), vegetation (20%), waterbirds (20%), frogs (0.0%), other biota (0.0%), connectivity (20%), process (0.0%), resilience (20%) and water quality (0.0%).

Table MCQ1. Commonwealth environmental water accounting information for the Macquarie valley over 2019–20 water year.

Total registered volume (ML)	Allocated volume (ML)	Carry over + allocated volume (ML)	Delivered (ML)	LTAAY (ML)	Carried over to 2020–21
134,516	0	22,663	0	70,008	22,663

9.5 Contribution of Commonwealth environmental water to flow regimes

9.5.1 Burrendong

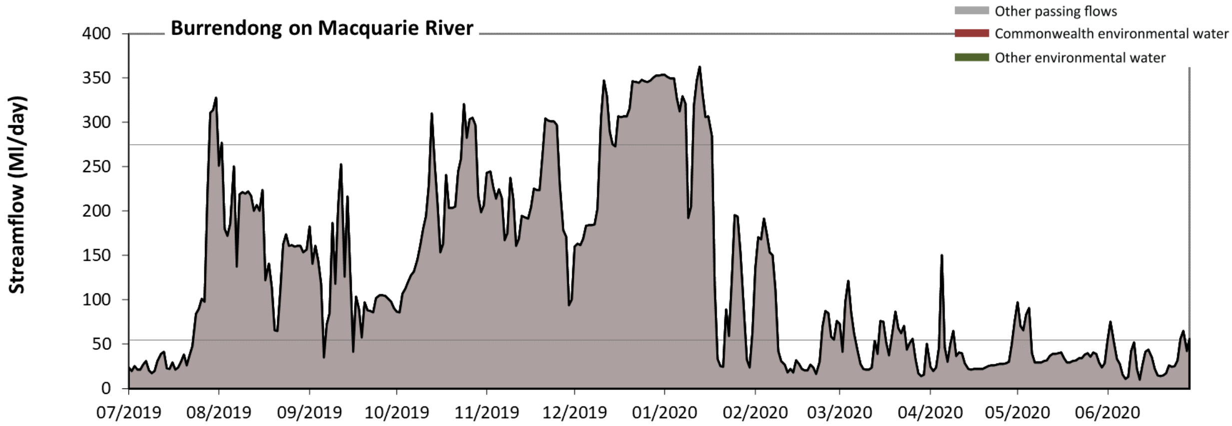


Figure MCQ2: Contribution of environmental water delivery at Burrendong. Horizontal lines indicate thresholds for very low flows and low flows (from lowest to highest).

There was no environmental water delivered at Burrendong on Macquarie River as carry-over water was not available to use. Without environmental water, the durations of very low flows (i.e. < 55 ML/day) in the periods July to September, January to March and April to June were substantially in excess of durations expected in an average year in the natural flow regime. Similarly, without environmental water, the durations of low flows (i.e. < 270 ML/day) in the periods July to September, October to December, January to March and April to June were substantially in excess of durations expected in an average year in the natural flow regime.

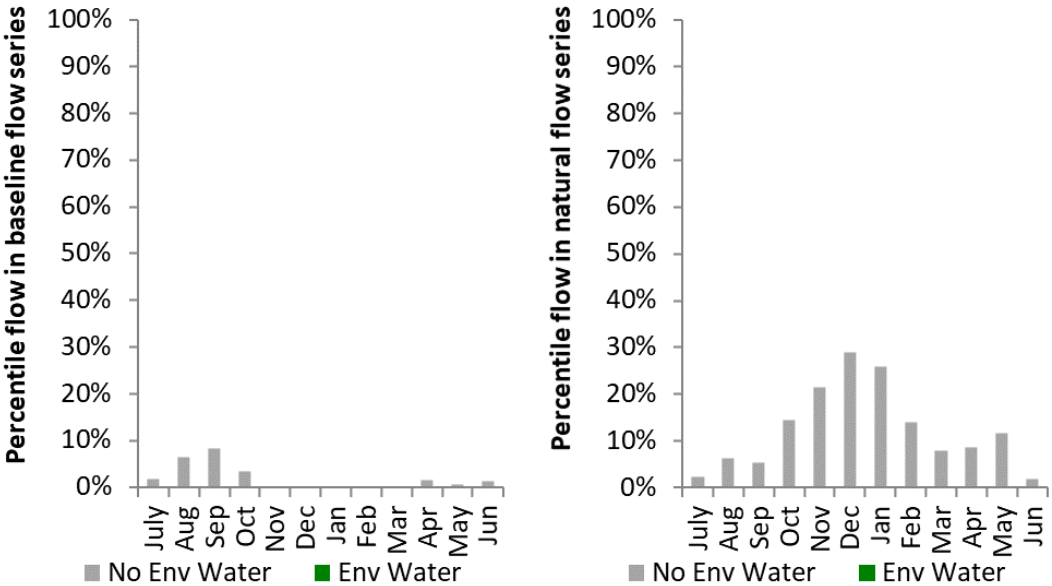


Figure MCQ3: Contribution of environmental water delivery at Burrendong as percentiles in the natural and baseline flow series.

9.5.2 Dubbo

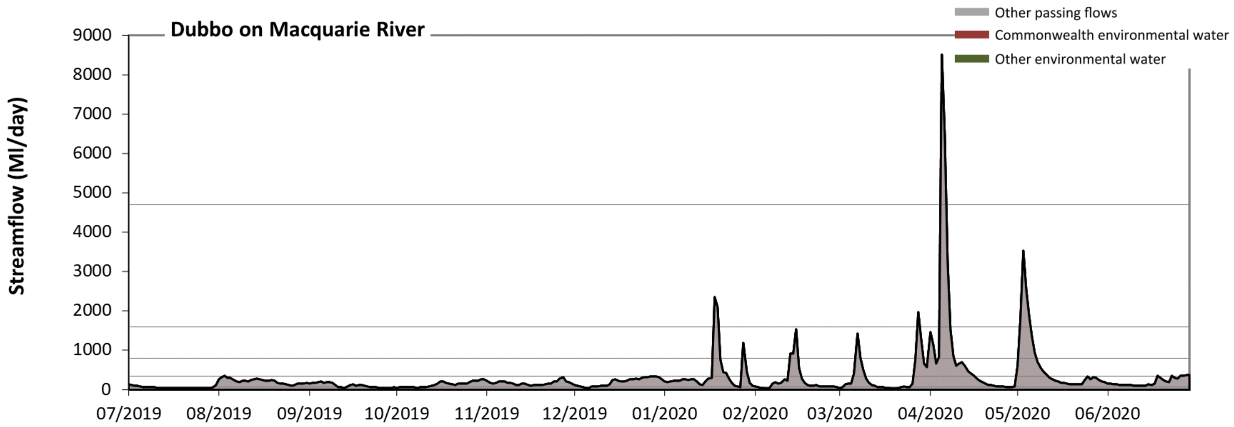


Figure MCQ4: Contribution of environmental water delivery at Dubbo. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

There was no environmental water delivered at Dubbo on Macquarie River. Without environmental water, the durations of very low flows (i.e. < 68 ML/day) in the periods July to September, October to December and January to March was substantially in excess of durations expected in an average year in the natural flow regime. Similarly, without environmental water, the durations of low flows (i.e. < 340 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. There was at least one low fresh (i.e. > 800 ML/day) in the periods January to March and April to June. There was at least one medium fresh (i.e. > 1600 ML/day) in the periods January to March and April to June. In the absence of environmental water there was at least one high fresh in the period April to June.

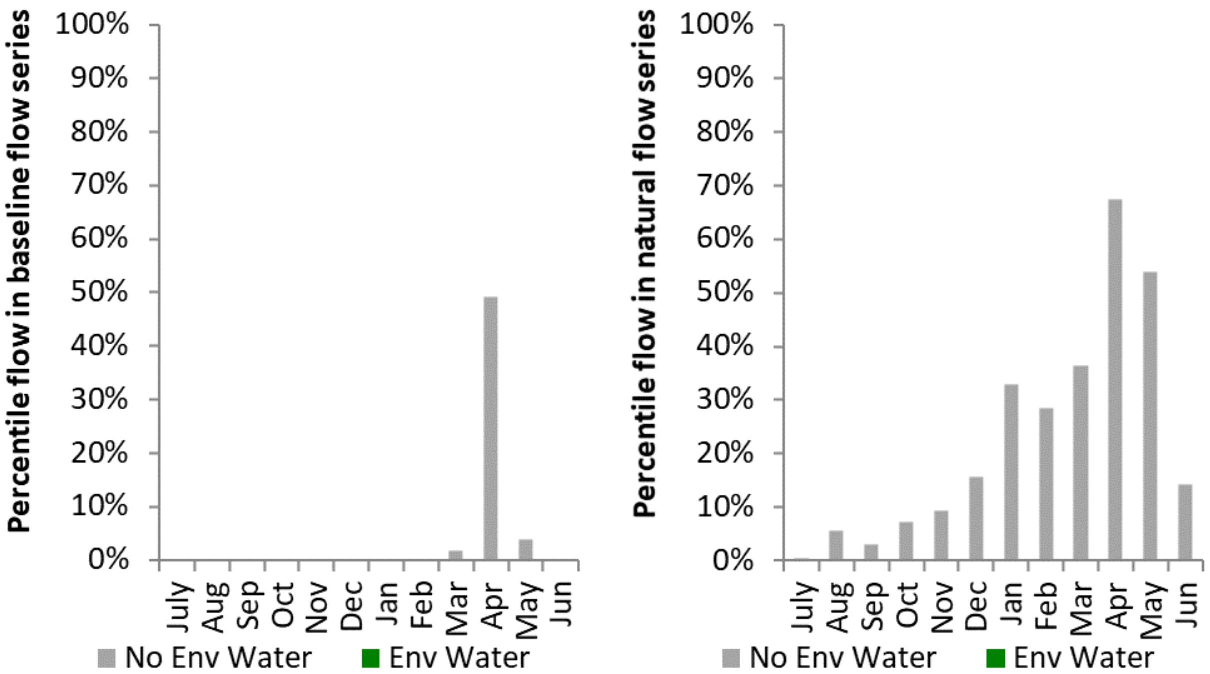


Figure MCQ5: Contribution of environmental water delivery at Dubbo as percentiles in the natural and baseline flow series.

9.5.3 Baroona

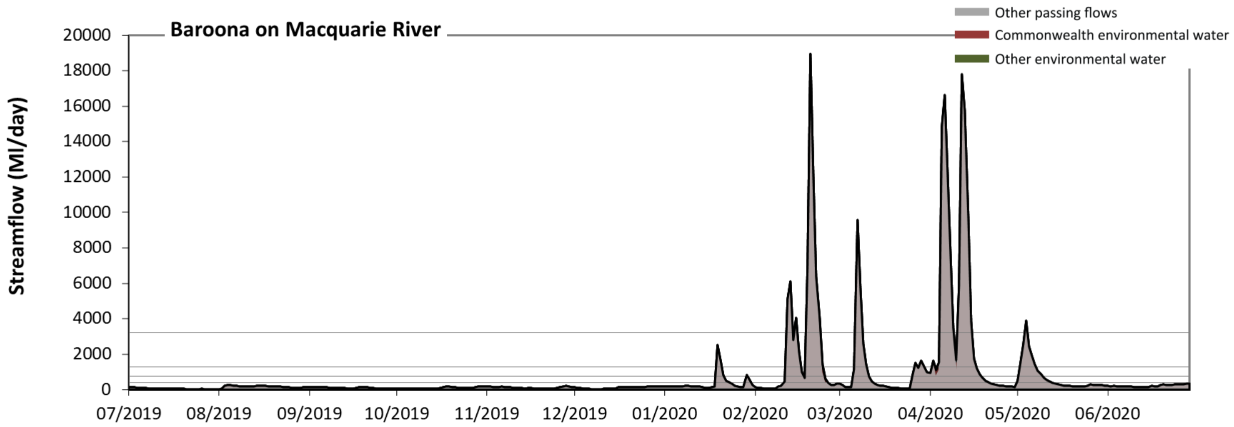


Figure MCQ6: Contribution of environmental water delivery at Baroona. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Baroona on Macquarie River environmental water contributed 2% of the total streamflow volume (most of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 3% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 77 ML/day) in the periods July to September and October to December would have substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these very low flows, which occurred for 22% of the year. Similarly, without environmental water, the durations of low flows (i.e. < 390 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these low flows, which occurred for 81% of the year. There was at least one low fresh (i.e. > 740 ML/day) in the periods January to March and April to June. Environmental water made little change to the duration of these low freshes. In the absence of environmental water there would have been at least one medium fresh (i.e. > 1300 ML/day) in the periods January to March and April to June. Environmental water increased the duration of the longest medium fresh during the period April to June (from 6 days to 13 days). Commonwealth environmental water was entirely responsible for these increased durations of medium freshes. In the absence of environmental water there would have been at least one high fresh in the periods January to March and April to June. Environmental water made no change to the duration of these high freshes.

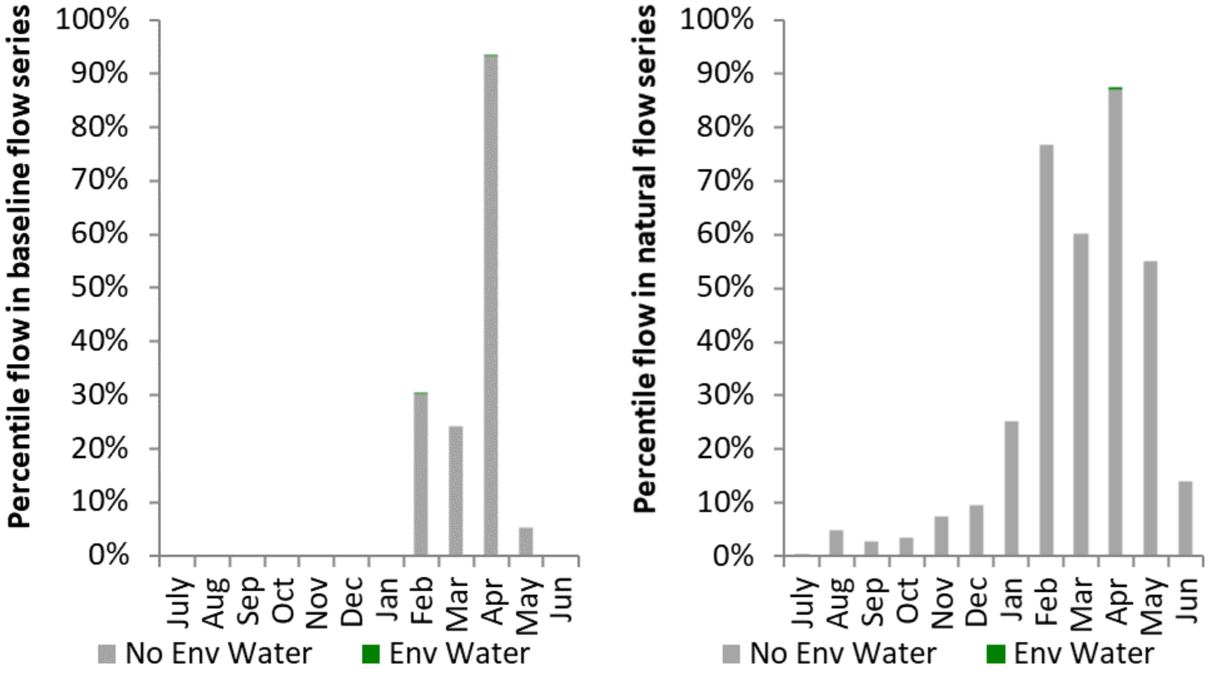


Figure MCQ7: Contribution of environmental water delivery at Baroona as percentiles in the natural and baseline flow series.

9.5.4 Gin Gin

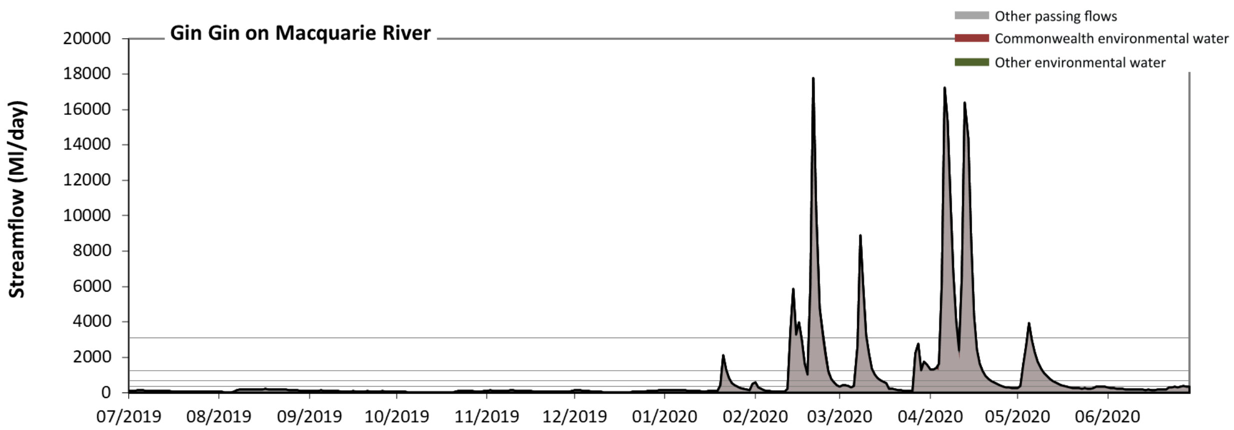


Figure MCQ8: Contribution of environmental water delivery at Gin. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Gin Gin on Macquarie River environmental water contributed 2% of the total streamflow volume (most of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 3% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 69 ML/day) in the periods July to September and October to December would have substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these very low flows, which occurred for 23% of the year. Similarly, without environmental water, the durations of low flows (i.e. < 350 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these low flows, which occurred for 75% of the year. There was at least one low fresh (i.e. > 690 ML/day) in the periods January to March and April to June. Environmental water made little change to the duration of these low freshes. There was at least one medium fresh (i.e. > 1200 ML/day) in the periods January to March and April to June. Environmental water made little change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the periods January to March and April to June. Environmental water made little change to the duration of these high freshes. Commonwealth environmental water made little or no contribution to these increased durations of high freshes.

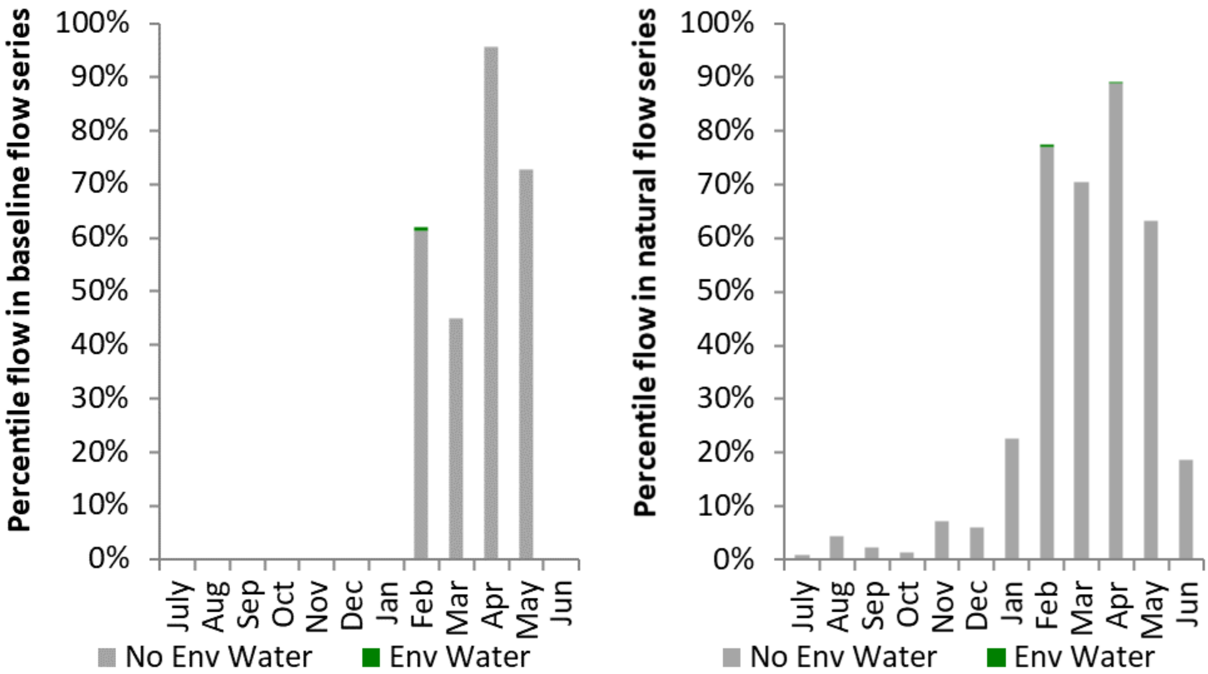


Figure MCQ9: Contribution of environmental water delivery at Gin as percentiles in the natural and baseline flow series.

9.5.5 Warren

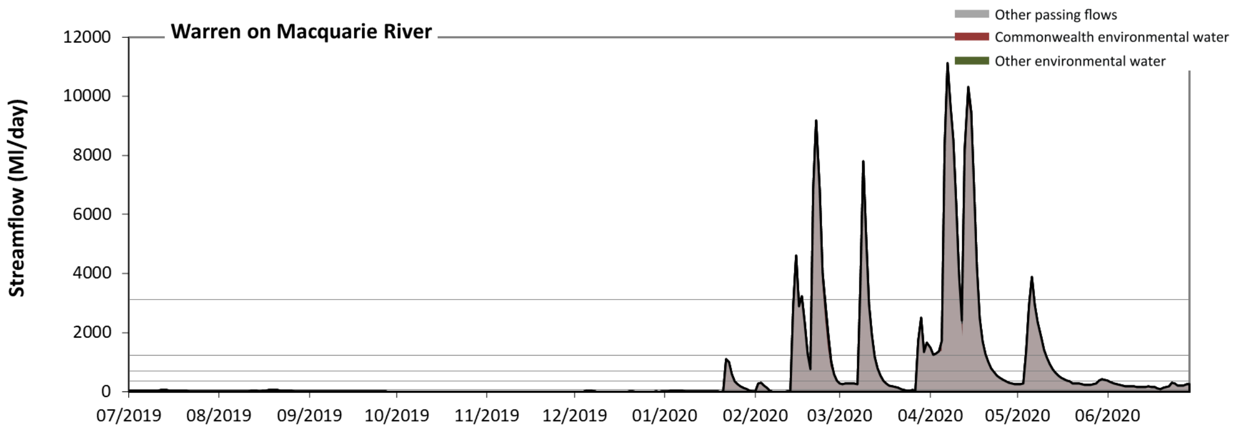


Figure MCQ10: Contribution of environmental water delivery at Warren. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Warren on Macquarie River environmental water contributed 2% of the total streamflow volume (most of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 3% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 69 ML/day) in the periods July to September, October to December and January to March would have substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these very low flows, which occurred for

61% of the year. Similarly, without environmental water, the durations of low flows (i.e. < 350 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these low flows, which occurred for 79% of the year. There was at least one low fresh (i.e. > 690 ML/day) in the periods January to March and April to June. Environmental water made no change to the duration of these low freshes. There was at least one medium fresh (i.e. > 1200 ML/day) in the periods January to March and April to June. Environmental water made no change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the periods January to March and April to June. Environmental water made no change to the duration of these high freshes.

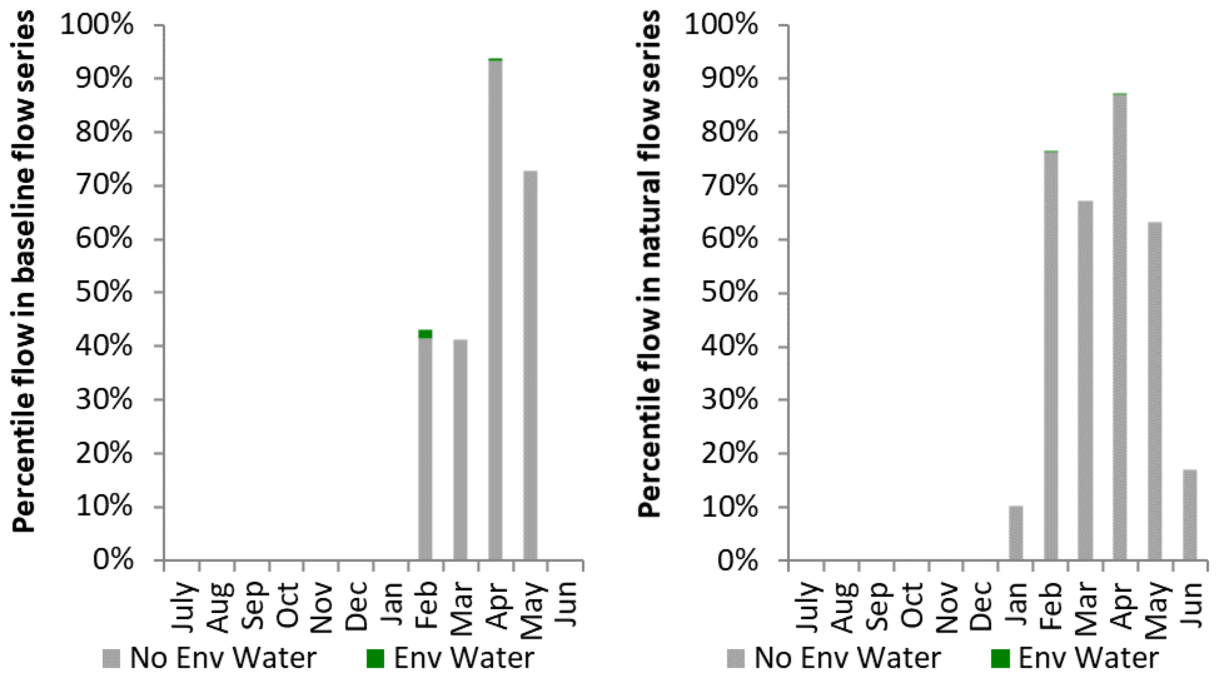


Figure MCQ11: Contribution of environmental water delivery at Warren as percentiles in the natural and baseline flow series.

9.5.6 Marebone

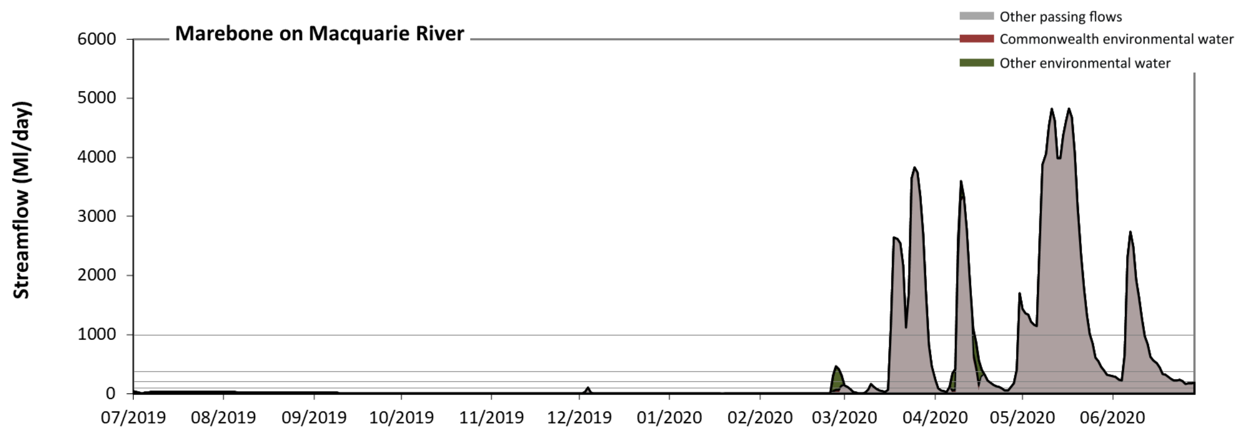


Figure MCQ12: Contribution of environmental water delivery at Marebone. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Marebone on Macquarie River environmental water contributed 3% of the total streamflow volume (with a relatively small contribution of Commonwealth environmental water). Environmental watering actions affected streamflows for 3% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 20 ML/day) in the periods July to September, October to December and January to March would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 54% to 53% of the year, with greatest influence in the periods January to March and April to June. Similarly, without environmental water, the durations of low flows (i.e. < 98 ML/day) in the periods July to September, October to December and January to March would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 73% to 71% of the year, with greatest influence in the periods January to March and April to June. There was at least one low fresh (i.e. > 200 ML/day) in the periods January to March and April to June. Environmental water made no change to the duration of these low freshes. There was at least one medium fresh (i.e. > 380 ML/day) in the periods January to March and April to June. Environmental water made no change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the periods January to March and April to June. Environmental water made no change to the duration of these high freshes.

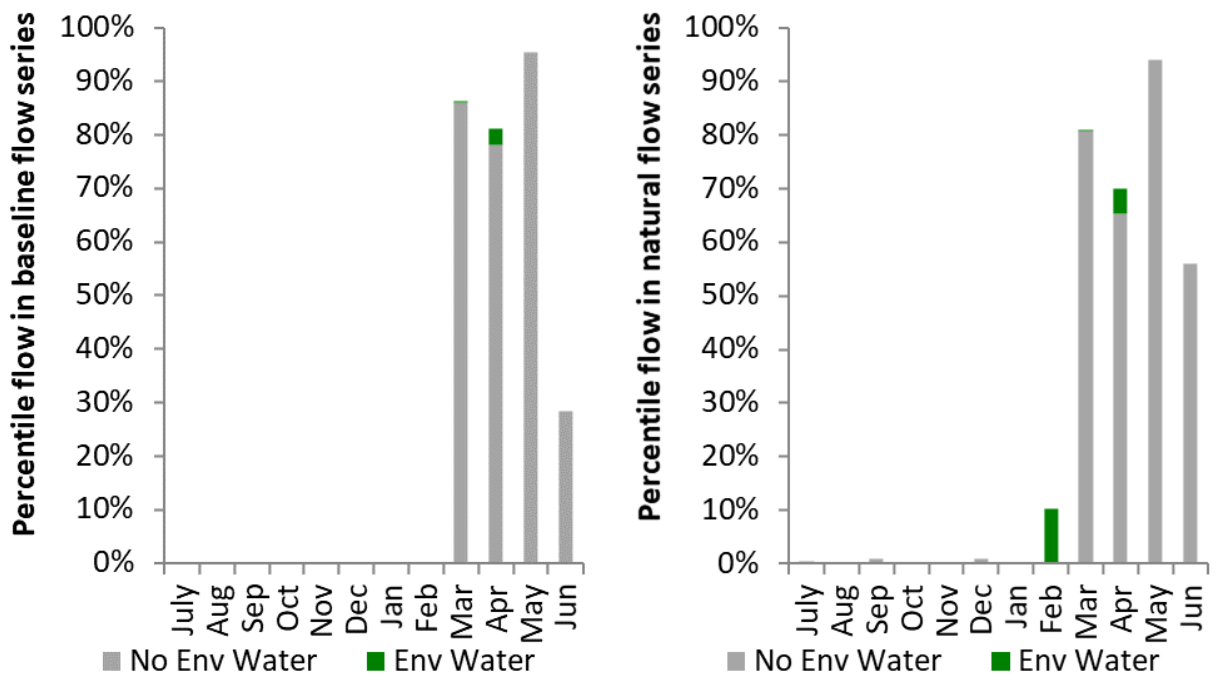


Figure MCQ13: Contribution of environmental water delivery at Marebone as percentiles in the natural and baseline flow series.

10 Loddon Valley

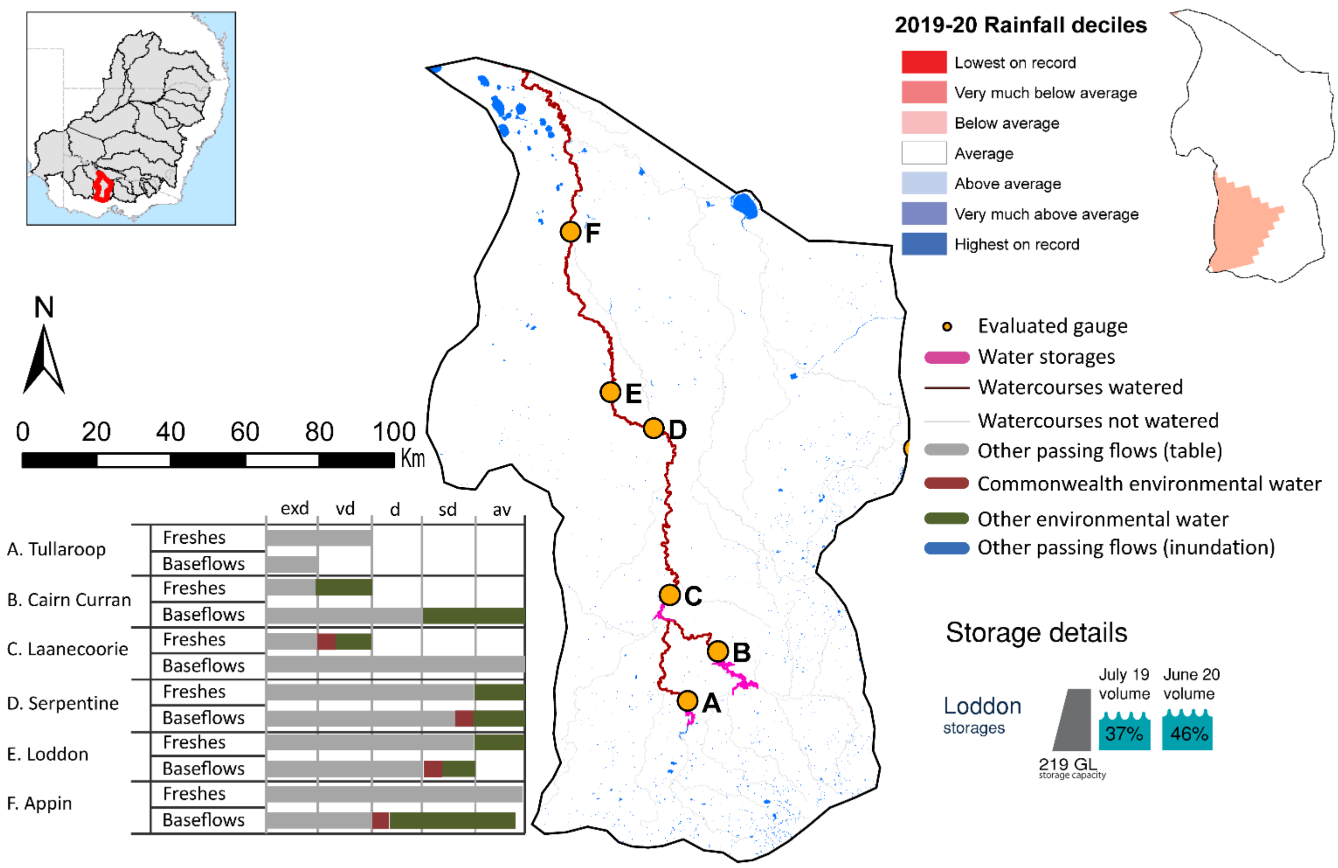


Figure LOD1: Watercourses influenced, areas inundated (where applicable) and gauge stations evaluated in the Loddon valley during the 2019–20 water year. Inset bar graphs report the condition of annual flow regimes by showing the improvements in hydrological condition with the addition of environmental water as well as the hypothetical scenario in 'grey' (if no environmental flow had been delivered). Rainfall conditions (rainfall deciles) and trend in storage levels for the water year are also shown. The classified bands are: exd = extremely dry, vd=very dry, sd=somewhat dry and av=average.

10.1 Summary

The volume of environmental water delivery for the 2019–20 year in the Loddon valley is quantified using data for 6 sites. This evaluation only considers the contribution of held environmental water, which is a primary focus for the Commonwealth. The contributions of planned environmental water (e.g. passing flows), unregulated tributary inflows and clever use of irrigation flows for environmental benefits can all be very important but these are outside the scope of this report. Environmental watering actions lasted on average 155 days over the course of the year. The volume of environmental water at these 6 sites was between 17% and 24% of the total streamflow. Commonwealth environmental water contributed on average 9% of this environmental water. The contribution of environmental water delivery to improved flow regimes is evaluated using data for 6 sites. Ideally, baseflows should be maintained and long periods of excessively low flows avoided. In this valley, the baseflow regime was generally considered to be somewhat dry relative to the pre-development flow regime. In our analysis, a low fresh refers to a period of increased flow, when the water level rises at least one eighth of the way up the river bank (above the low flow level). These low freshes are a regular part of the natural flow regime and support a range of natural processes. In the Loddon valley, in terms of the occurrence and duration of low freshes, the year was assessed as being average. In our analysis, a medium fresh refers to a period of increased flow, when the water level rises at least one quarter of the way up the river bank. These medium freshes are not as frequent as low freshes but are also a regular and important part of the natural flow regime. In the Loddon valley, in terms of the occurrence of medium freshes, the year was assessed as being somewhat dry. In our analysis, a high fresh refers to a period of increased flow, when the water level rises more than half way up the river. A high fresh may not occur every year but they are still important and long periods without major freshes can have serious consequences for floodplains and their contribution to river ecosystem health. Delivering environmental high in channel flows normally requires that all risks to riparian landholders and infrastructure have been resolved. In the Loddon valley, in terms of the occurrence of high freshes, the year was assessed as being dry.

10.2 Water delivery context

During the 2019–20 water year, the Commonwealth Environmental Water Holder (CEWH) held water entitlements of up to 3,883 ML for environmental use in the Loddon valley. Each year, water utilities allocate water entitlement holders a percentage of water based on their holding, licence type and carryover (the exact rules vary among Jurisdictions and licence type). In 2019–20, the Loddon entitlements held by the CEWH were allocated 2,672 ML of water, representing 126% of the Long term average annual yield for the Loddon valley (2,121 ML). Information and data relating to the portfolio of held Commonwealth environmental water is shown in Table LOD1.

The 2019–20 water allocation (2,672 ML) together with the carryover volume of 684 ML of water meant the CEWH had 3,356 ML of water available for delivery (of the 3,883 ML entitlement). A total of 3,356 ML of Commonwealth environmental water was delivered in the Loddon valley. No Commonwealth environmental water was carried over to the 2020–21 water year.

10.3 Environmental conditions and resource availability

The water available for environmental delivery combined with the present and antecedent environmental conditions are key inputs used by environmental water managers in planning and implementing watering actions. *Post hoc*, this information provides important context when evaluating the effectiveness and appropriateness of environmental water use with respect to hydrological outputs.

The rainfall conditions in the Loddon valley were classified as average, based on rainfall percentile data for the entire record held by the Bureau of Meteorology for this valley. The water held in major storages in the Loddon valley decreased over the water year, for example Cairn Curran and Tullaroop dam was 38.6% full at the beginning of the water year and 46.4% full by the end of the year (Figure LOD1).

The CEWO calculates resource availability scenarios (RAS) to guide the use and prioritisation of held environmental water. The RAS are progressively calculated over the year as part of the continual adaptive management planning processes. The RAS are based on the availability of held environmental water (including progressive licence acquisitions and allocations) as well as the potential for unregulated or planned environmental flows. The outcome is then used to determine the demand for environmental water across the Basin.

In 2019–20, the resource availability of held Commonwealth environmental water in the Loddon was classified as low to high, whilst the overall demand for environmental water was classified as high to moderate. The physical conditions meant that the CEWO was managing to protect and improve the aquatic and riparian vegetation and native fish and other biota via habitat provision.

10.4 Watering actions

A total of 4 watering actions were delivered over the 2019–20 water year, the duration of these actions varied (range of individual actions: 4 - 7 days) and Commonwealth environmental water was delivered for a total of 19 days. The number of water actions commencing in each season included, summer (2), autumn (2), winter (0), spring (0). Similarly, the count of flow component types delivered in the Loddon valley were; (0) baseflow, (0) baseflow-fresh, (0) baseflow-fresh-bankfull, (0) baseflow-fresh-overbank-wetland, (4) fresh, (0) fresh-wetland, (0) bankfull, (0) overbank, (0) wetland and (0) wetland-overbank.

In the Loddon, watering actions were delivered for water quality, ecosystem processes, biota, fish and vegetation purposes, but water was also delivered for other purposes too. The percentage of watering actions delivered across the nine main themes included fish (14.29%), vegetation (28.57%), waterbirds (0.0%), frogs (0.0%), other biota (28.57%), connectivity (0.0%), process (14.29%), resilience (0.0%) and water quality (14.29%).

Table LOD1. Commonwealth environmental water accounting information for the Loddon valley over 2019–20 water year.

Total registered volume (ML)	Allocated volume (ML)	Carry over + allocated volume (ML)	Delivered (ML)	LTAAY (ML)	Carried over to 2020–21
3,883	2,672	3,356	1127	2,121	0

10.5 Contribution of Commonwealth environmental water to flow regimes

10.5.1 Cairn Curran

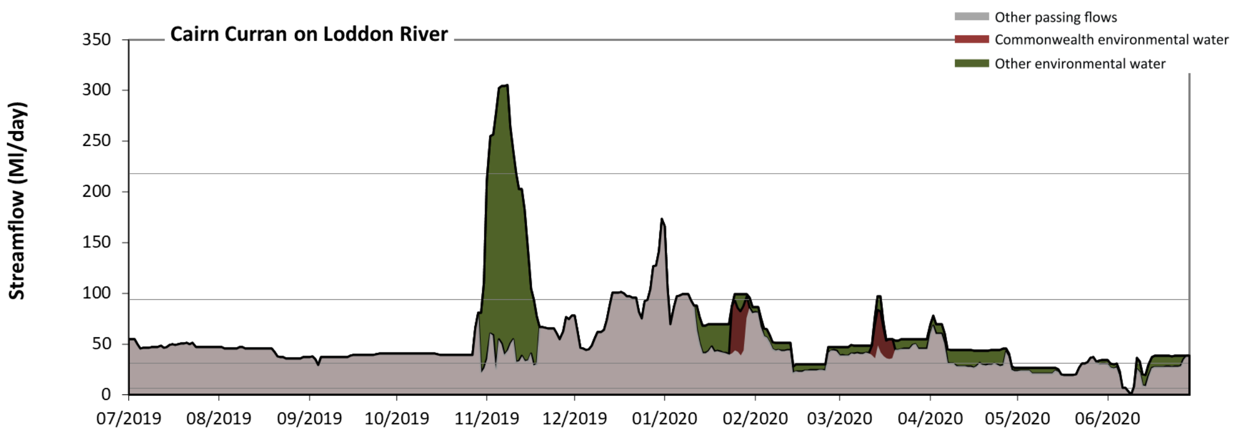


Figure LOD2: Contribution of environmental water delivery at Cairn Curran. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Cairn Curran on Loddon River environmental water contributed 24% of the total streamflow volume (with a relatively small contribution of Commonwealth environmental water). Environmental watering actions affected streamflows for 47% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 6.2 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the duration of low flows (i.e. < 31 ML/day) in the period April to June would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 25% to 14% of the year, with greatest influence in the period April to June.

Commonwealth environmental water made little or no contribution to these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 94 ML/day) in the periods October to December and January to March. Environmental water increased the duration of the longest low fresh during the period October to December (from 9 days to 17 days). Commonwealth environmental water made little or no contribution to these increased durations of low freshes. In the absence of environmental water there would have been no medium or high freshes this year. Environmental water increased the duration of the longest medium fresh during the period October to December (from 0 days to 10 days). Commonwealth environmental water made little or no contribution to these increased durations of medium freshes.

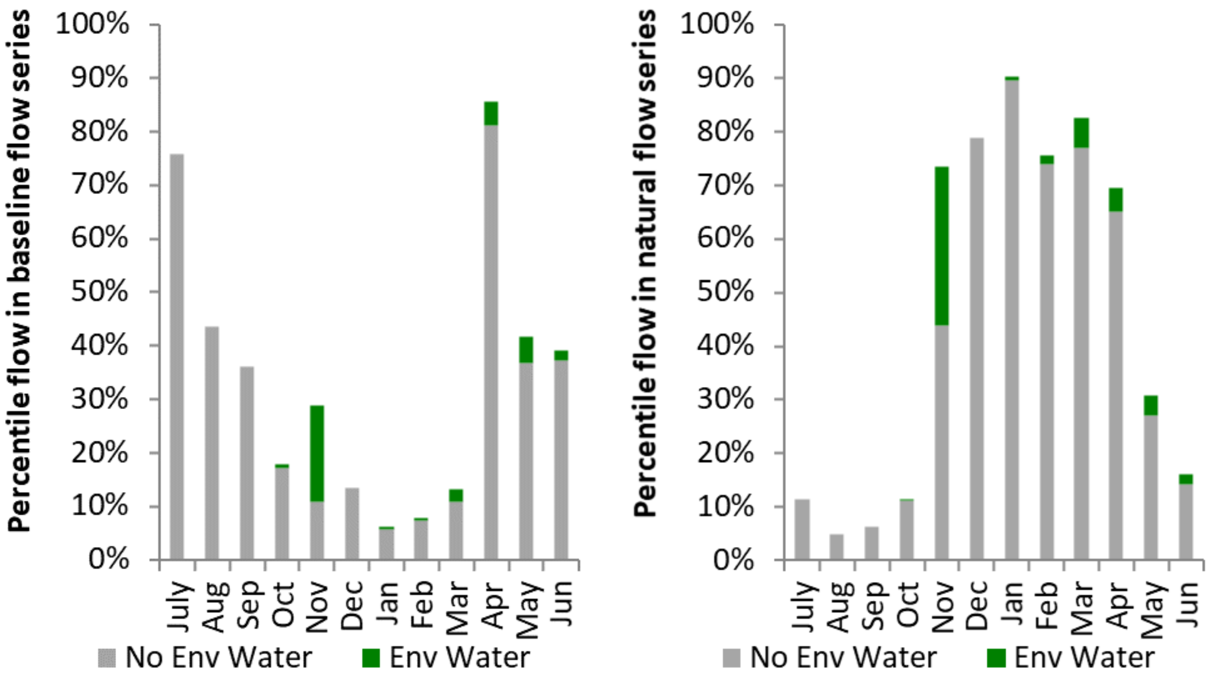


Figure LOD3: Contribution of environmental water delivery at Cairn Curran as percentiles in the natural and baseline flow series.

10.5.2 Tullaroop

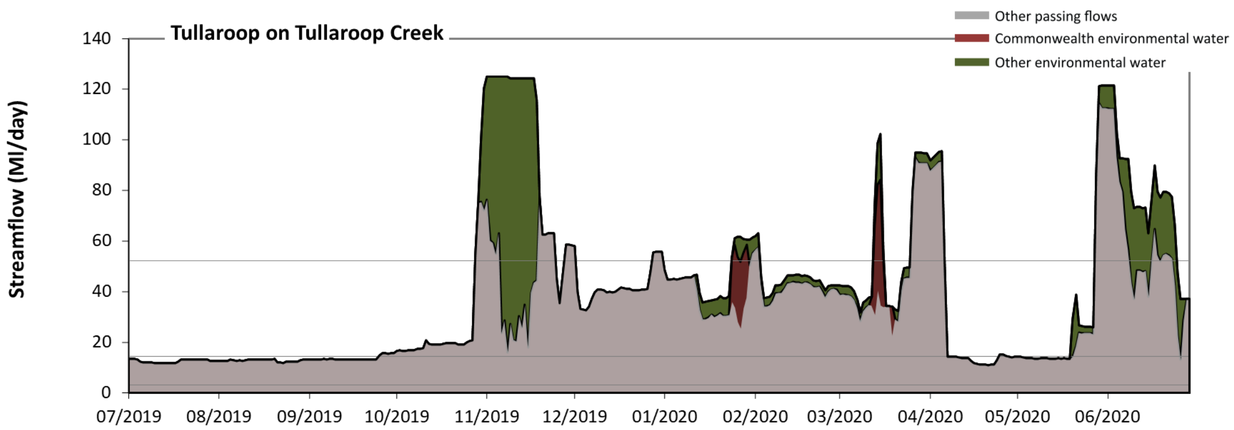


Figure LOD4: Contribution of environmental water delivery at Tullaroop. Horizontal lines indicate thresholds for very low flows, low flows and low freshes (from lowest to highest).

At Tullaroop on Tullaroop Creek environmental water contributed 20% of the total streamflow volume (with a relatively small contribution of Commonwealth environmental water). Environmental watering actions affected streamflows for 39% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 2.9 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the durations of low flows (i.e. < 14 ML/day) in the periods July to September and April to June would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 35% to 35% of the year, with greatest influence in the period April to June. In the absence of environmental water there would have been at least one low fresh (i.e. > 52 ML/day) in the periods October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the periods October to December (from 9 days to 28 days), January to March (from 5 days to 10 days) and April to June (from 12 days to 28 days). Commonwealth environmental water equally shared responsibility with other environmental water holders for these increased durations of low freshes. There was no medium or high freshes this year.

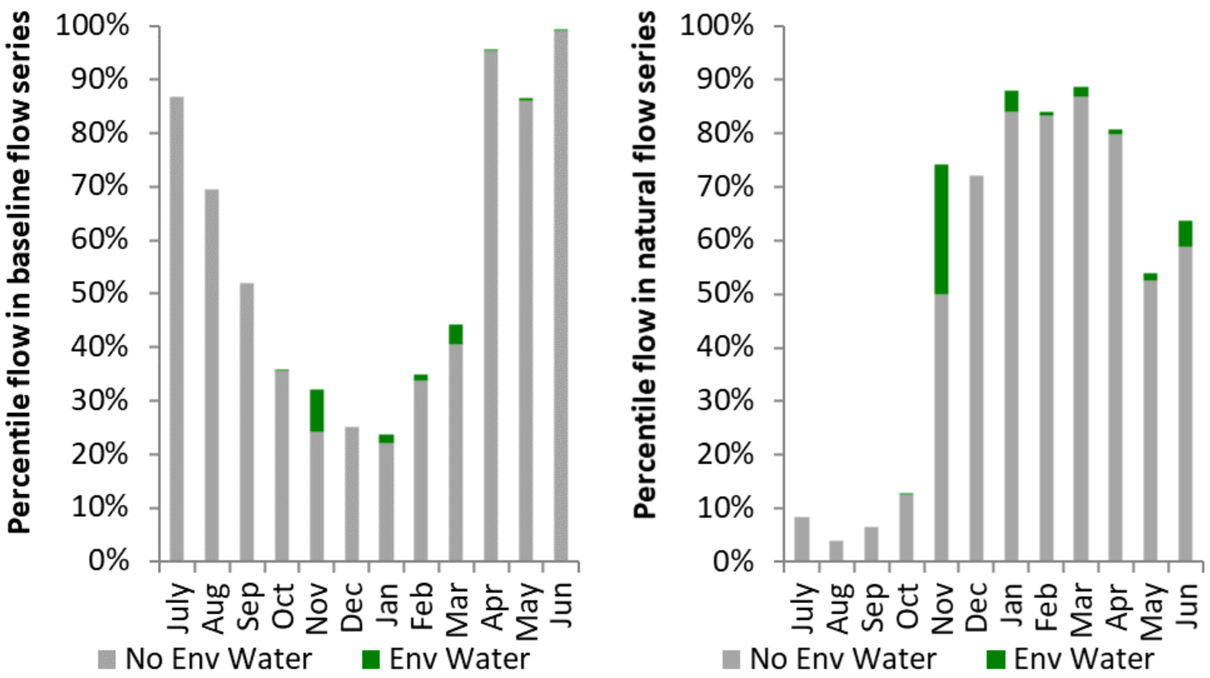


Figure LOD5: Contribution of environmental water delivery at Tullaroop as percentiles in the natural and baseline flow series.

10.5.3 Laanecoorie

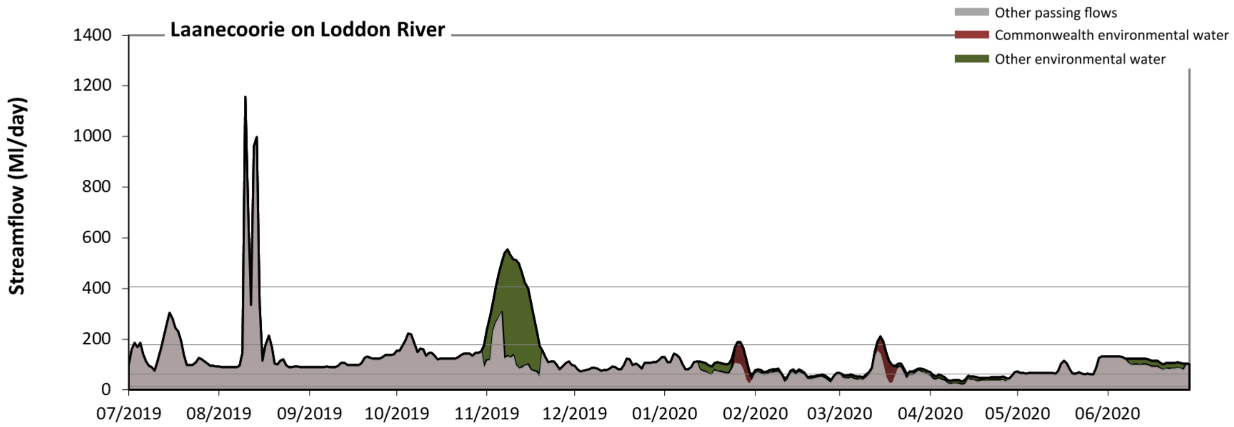


Figure LOD6: Contribution of environmental water delivery at Laanecoorie. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Laanecoorie on Loddon River environmental water contributed 17% of the total streamflow volume (with a relatively small contribution of Commonwealth environmental water). Environmental watering actions affected streamflows for 42% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 12 ML/day) compared to an average year in the natural flow regime. Flow regulation does not substantially increase the duration of low flows (i.e. < 60 ML/day) compared to an average year in the natural flow regime. Commonwealth environmental water made a modest contribution to these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 180 ML/day) in the periods July to September and October to December. Environmental water increased the duration of the longest low fresh during the periods October to December (from 4 days to 18 days) and January to March (from 0 days to 3 days). Commonwealth environmental water equally shared responsibility with other environmental water holders for these increased durations of low freshes. In the absence of environmental water there would have been at least one medium fresh (i.e. > 410 ML/day) in the period July to September. Environmental water increased the duration of the longest medium fresh during the period October to December (from 0 days to 11 days). Commonwealth environmental water made little or no contribution to these increased durations of medium freshes. There were no high freshes (i.e. > 1400 ML/day) this year.

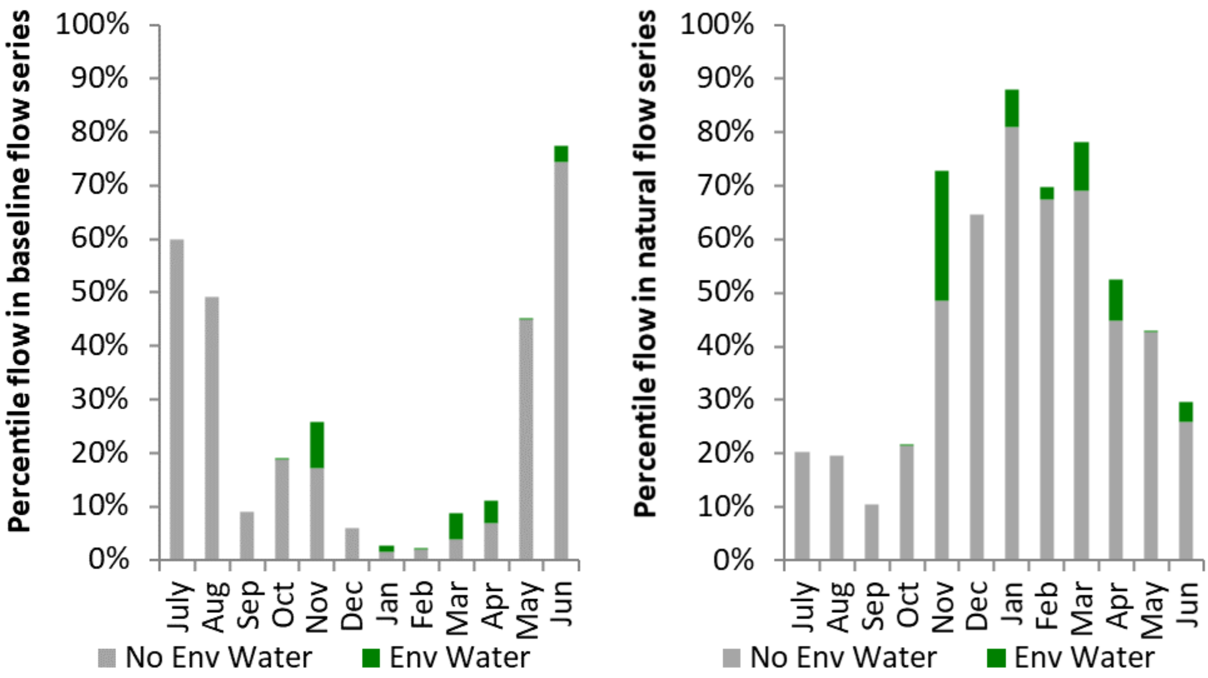


Figure LOD7: Contribution of environmental water delivery at Laanecoorie as percentiles in the natural and baseline flow series.

10.5.4 Serpentine

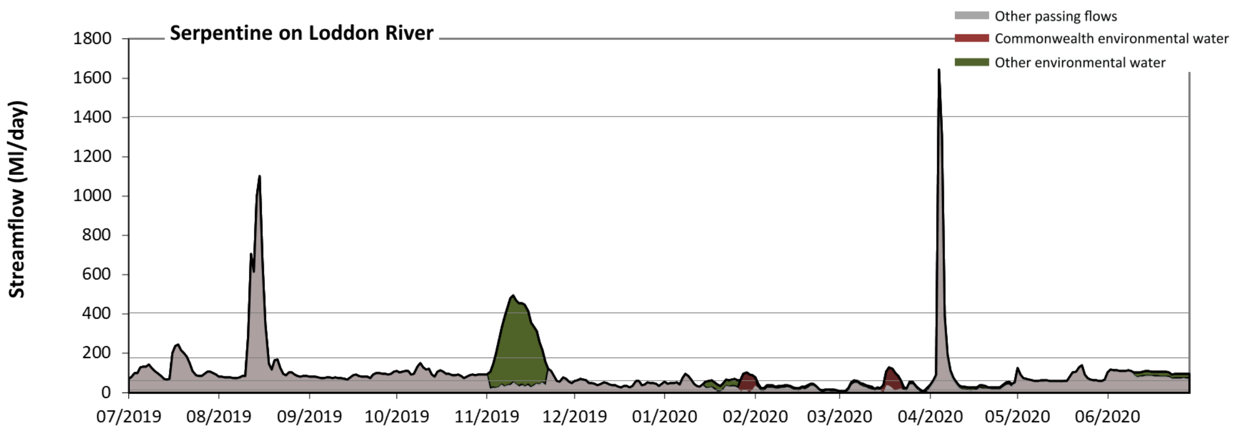


Figure LOD8: Contribution of environmental water delivery at Serpentine. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Serpentine on Loddon River environmental water contributed 22% of the total streamflow volume (with a relatively small contribution of Commonwealth environmental water). Environmental watering actions affected streamflows for 42% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 12 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the durations of low flows (i.e. < 60 ML/day) in the periods October to December and January to March would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 47% to 35% of the year, with greatest influence in the periods October to December and January to March. Commonwealth environmental water made a modest contribution to these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 180 ML/day) in the periods July to September and April to June. Environmental water increased the duration of the longest low fresh during the period October to December (from 0 days to 17 days). Commonwealth environmental water made little or no contribution to these increased durations of low freshes. In the absence of environmental water there would have been at least one medium fresh (i.e. > 410 ML/day) in the periods July to September and April to June. Environmental water increased the duration of the longest medium fresh during the period October to December (from 0 days to 8 days). Commonwealth environmental water made little or no contribution to these increased durations of medium freshes. In the absence of environmental water there would have been at least one high fresh in the period April to June. Environmental water made no change to the duration of these high freshes.

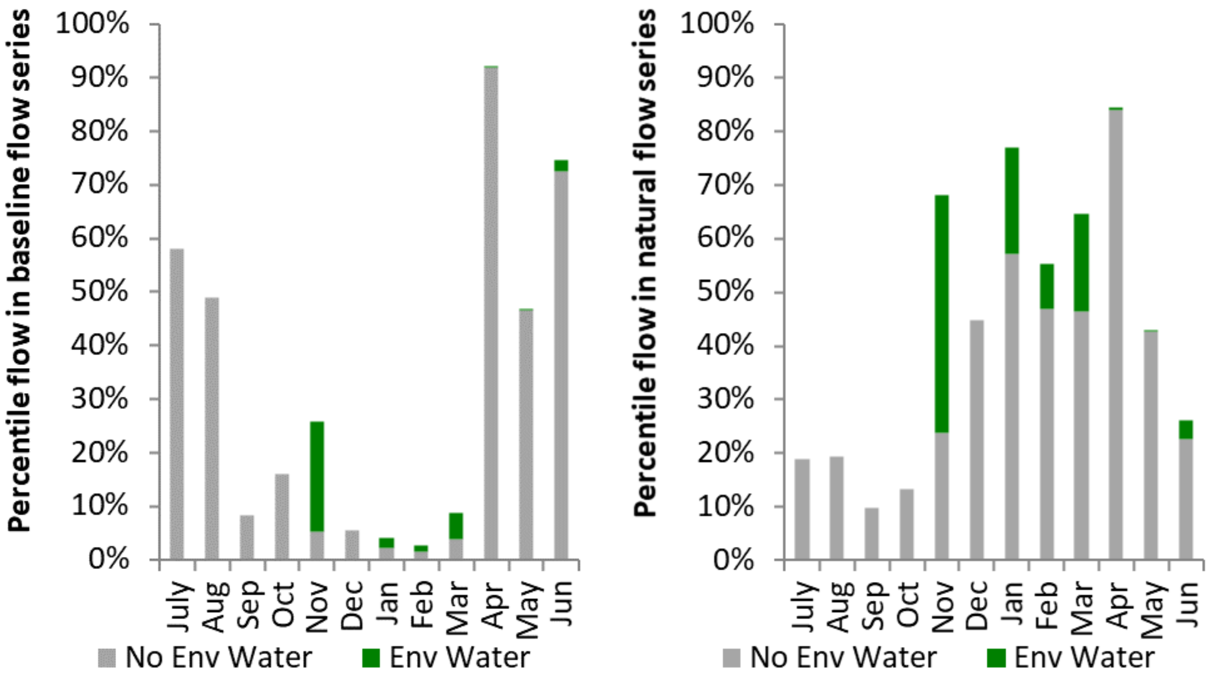


Figure LOD9: Contribution of environmental water delivery at Serpentine as percentiles in the natural and baseline flow series.

10.5.5 Loddon

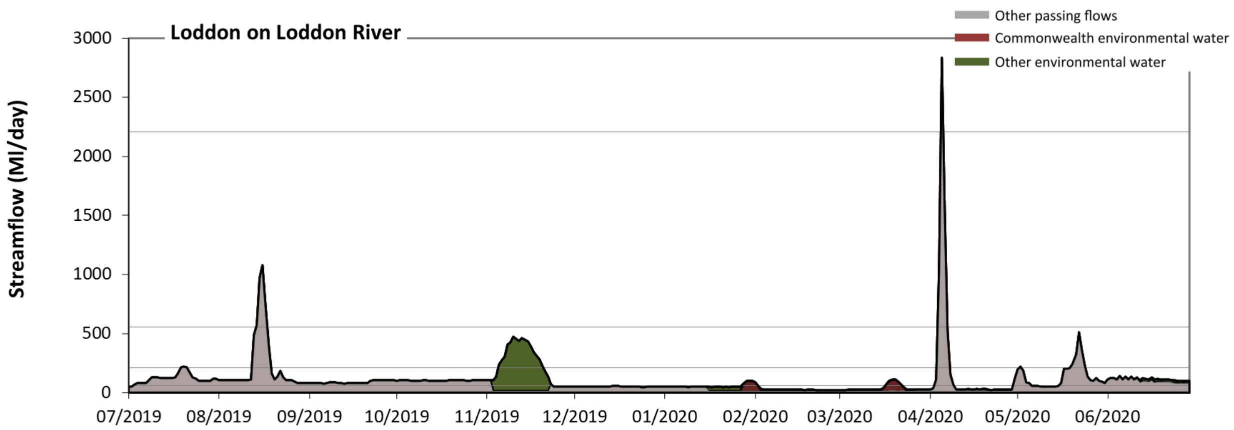


Figure LOD10: Contribution of environmental water delivery at Loddon. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Loddon on Loddon River environmental water contributed 20% of the total streamflow volume (with a relatively small contribution of Commonwealth environmental water). Environmental watering actions affected streamflows for 42% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 11 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the durations of low flows (i.e. < 56 ML/day) in the periods October to December and January to March would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 50% to 41% of the year, with greatest influence in the periods October to December and January to March. Commonwealth environmental water made a modest contribution to these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 210 ML/day) in the periods July to September and April to June. Environmental water increased the duration of the longest low fresh during the period October to December (from 0 days to 16 days). Commonwealth environmental water made little or no contribution to these increased durations of low freshes. There was at least one medium fresh (i.e. > 550 ML/day) in the periods July to September and April to June. Environmental water made no change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the period April to June. Environmental water made no change to the duration of these high freshes.

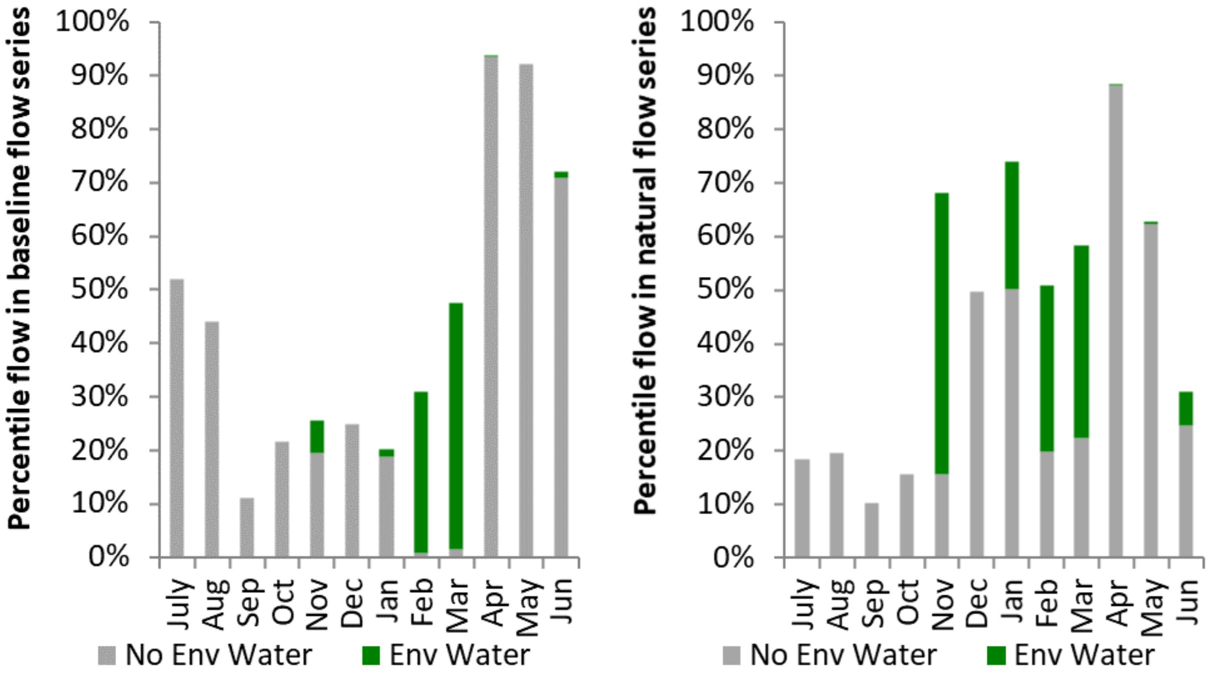


Figure LOD11: Contribution of environmental water delivery at Loddon as percentiles in the natural and baseline flow series.

10.5.6 Appin

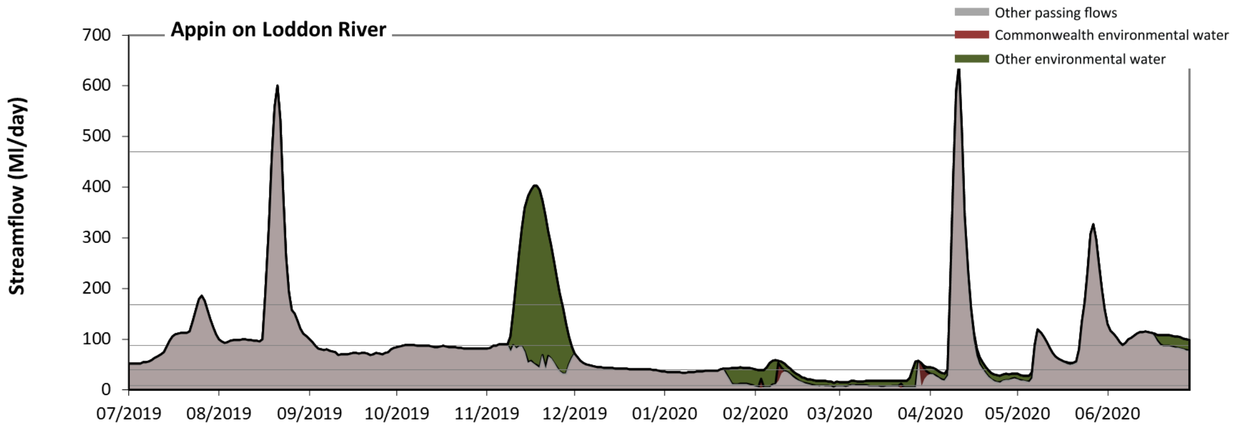


Figure LOD12: Contribution of environmental water delivery at Appin. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Appin on Loddon River environmental water contributed 19% of the total streamflow volume (with a relatively small contribution of Commonwealth environmental water). Environmental watering actions affected streamflows for 42% of days between 1 July 2019 and 30 June 2020. Without environmental water, the duration of very low flows (i.e. < 7.9 ML/day) in the period January to March would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 10% to 0% of the year, with greatest influence in the period January to March. Similarly, without environmental water, the duration of low flows (i.e. < 39 ML/day) in the period January to March would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 33% to 24% of the year, with greatest influence in the period January to March. Commonwealth environmental water made a small contribution to these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 88 ML/day) in the periods July to September, October to December and April to June. Environmental water increased the duration of the longest low fresh during the periods October to December (from 4 days to 25 days) and April to June (from 28 days to 38 days). Commonwealth environmental water made little or no contribution to these increased durations of low freshes. In the absence of environmental water there would have been at least one medium fresh (i.e. > 170 ML/day) in the periods July to September and April to June. Environmental water increased the duration of the longest medium fresh during the period October to December (from 0 days to 16 days). Commonwealth environmental water made little or no contribution to these increased durations of medium freshes. In the absence of environmental water there would have been at least one high fresh in the periods July to September and April to June. Environmental water made no change to the duration of these high freshes.

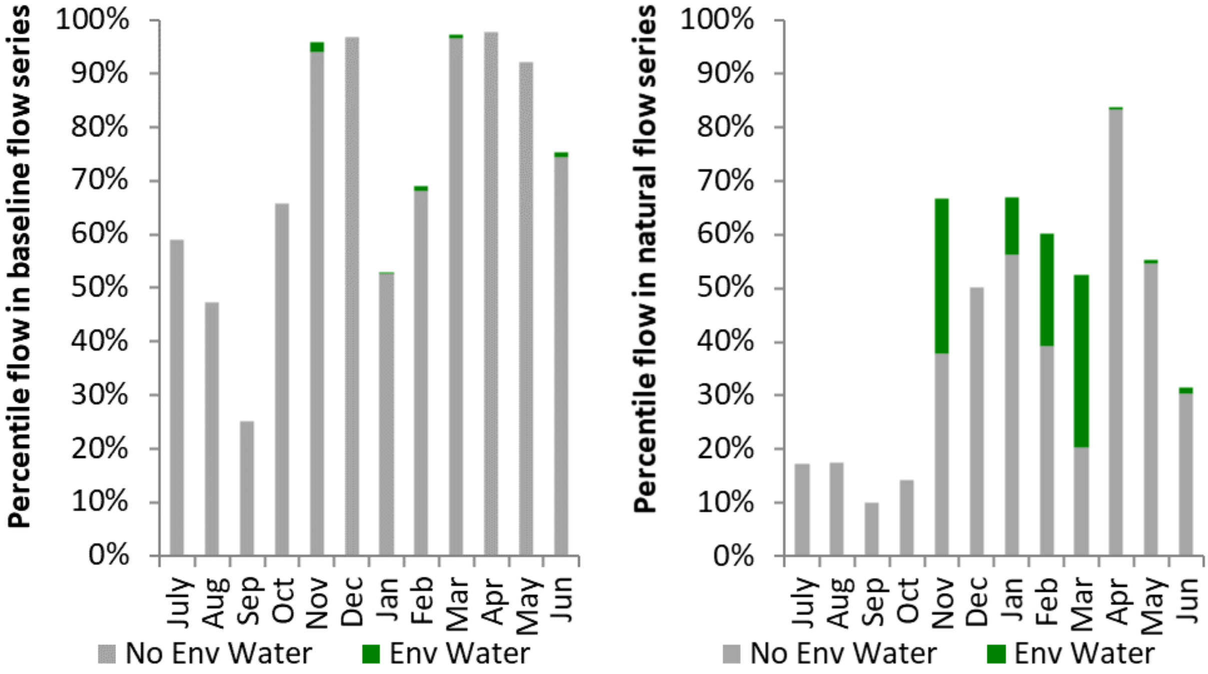


Figure LOD13: Contribution of environmental water delivery at Appin as percentiles in the natural and baseline flow series.

11 Lower Darling Valley

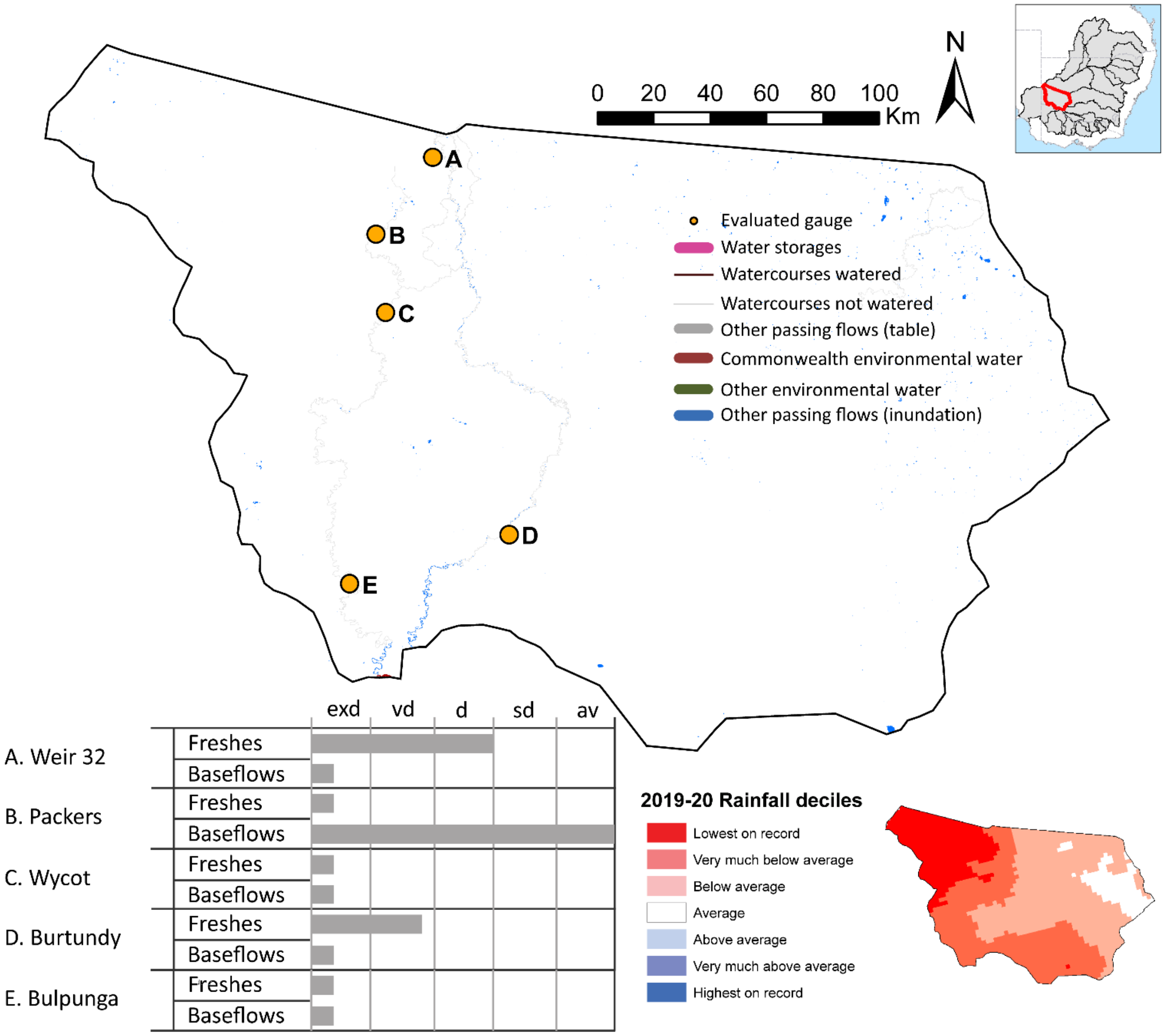


Figure LDL1: Watercourses influenced, areas inundated (where applicable) and gauge stations evaluated in the Lower Darling valley during the 2019–20 water year. Inset bar graphs report the condition of annual flow regimes by showing the improvements in hydrological condition with the addition of environmental water as well as the hypothetical scenario in 'grey' (if no environmental flow had been delivered). Rainfall conditions (rainfall deciles) and trend in storage levels for the water year are also shown. The classified bands are: exd = extremely dry, vd=very dry, sd=somewhat dry and av=average.

11.1 Summary

The volume of environmental water delivery for the 2019–20 year in the Lower Darling valley is quantified using data for 5 sites. This evaluation only considers the contribution of held environmental water, which is a primary focus for the Commonwealth. The contributions of planned environmental water (e.g. passing flows), unregulated tributary inflows and clever use of irrigation flows for environmental benefits can all be very important but these are outside the scope of this report. Environmental watering actions lasted on average 0 days over the course of the year. The volume of environmental water at these 5 sites was between 0% and 0% of the total streamflow. Commonwealth environmental water contributed on average 0% of this environmental water. The contribution of environmental water delivery to improved flow regimes is evaluated using data for 5 sites. Ideally, baseflows should be maintained and long periods of excessively low flows avoided. In this valley, the baseflow regime was generally considered to be very dry relative to the pre-development flow regime. In our analysis, a low fresh refers to a period of increased flow, when the water level rises at least one eighth of the way up the river bank (above the low flow level). These low freshes are a regular part of the natural flow regime and support a range of natural processes. In the Lower Darling valley, in terms of the occurrence and duration of low freshes, the year was assessed as being extremely dry. In our analysis, a medium fresh refers to a period of increased flow, when the water level rises at least one quarter of the way up the river bank. These medium freshes are not as frequent as low freshes but are also a regular and important part of the natural flow regime. In the Lower Darling valley, in terms of the occurrence of medium freshes, the year was assessed as being very dry. In our analysis, a high fresh refers to a period of increased flow, when the water level rises more than half way up the river. A high fresh may not occur every year but they are still important and long periods without major freshes can have serious consequences for floodplains and their contribution to river ecosystem health. Delivering environmental high in channel flows normally requires that all risks to riparian landholders and infrastructure have been resolved. In the Lower Darling valley, in terms of the occurrence of high freshes, the year was assessed as being very dry.

11.2 Water delivery context

During the 2019–20 water year, the Commonwealth Environmental Water Holder (CEWH) held water entitlements of up to 25,798 ML for environmental use in the Lower Darling valley. Each year, water utilities allocate water entitlement holders a percentage of water based on their holding, licence type and carryover (the exact rules vary among Jurisdictions and licence type). In 2019–20, the Lower Darling entitlements held by the CEWH were allocated 10,288 ML of water, representing 44% of the Long term average annual yield for the Lower Darling valley (23,184 ML). Information and data relating to the portfolio of held Commonwealth environmental water is shown in Table LDL1.

The 2019–20 water allocation (10,288 ML) together with the carryover volume of 3,608 ML of water meant the CEWH had 13,896 ML of water available for delivery. A total of 0 ML of Commonwealth environmental water was delivered in the Lower Darling valley. A total 10782 ML (78%) of available Commonwealth environmental water was carried over for environmental use into the 2020–21 water year.

11.3 Environmental conditions and resource availability

The water available for environmental delivery combined with the present and antecedent environmental conditions are key inputs used by environmental water managers in planning and implementing watering actions. *Post hoc*, this information provides important context when evaluating the effectiveness and appropriateness of environmental water use with respect to hydrological outputs.

The rainfall conditions in the Lower Darling valley were classified as below average, based on rainfall percentile data for the entire record held by the Bureau of Meteorology for this valley. The water held in major storages in the Lower Darling valley decreased over the water year, for example Menindee dam was 0.9% full at the beginning of the water year and 27.7% full by the end of the year (Figure LDL1).

The CEWO calculates resource availability scenarios (RAS) to guide the use and prioritisation of held environmental water. The RAS are progressively calculated over the year as part of the continual adaptive management planning processes. The RAS are based on the availability of held environmental water (including progressive licence acquisitions and allocations) as well as the potential for unregulated or planned environmental flows. The outcome is then used to determine the demand for environmental water across the Basin.

In 2019–20, the resource availability of held Commonwealth environmental water in the Lower Darling was classified as very low, whilst the overall demand for environmental water was classified as critical to high. The physical conditions meant that the CEWO was managing to primarily protect and/or avoid damage or decline in the Lower Darling Region.

11.4 Watering actions

The Commonwealth did not contribute to any watering actions in the Lower Darling valley via direct releases from the Darling storages. A weir pool raising action in the Murray River did push some environmental water into the lower reaches of the Darling River.

Table LDL1. Commonwealth environmental water accounting information for the Lower Darling valley over 2019–20 water year.

Total registered volume (ML)	Allocated volume (ML)	Carry over + allocated volume (ML)	Delivered (ML)	LTAAY (ML)	Carried over to 2020–21
25,798	10,288	13,896	0	23,184	10,782

11.5 Contribution of Commonwealth environmental water to flow regimes

11.5.1 Weir32

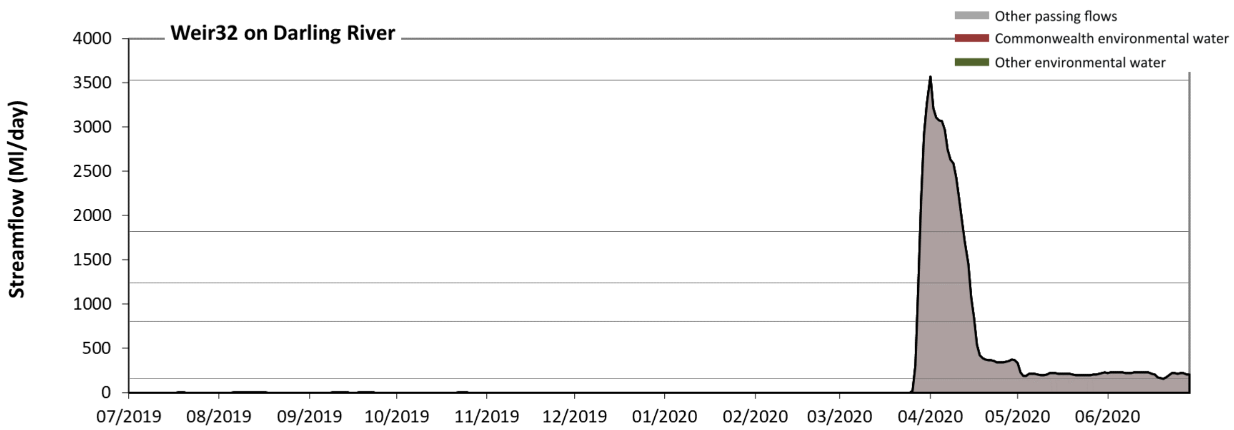


Figure LDL2: Contribution of environmental water delivery at Weir32. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

There was no environmental water delivered at Weir32 on Darling River. Without environmental water, the durations of very low flows (i.e. < 160 ML/day) in the periods July to September, October to December and January to March was substantially in excess of durations expected in an average year in the natural flow regime. Similarly, without environmental water, the durations of low flows (i.e. < 810 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. There was at least one low fresh (i.e. > 1200 ML/day) in the periods January to March and April to June. There was at least one medium fresh (i.e. > 1800 ML/day) in the periods January to March and April to June. In the absence of environmental water there was at least one high fresh in the period April to June.

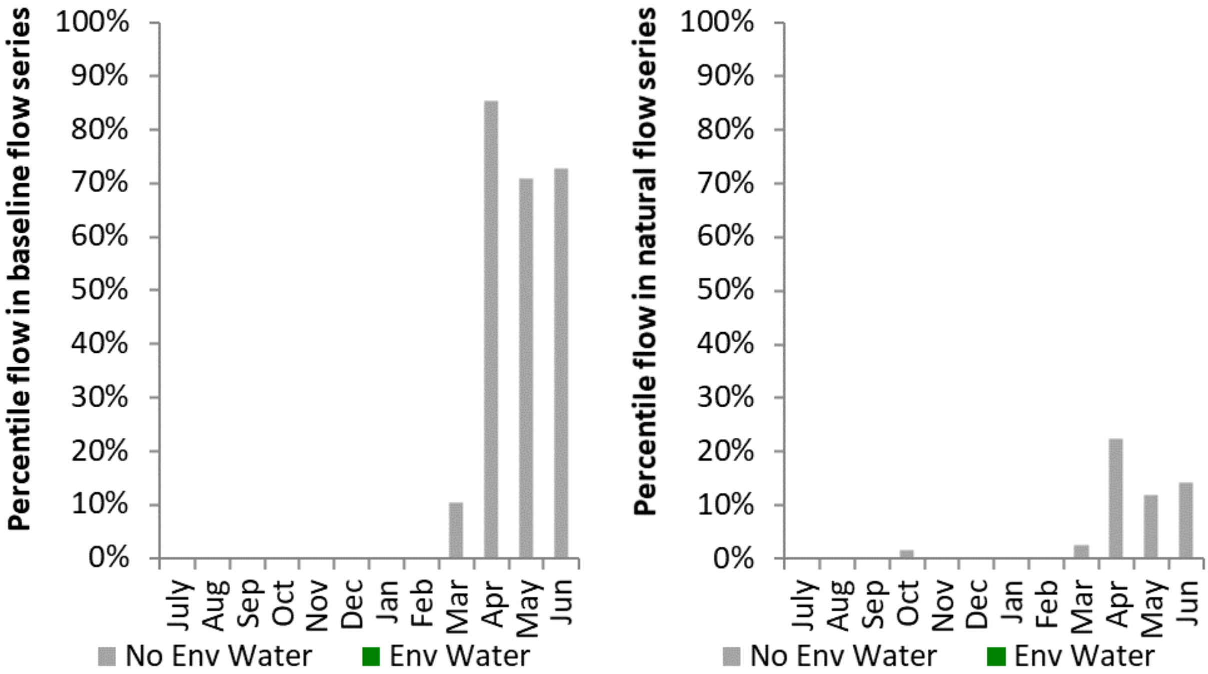


Figure LDL3: Contribution of environmental water delivery at Weir32 as percentiles in the natural and baseline flow series.

11.5.2 Burtundy

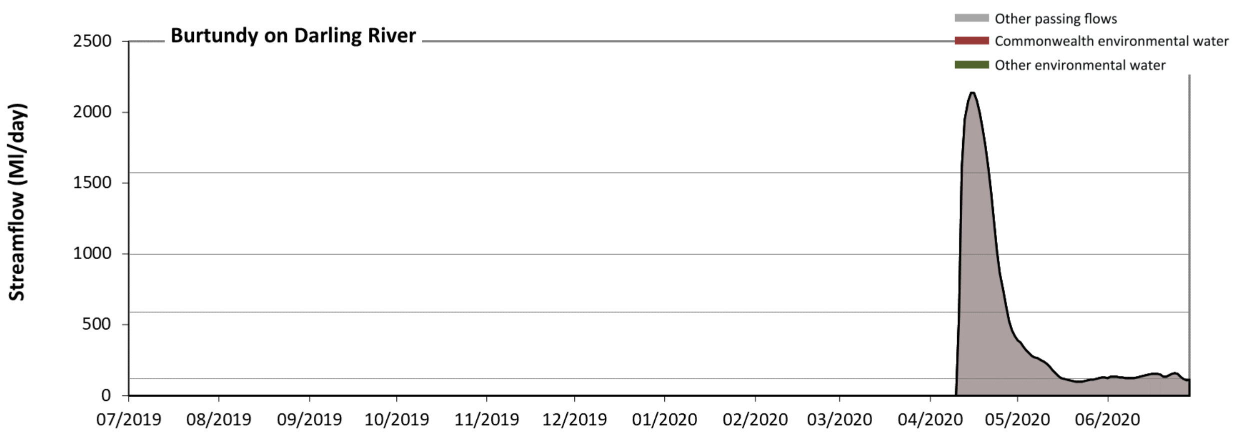


Figure LDL4: Contribution of environmental water delivery at Burtundy. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

There was no environmental water delivered at Burtundy on Darling River. Without environmental water, the durations of very low flows (i.e. < 120 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. Similarly, without environmental water, the durations of low flows (i.e. < 590 ML/day) in the periods July to September, October to December, January to March and April to June was substantially in excess of durations expected in an average year in the natural flow regime. There was at least one low fresh (i.e. > 990 ML/day) in the period April to June. There was at least one medium fresh (i.e. > 1600 ML/day) in the period April to June. There was no high freshes (i.e. > 3400 ML/day) this year.

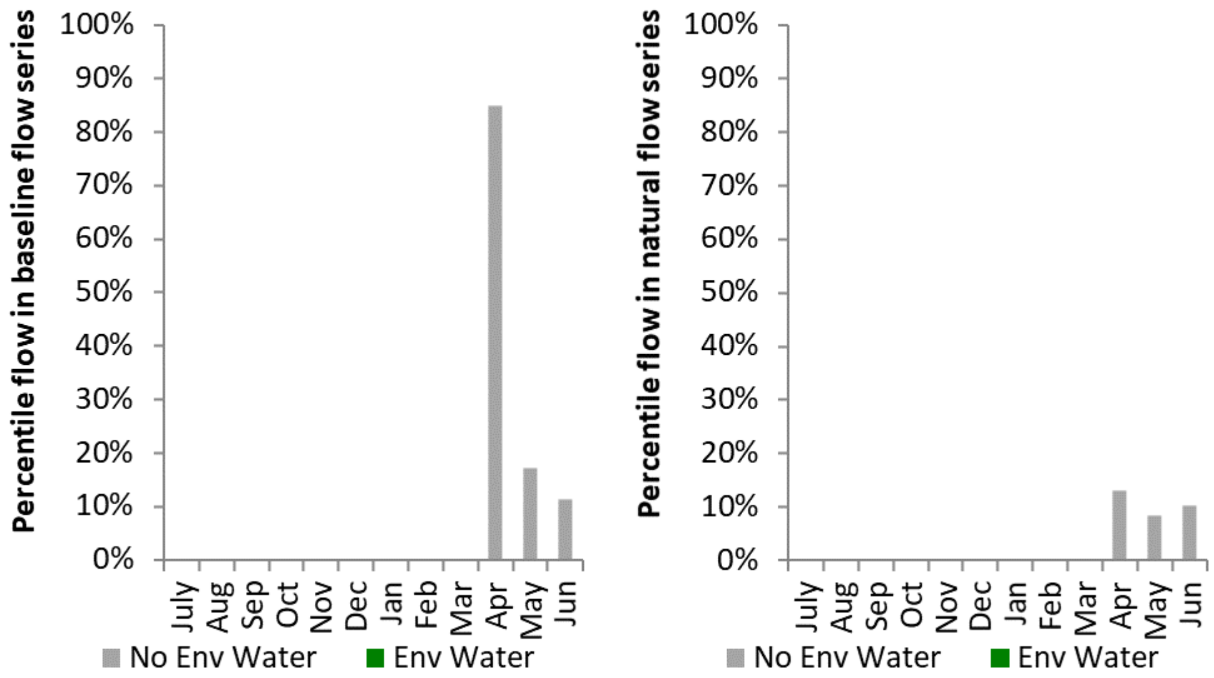


Figure LDL5: Contribution of environmental water delivery at Burtundy as percentiles in the natural and baseline flow series.

11.5.3 Packers

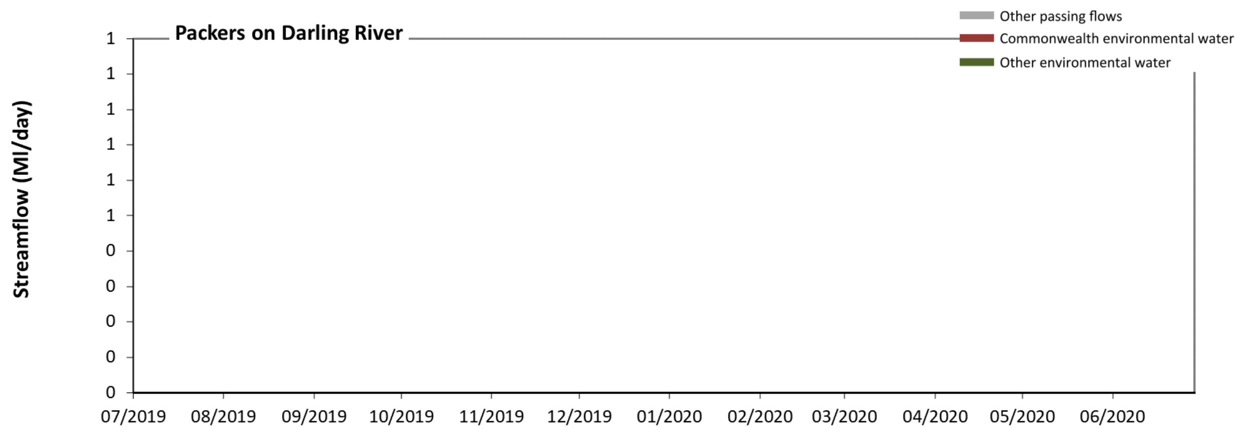


Figure LDL6: Contribution of environmental water delivery at Packers. Horizontal lines indicate thresholds for very low flows and low flows (from lowest to highest).

There was no river flow observed at Packers on the Darling River.

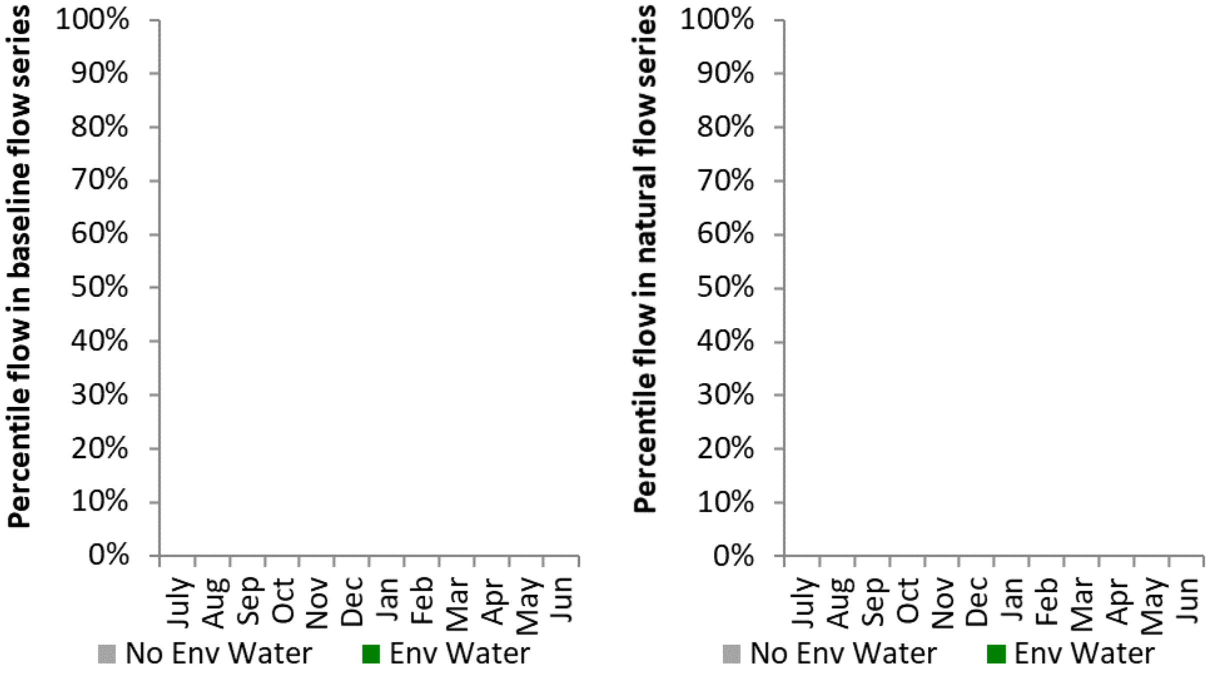


Figure LDL7: Contribution of environmental water delivery at Packers as percentiles in the natural and baseline flow series.

11.5.4 Wycot

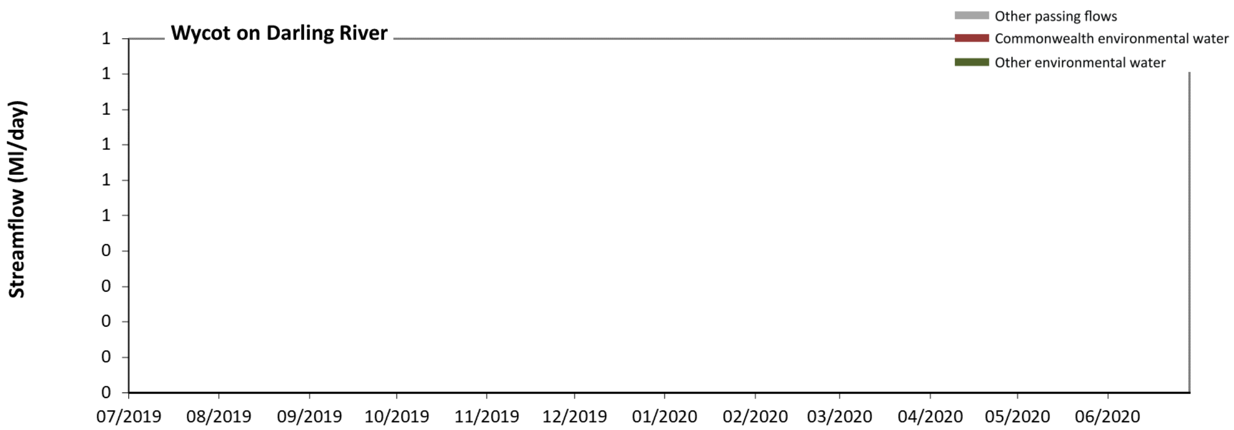


Figure LDL8: Contribution of environmental water delivery at Wycot. Horizontal lines indicate thresholds for very low flows and low flows (from lowest to highest).

There was no river flow observed at Wycot on Darling River.

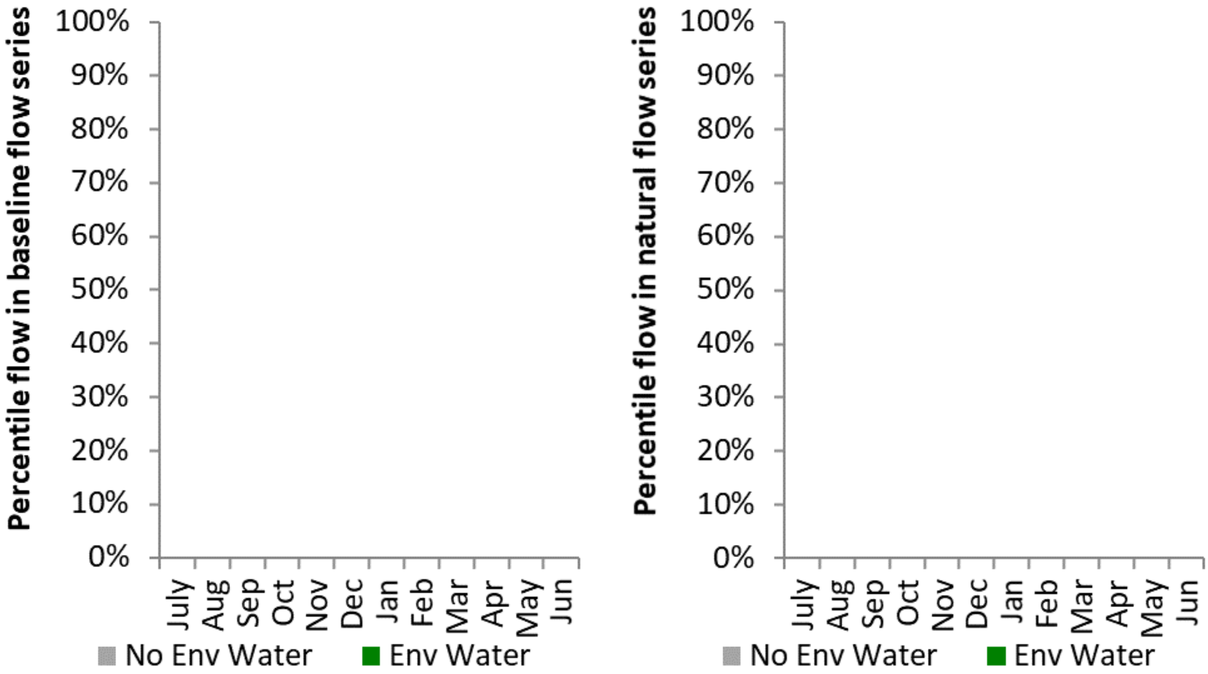


Figure LDL9: Contribution of environmental water delivery at Wycot as percentiles in the natural and baseline flow series.

11.5.5 Bulpunga

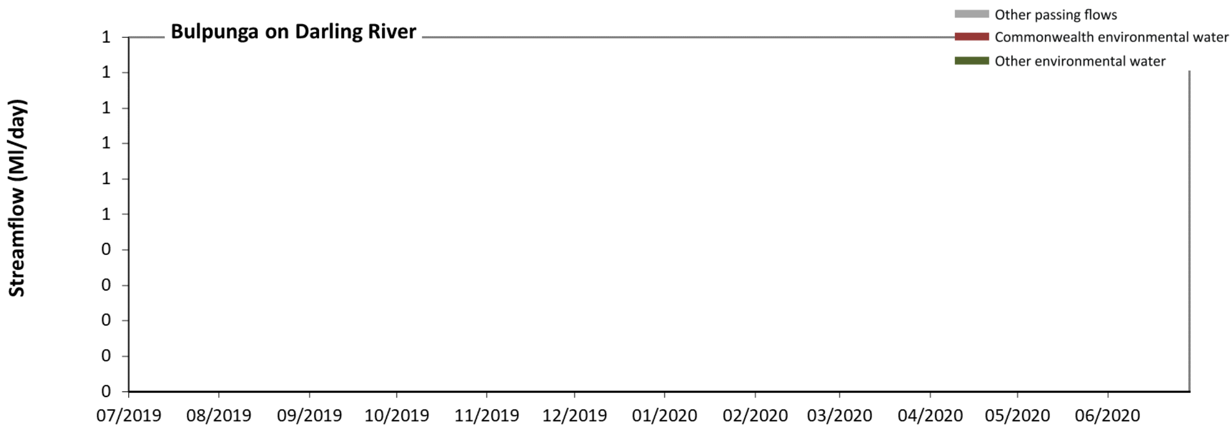


Figure LDL10: Contribution of environmental water delivery at Bulpunga. Horizontal lines indicate thresholds for very low flows and low flows (from lowest to highest).

There was no river flow observed at Bulpunga on Darling River.

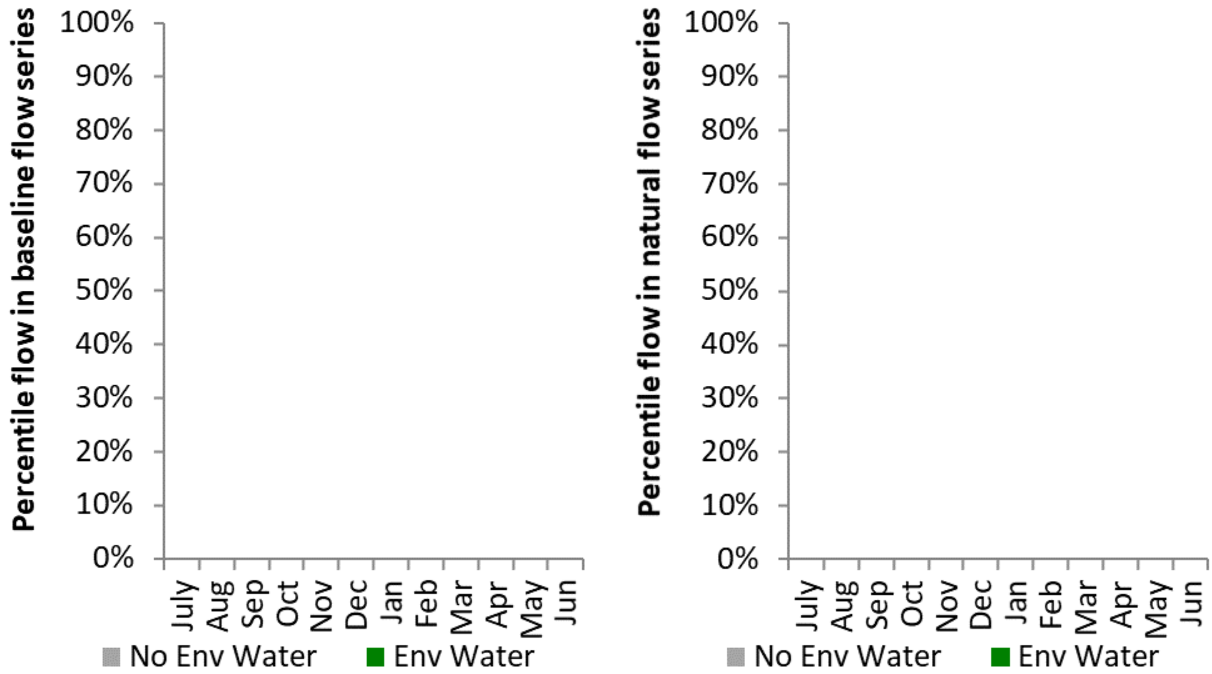


Figure LDL11: Contribution of environmental water delivery at Bulpunga as percentiles in the natural and baseline flow series.

12 Border Rivers Valley

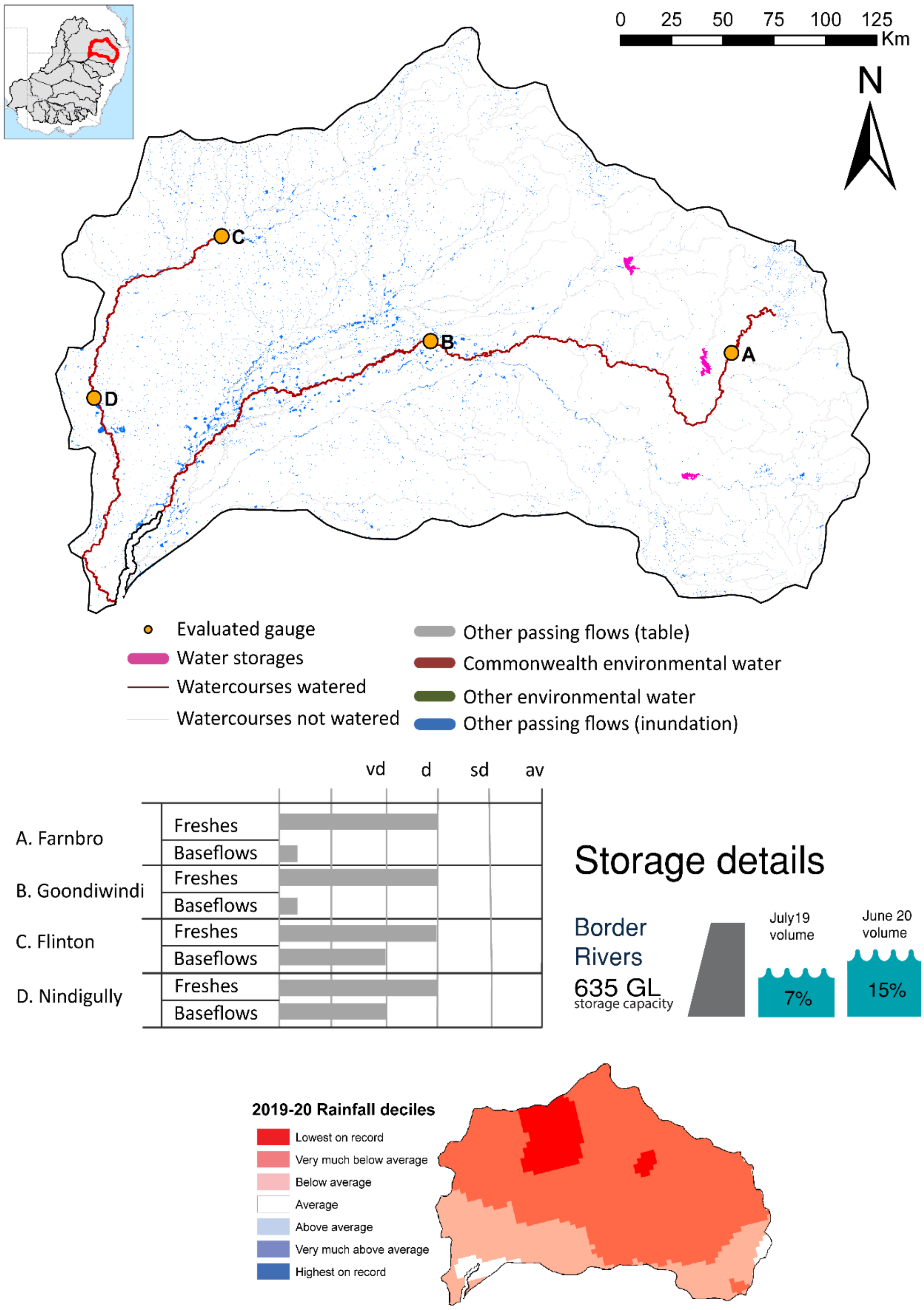


Figure BRD1: Watercourses influenced, areas inundated (where applicable) and gauge stations evaluated in the Border Rivers valley during the 2019–20 water year. Inset bar graphs report the condition of annual flow regimes by showing the improvements in hydrological condition with the addition of environmental water as well as the hypothetical scenario in 'grey' (if no environmental flow had been delivered). Rainfall conditions (rainfall deciles) and trend in storage levels for the water year are also shown. The classified bands are: exd = extremely dry, vd=very dry, sd=somewhat dry and av=average

12.1 Summary

The volume of environmental water delivery for the 2019–20 year in the Border Rivers valley is quantified using data for 4 sites. This evaluation only considers the contribution of held environmental water, which is a primary focus for the Commonwealth. The contributions of planned environmental water (e.g. passing flows), unregulated tributary inflows and clever use of irrigation flows for environmental benefits can all be very important but these are outside the scope of this report. Environmental watering actions lasted on average 27 days over the course of the year. The volume of environmental water at these 4 sites was between 1% and 5% of the total streamflow. Commonwealth environmental water contributed on average 100% of this environmental water. The contribution of environmental water delivery to improved flow regimes is evaluated using data for 4 sites. Ideally, baseflows should be maintained and long periods of excessively low flows avoided. In this valley, the baseflow regime was generally considered to be very dry relative to the pre-development flow regime. In our analysis, a low fresh refers to a period of increased flow, when the water level rises at least one eighth of the way up the river bank (above the low flow level). These low freshes are a regular part of the natural flow regime and support a range of natural processes. In the Border Rivers valley, in terms of the occurrence and duration of low freshes, the year was assessed as being dry. In our analysis, a medium fresh refers to a period of increased flow, when the water level rises at least one quarter of the way up the river bank. These medium freshes are not as frequent as low freshes but are also a regular and important part of the natural flow regime. In the Border Rivers valley, in terms of the occurrence of medium freshes, the year was assessed as being dry. In our analysis, a high fresh refers to a period of increased flow, when the water level rises more than half way up the river. A high fresh may not occur every year but they are still important and long periods without major freshes can have serious consequences for floodplains and their contribution to river ecosystem health. Delivering environmental high in channel flows normally requires that all risks to riparian landholders and infrastructure have been resolved. In the Border Rivers valley, in terms of the occurrence of high freshes, the year was assessed as being average.

12.2 Water delivery context

During the 2019–20 water year, the Commonwealth Environmental Water Holder (CEWH) held water entitlements of up to 45,440 ML for environmental use in the Border Rivers valley. Each year, water utilities allocate water entitlement holders a percentage of water based on their holding, licence type and carryover (the exact rules vary among Jurisdictions and licence type). In 2019–20, the Border Rivers entitlements held by the CEWH were allocated 21 ML of water, representing 0% of the Long term average annual yield for the Border Rivers valley (17,806 ML). Information and data relating to the portfolio of held Commonwealth environmental water is shown in Table BRD1.

The 2019–20 water allocation (21 ML) together with the carryover volume of 2,191 ML of water meant the CEWH had 2,212 ML of held water available for delivery. However, a total of 7,837 ML of Commonwealth environmental water was triggered and delivered in the Border Rivers valley through unregulated entitlements. The held volume of 2192 ML (99%) was carried over for environmental use into the 2020–21 water year.

12.3 Environmental conditions and resource availability

The water available for environmental delivery combined with the present and antecedent environmental conditions are key inputs used by environmental water managers in planning and implementing watering actions. *Post hoc*, this information provides important context when evaluating the effectiveness and appropriateness of environmental water use with respect to hydrological outputs.

The rainfall conditions in the Border Rivers valley were classified as very much below average, based on rainfall percentile data for the entire record held by the Bureau of Meteorology for this valley. The water held in major storages in the Border Rivers valley decreased over the water year, for example Glynlyon, Pindari, and Coolmunda dam was 7.2% full at the beginning of the water year and 15.0% full by the end of the year (Figure BRD1).

The CEWO calculates resource availability scenarios (RAS) to guide the use and prioritisation of held environmental water. The RAS are progressively calculated over the year as part of the continual adaptive management planning processes. The RAS are based on the availability of held environmental water (including progressive licence acquisitions and allocations) as well as the potential for unregulated or planned environmental flows. The outcome is then used to determine the demand for environmental water across the Basin.

In 2019–20, the resource availability of held Commonwealth environmental water in the Border Rivers was classified as very low, whilst the overall demand for environmental water was classified as critical to high. The physical conditions meant that the CEWO was managing to avoid damage to environmental assets including in-channel habitats, drought refugia and fish condition and resilience.

12.4 Watering actions

A total of 4 watering actions were delivered over the 2019–20 water year, the duration of these actions varied (range of individual actions: 167 - 365 days) and Commonwealth environmental water was delivered for a total of 365 days. The number of water actions commencing in each season included, summer (0), autumn (0), winter (4), spring (0). Similarly, the count of flow component types delivered in the Border Rivers valley were; (0) baseflow, (3) baseflow-fresh, (1) baseflow-fresh-bankfull, (0) baseflow-fresh-overbank-wetland, (0) fresh, (0) fresh-wetland, (3) bankfull, (0) overbank, (0) wetland and (0) wetland-overbank.

In the Border Rivers, watering actions were delivered for resilience, water quality, connectivity, biota and fish purposes, but water was also delivered for other purposes too. The percentage of watering actions delivered across the nine main themes included fish (40%), vegetation (0.0%), waterbirds (0.0%), frogs (0.0%), other biota (10%), connectivity (10%), process (0.0%), resilience (10%) and water quality (30%).

Table BRD1. Commonwealth environmental water accounting information for the Border Rivers valley over 2019–20 water year.

Total registered volume (ML)	Held allocated volume (ML)	Carry over + allocated volume (ML)	Unregulated licences (ML)	Delivered (ML)	LTAAY (ML)	Carried over to 2020–21
45,440	21	2,212	7,837	7,837	17,806	2,192

12.5 Contribution of Commonwealth environmental water to flow regimes

12.5.1 Nindigully

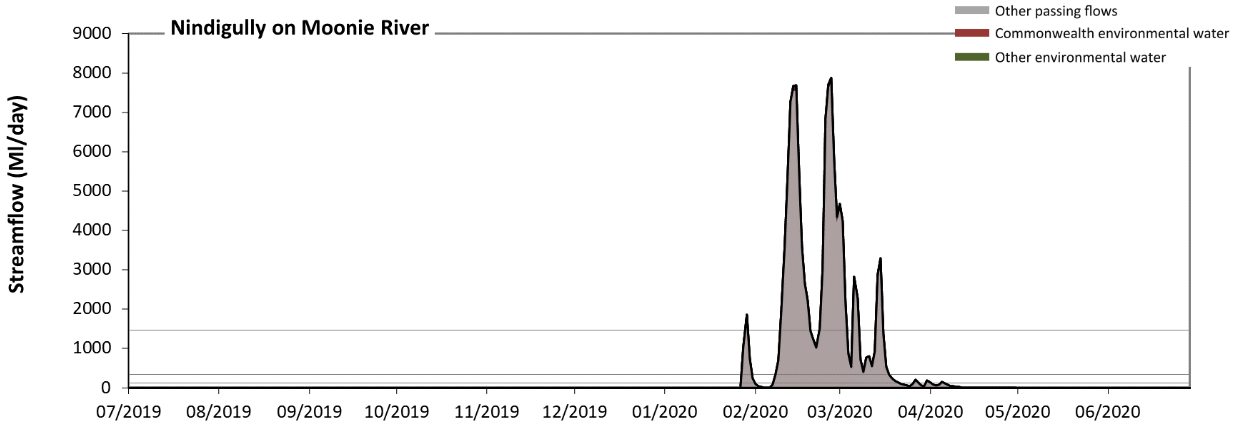


Figure BRD2: Contribution of environmental water delivery at Nindigully. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Nindigully on Moonie River environmental water contributed 3% of the total streamflow volume (all of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 19% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 5.1 ML/day) in the periods July to September, October to December and April to June would have substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these very low flows, which occurred for 78% of the year. Similarly, without environmental water, the durations of low flows (i.e. < 25 ML/day) in the periods July to September, October to December and April to June would have substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these low flows, which occurred for 81% of the year. There was at least one low fresh (i.e. > 120 ML/day) in the periods January to March and April to June. Environmental water made no change to the duration of these low freshes. There was at least one medium fresh (i.e. > 330 ML/day) in the period January to March. Environmental water made no change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the period January to March. Environmental water made no change to the duration of these high freshes.

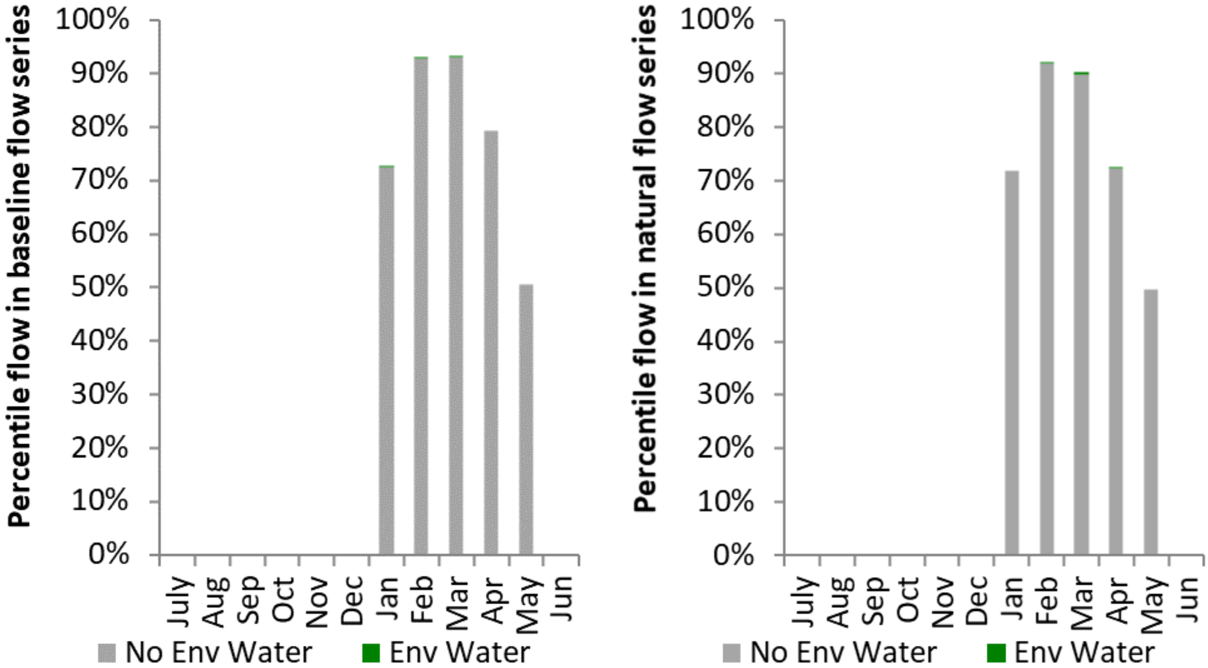


Figure BRD3: Contribution of environmental water delivery at Nindigully as percentiles in the natural and baseline flow series.

12.5.2 Flinton

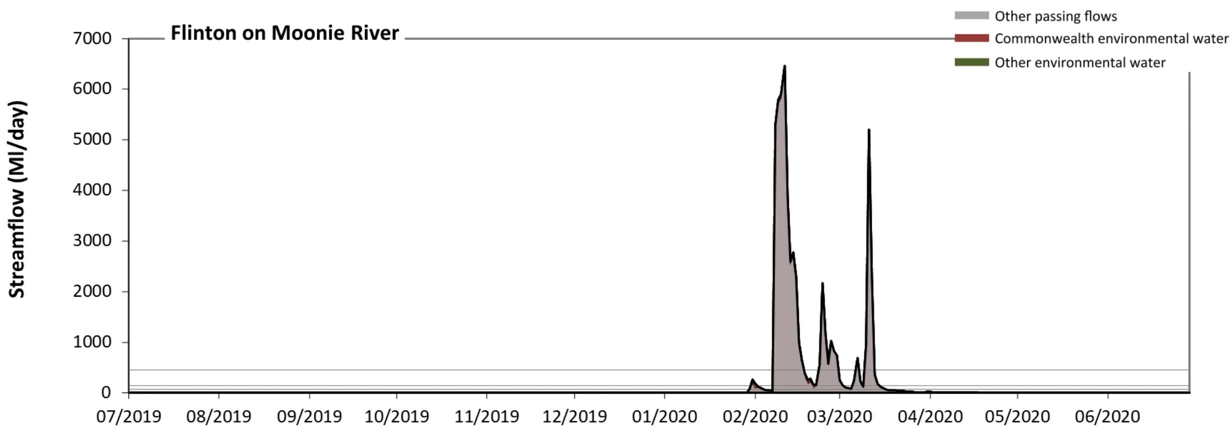


Figure BRD4: Contribution of environmental water delivery at Flinton. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Flinton on Moonie River environmental water contributed 2% of the total streamflow volume (all of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 5% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 5.1 ML/day) in the periods July to September, October to December and April to June would have substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these very low flows, which occurred for 81% of the year. Similarly, without environmental water, the durations of low flows (i.e. < 25 ML/day) in the periods July to September, October to December and April to June would have substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these low flows, which occurred for 85% of the year. There was at least one low fresh (i.e. > 66 ML/day) in the period January to March. Environmental water made little change to the duration of these low freshes. There was at least one medium fresh (i.e. > 140 ML/day) in the period

January to March. Environmental water made little change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the period January to March. Environmental water made no change to the duration of these high freshes.

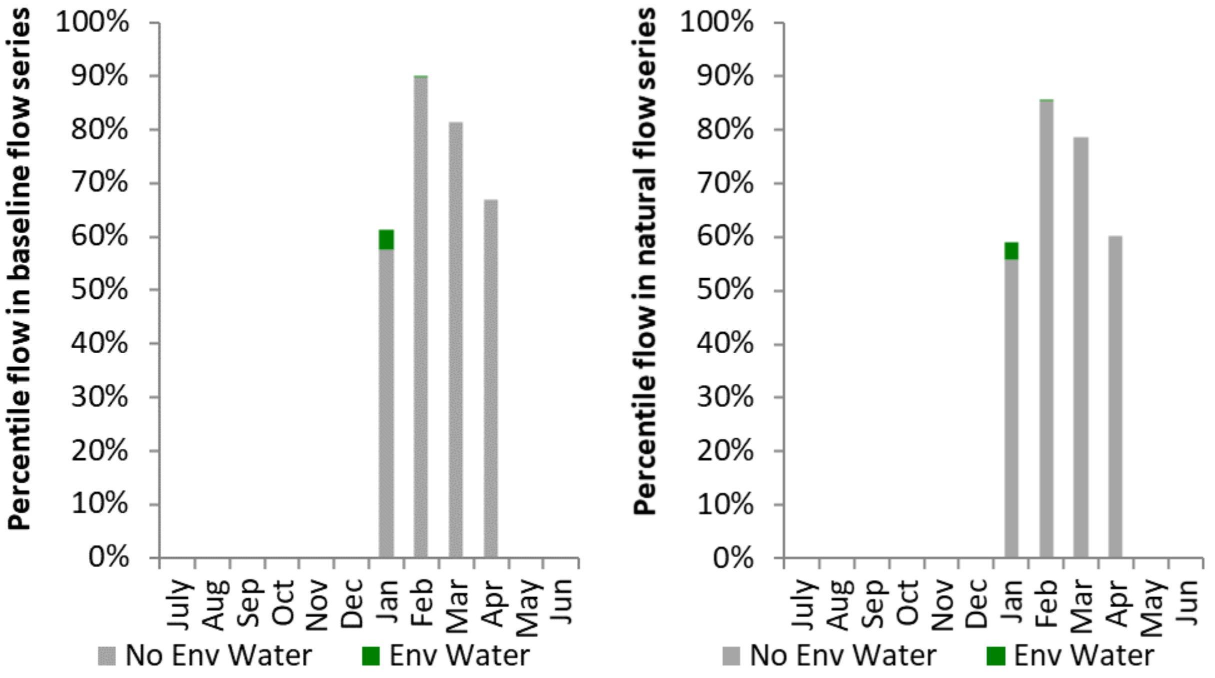


Figure BRD5: Contribution of environmental water delivery at Flinton as percentiles in the natural and baseline flow series.

12.5.3 Farnbro

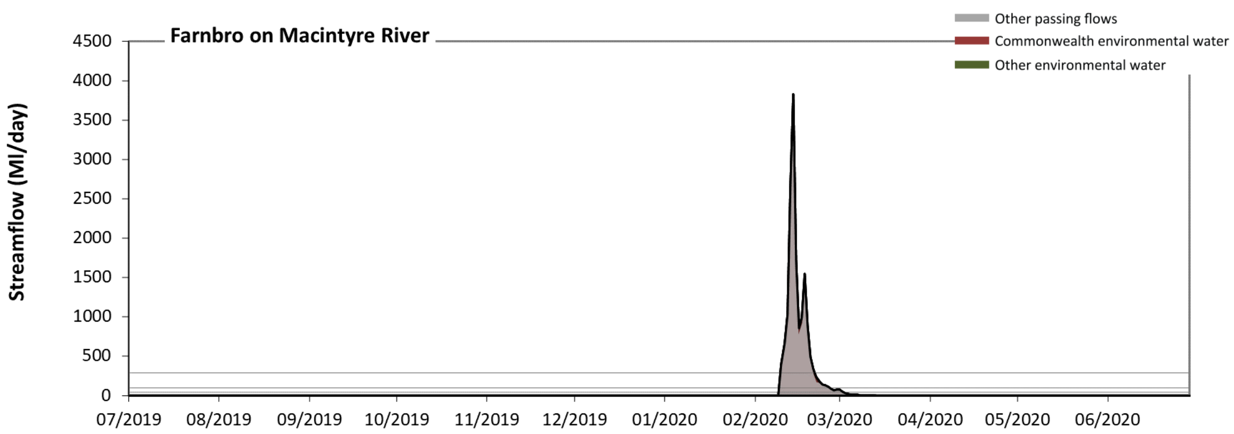


Figure BRD6: Contribution of environmental water delivery at Farnbro. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Farnbro on Macintyre River environmental water contributed 5% of the total streamflow volume (all of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 4% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 3.9 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these very low flows, which occurred for 92% of the year. Similarly, without environmental water, the durations of low flows (i.e. < 19 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these low flows, which occurred for 93% of the year. There was at least one low fresh (i.e. > 47 ML/day) in the period January to March. Environmental water made no change to the duration of these low freshes. There was at least one medium fresh (i.e. > 97 ML/day) in the period January to March. Environmental water made no change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the period January to March. Environmental water made little change to the duration of these high freshes.

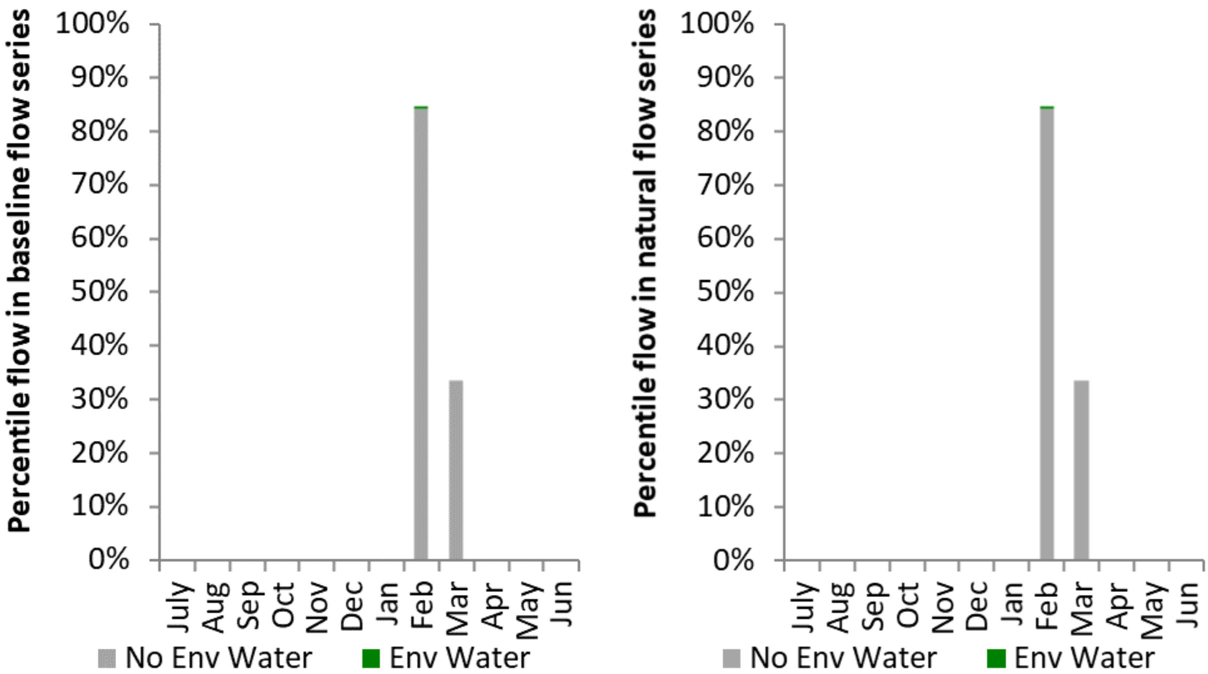


Figure BRD7: Contribution of environmental water delivery at Farnbro as percentiles in the natural and baseline flow series.

12.5.4 Goondiwindi

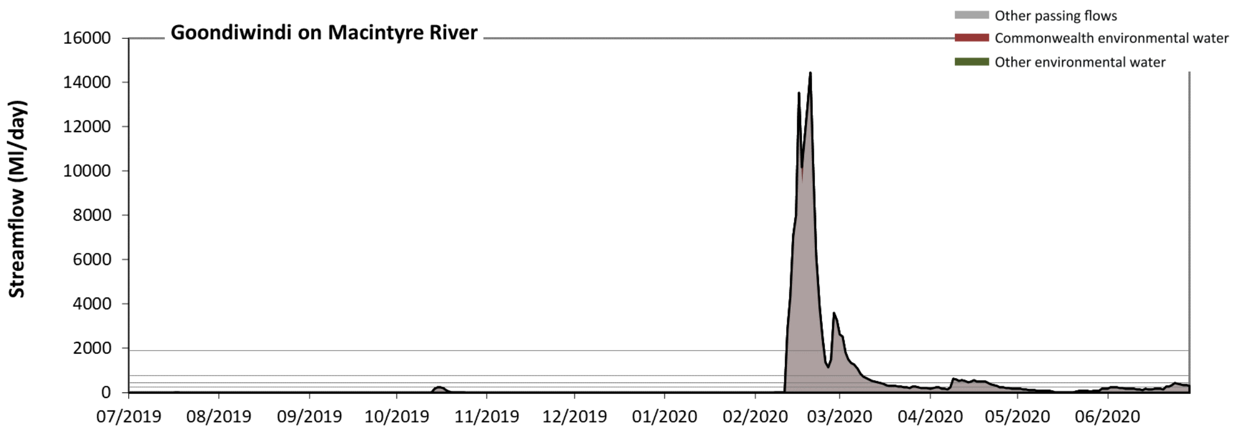


Figure BRD8: Contribution of environmental water delivery at Goondiwindi. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Goondiwindi on Macintyre River environmental water contributed 1% of the total streamflow volume (all of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 1% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 48 ML/day) in the periods July to September, October to December and

January to March would have substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these very low flows, which occurred for 62% of the year. Similarly, without environmental water, the durations of low flows (i.e. < 240 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these low flows, which occurred for 81% of the year. There was at least one low fresh (i.e. > 450 ML/day) in the periods January to March and April to June. Environmental water made no change to the duration of these low freshes. There was at least one medium fresh (i.e. > 780 ML/day) in the period January to March. Environmental water made no change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the period January to March. Environmental water made no change to the duration of these high freshes.

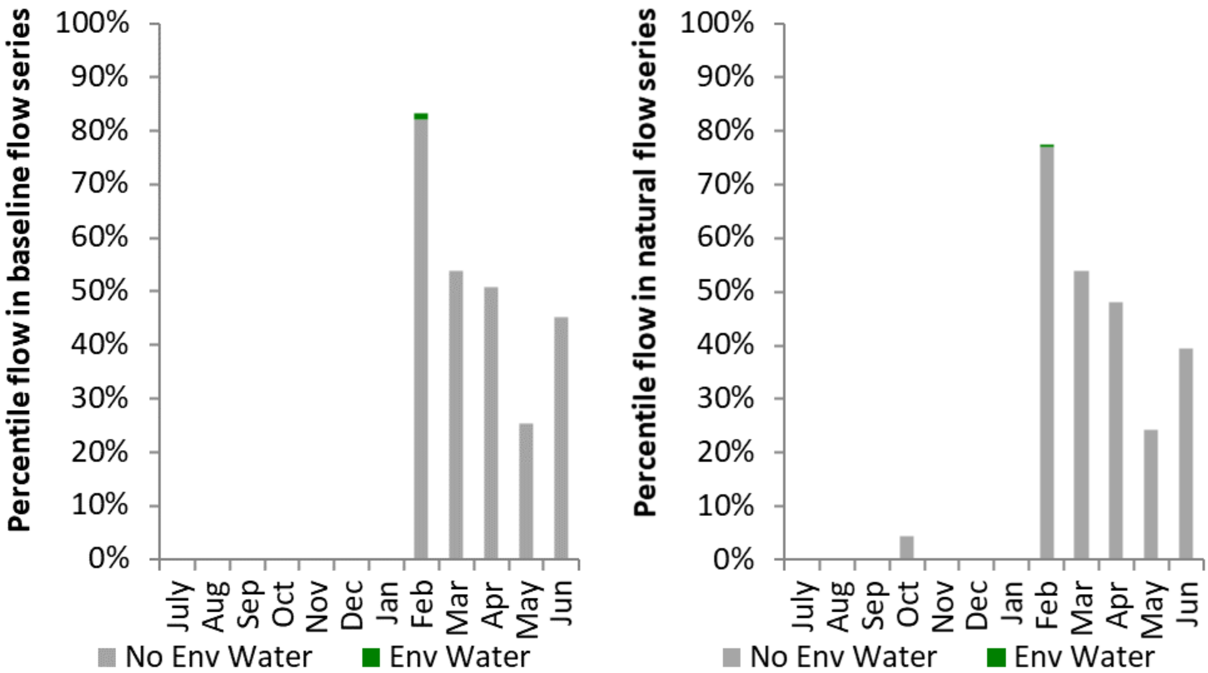


Figure BRD9: Contribution of environmental water delivery at Goondiwindi as percentiles in the natural and baseline flow series.

13 Goulburn Valley

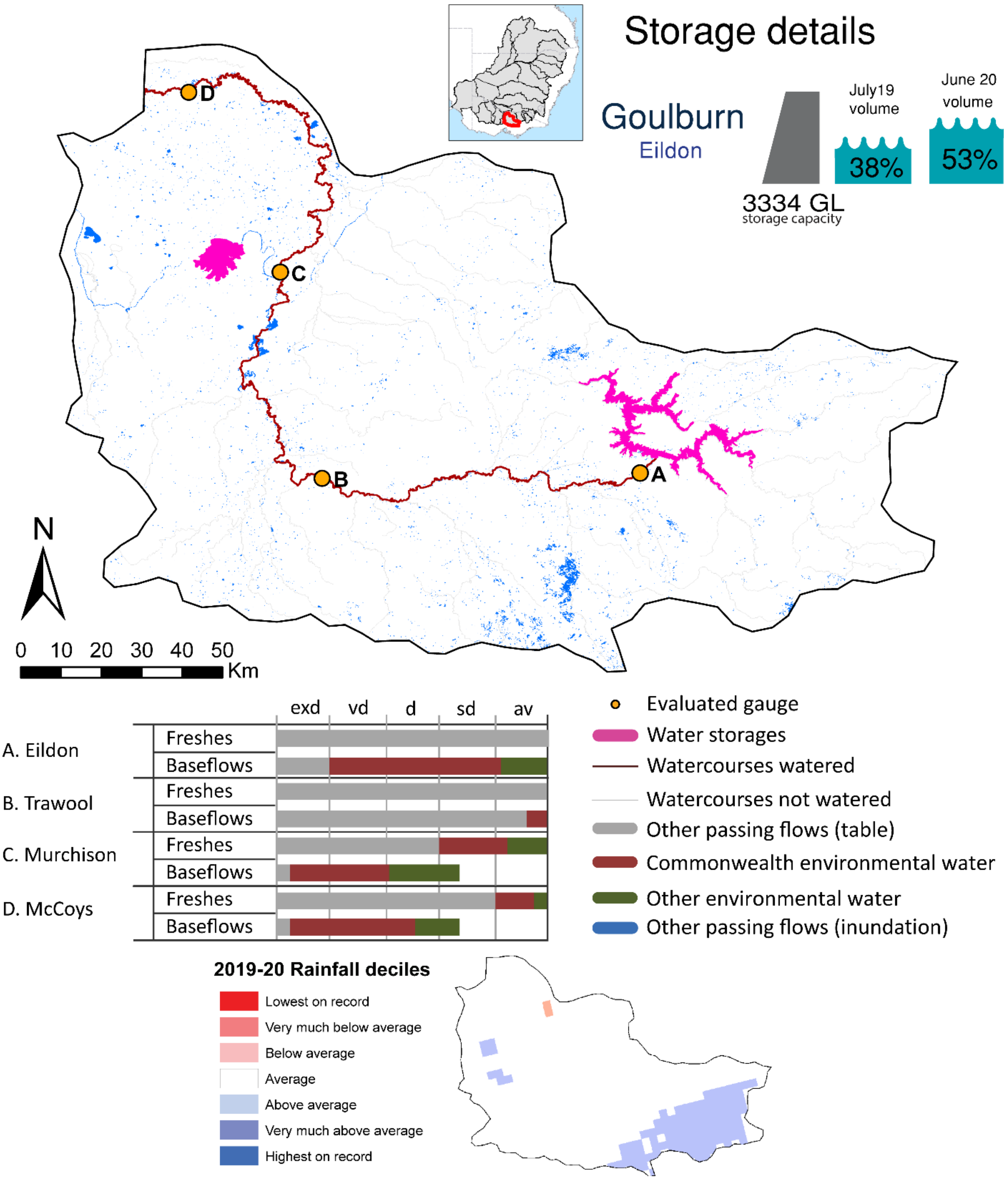


Figure GLB1: Watercourses influenced, areas inundated (where applicable) and gauge stations evaluated in the Goulburn valley during the 2019–20 water year. Inset bar graphs report the condition of annual flow regimes by showing the improvements in hydrological condition with the addition of environmental water as well as the hypothetical scenario in 'grey' (if no environmental flow had been delivered). Rainfall conditions (rainfall deciles) and trend in storage levels for the water year are also shown. The classified bands are: exd = extremely dry, vd=very dry, sd=somewhat dry and av=average.

13.1 Summary

The volume of environmental water delivery for the 2019–20 year in the Goulburn valley is quantified using data for 4 sites. This evaluation only considers the contribution of held environmental water, which is a primary focus for the Commonwealth. The contributions of planned environmental water (e.g. passing flows), unregulated tributary inflows and clever use of irrigation flows for environmental benefits can all be very important but these are outside the scope of this report. Environmental watering actions lasted on average 227 days over the course of the year. The volume of environmental water at these 4 sites was between 19% and 43% of the total streamflow. Commonwealth environmental water contributed on average 82% of this environmental water. The contribution of environmental water delivery to improved flow regimes is evaluated using data for 4 sites. Ideally, baseflows should be maintained and long periods of excessively low flows avoided. In this valley, the baseflow regime was generally considered to be somewhat dry relative to the pre-development flow regime. In our analysis, a low fresh refers to a period of increased flow, when the water level rises at least one eighth of the way up the river bank (above the low flow level). These low freshes are a regular part of the natural flow regime and support a range of natural processes. In the Goulburn valley, in terms of the occurrence and duration of low freshes, the year was assessed as being average. In our analysis, a medium fresh refers to a period of increased flow, when the water level rises at least one quarter of the way up the river bank. These medium freshes are not as frequent as low freshes but are also a regular and important part of the natural flow regime. In the Goulburn valley, in terms of the occurrence of medium freshes, the year was assessed as being average. In our analysis, a high fresh refers to a period of increased flow, when the water level rises more than half way up the river. A high fresh may not occur every year but they are still important and long periods without major freshes can have serious consequences for floodplains and their contribution to river ecosystem health. Delivering environmental high in channel flows normally requires that all risks to riparian landholders and infrastructure have been resolved. In the Goulburn valley, in terms of the occurrence of high freshes, the year was assessed as being average.

13.2 Water delivery context

During the 2019–20 water year, the Commonwealth Environmental Water Holder (CEWH) held water entitlements of up to 360,024 ML for environmental use in the Goulburn valley. Each year, water utilities allocate water entitlement holders a percentage of water based on their holding, licence type and carryover (the exact rules vary among Jurisdictions and licence type). In 2019–20, the Goulburn entitlements held by the CEWH were allocated 253,972 ML of water, representing 77% of the Long term average annual yield for the Goulburn valley (331,836 ML). Information and data relating to the portfolio of held Commonwealth environmental water is shown in Table GLB1.

The 2019–20 water allocation (253,972 ML) together with the carryover volume of 128,924 ML of water meant the CEWH had 382,896 ML of water available for delivery. A total of 311,211.6 ML of Commonwealth environmental water was delivered in the Goulburn valley. A total of 55,245 ML of available Commonwealth environmental water was carried over for environmental use into the 2020–21 water year.

13.3 Environmental conditions and resource availability

The water available for environmental delivery combined with the present and antecedent environmental conditions are key inputs used by environmental water managers in planning and implementing watering actions. *Post hoc*, this information provides important context when evaluating the effectiveness and appropriateness of environmental water use with respect to hydrological outputs.

The rainfall conditions in the Goulburn valley were classified as average, based on rainfall percentile data for the entire record held by the Bureau of Meteorology for this valley. The water held in major storages in the Goulburn valley decreased over the water year, for example Eildon dam was 38.1% full at the beginning of the water year and 52.8% full by the end of the year (Figure GLB1).

The CEWO calculates resource availability scenarios (RAS) to guide the use and prioritisation of held environmental water. The RAS are progressively calculated over the year as part of the continual adaptive management planning processes. The RAS are based on the availability of held environmental water (including progressive licence acquisitions and allocations) as well as the potential for unregulated or planned environmental flows. The outcome is then used to determine the demand for environmental water across the Basin.

In 2019–20, the resource availability of held Commonwealth environmental water in the Goulburn was classified as low to high, whilst the overall demand for environmental water was classified as high to moderate (Commonwealth Environmental Water Office. The physical conditions meant that the CEWO was managing to protect and improve the aquatic and riparian vegetation and native fish and other biota via habitat provision.

13.4 Watering actions

A total of 7 watering actions were delivered over the 2019–20 water year, the duration of these actions varied (range of individual actions: 4 - 82 days) and Commonwealth environmental water was delivered for a total of 231 days. The number of water actions commencing in each season included, summer (0), autumn (1), winter (4), spring (2). Similarly, the count of flow component types delivered in the Goulburn valley were; (5) baseflow, (0) baseflow-fresh, (0) baseflow-fresh-bankfull, (0) baseflow-fresh-overbank-wetland, (2) fresh, (0) fresh-wetland, (0) bankfull, (0) overbank, (0) wetland and (0) wetland-overbank.

The Goulburn watering actions were delivered for water quality, ecosystem processes, biota, fish and vegetation purposes, but water was also delivered for other purposes too. The percentage of watering actions delivered across the nine main themes included fish (18.18%), vegetation (22.73%), waterbirds (0.0%), frogs (0.0%), other biota (13.64%), connectivity (0.0%), process (27.27%), resilience (0.0%) and water quality (18.18%).

Table GLB1. Commonwealth environmental water accounting information for the Goulburn valley over 2019–20 water year.

Total registered volume (ML)	Allocated volume (ML)	Carry over + allocated volume (ML)	Delivered (ML)	LTAAY (ML)	Carried over to 2021–22
360,024	253,972	382,896	324,744	331,836	55,245

13.5 Contribution of Commonwealth environmental water to flow regimes

13.5.1 Eildon

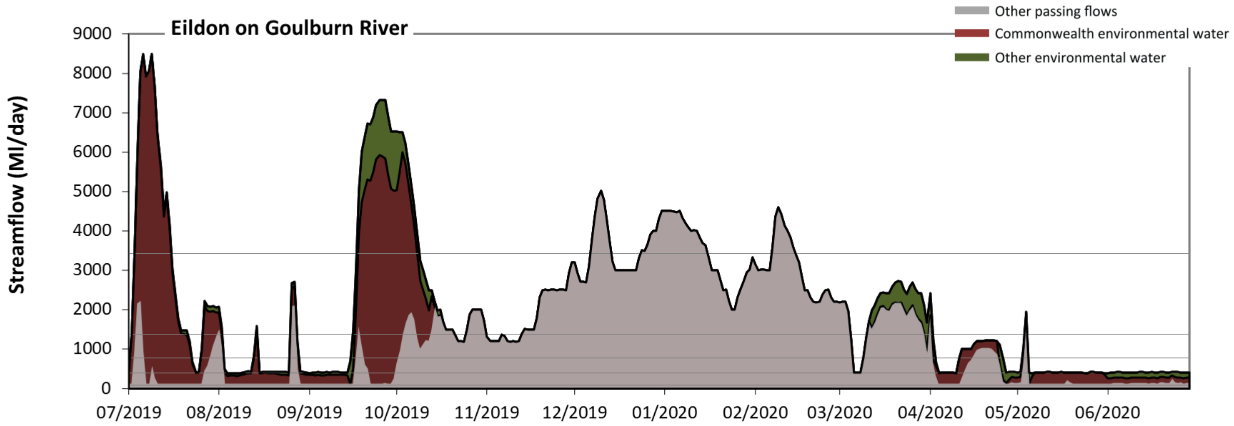


Figure GLB2: Contribution of environmental water delivery at Eildon. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Eildon on Goulburn River environmental water contributed 35% of the total streamflow volume (most of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 62% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 79 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the durations of low flows (i.e. < 400 ML/day) in the periods July to September and April to June would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 40% to 3% of the year, with greatest influence in the periods July to September and April to June. Commonwealth environmental water was almost entirely responsible for these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 780 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the periods July to September (from 5 days to 21 days) and April to June (from 9 days to 14 days). Commonwealth environmental water made the dominant contribution to these increased durations of low freshes. In the absence of environmental water there would have been at least one medium fresh (i.e. > 1400 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest medium fresh during the periods July to September (from 2 days to 20 days) and April to June (from 1 days to 2 days). Commonwealth environmental water made a modest contribution to these increased durations of medium freshes. In the absence of environmental water there would have been at least one high fresh in the periods November to December and January to March. Environmental water increased the duration of the longest high fresh during the period July to September (from 0 days to 13 days). Commonwealth environmental water was entirely responsible for these increased durations of high freshes.

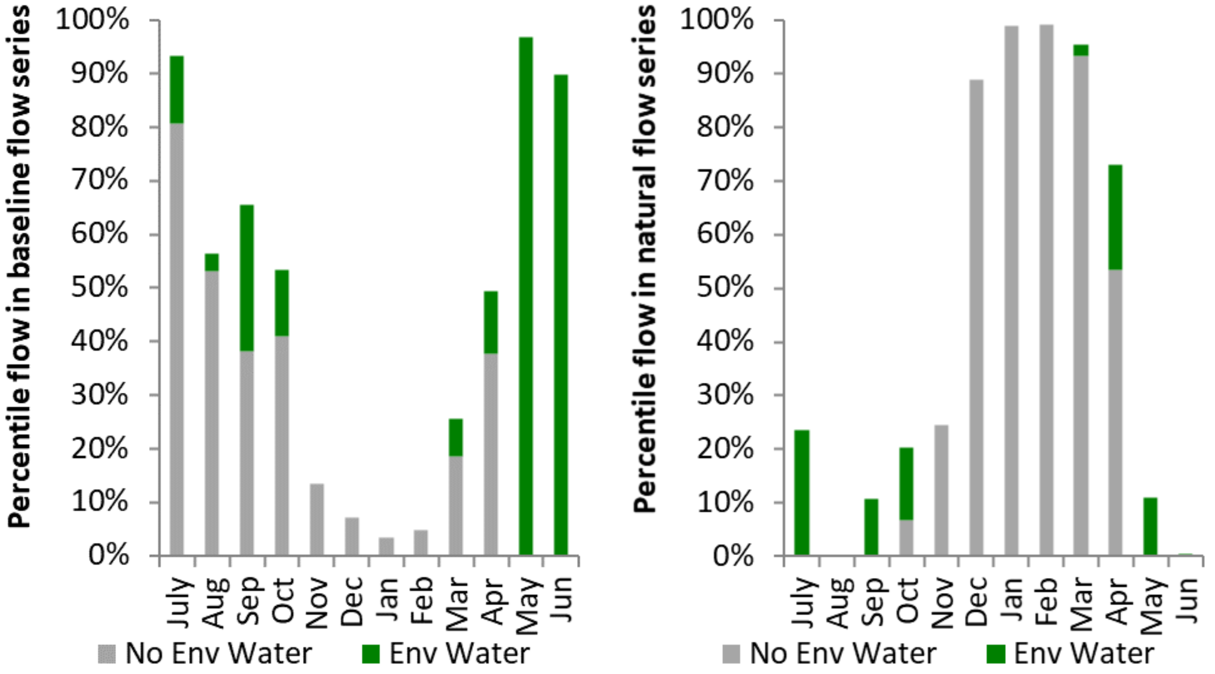


Figure GLB3: Contribution of environmental water delivery at Eildon as percentiles in the natural and baseline flow series.

13.5.2 Trawool

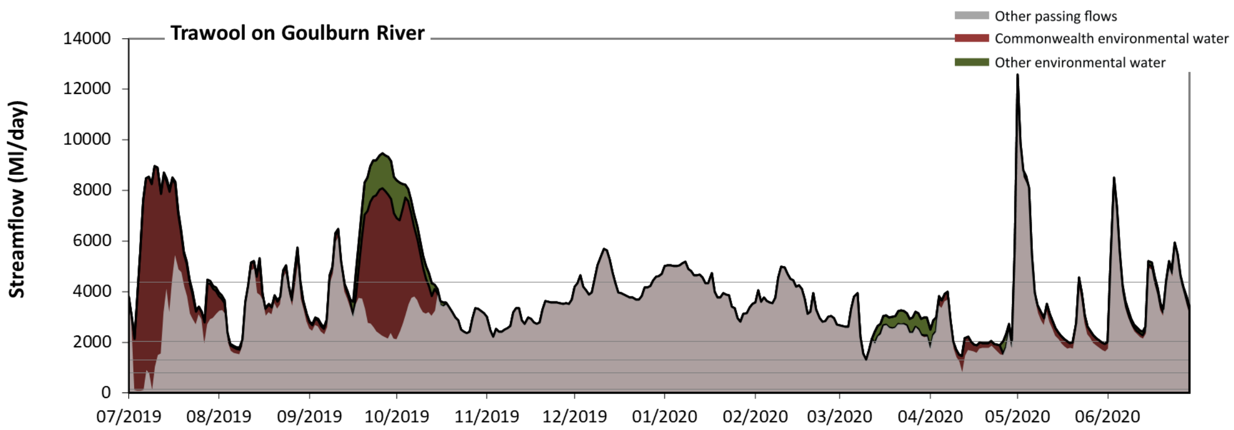


Figure GLB4: Contribution of environmental water delivery at Trawool. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Trawool on Goulburn River environmental water contributed 19% of the total streamflow volume (most of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 62% of days between 1 July 2019 and 30 June 2020. Without environmental water, the duration of very low flows (i.e. < 130 ML/day) in the period July to September would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 1% to 0% of the year, with greatest influence in the period July to September. Similarly, without environmental water, the duration of low flows (i.e. < 770 ML/day) in the period July to September would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 2% to 0% of the year, with greatest influence in the period July to September. There was at least one low fresh (i.e. > 1300 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water made little change to the duration of these low freshes. There was at least one medium fresh (i.e. > 2000 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water made little change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest high fresh during the periods July to September (from 4 days to 18 days) and October to December (from 7 days to 12 days). Commonwealth environmental water was almost entirely responsible for these increased durations of high freshes.

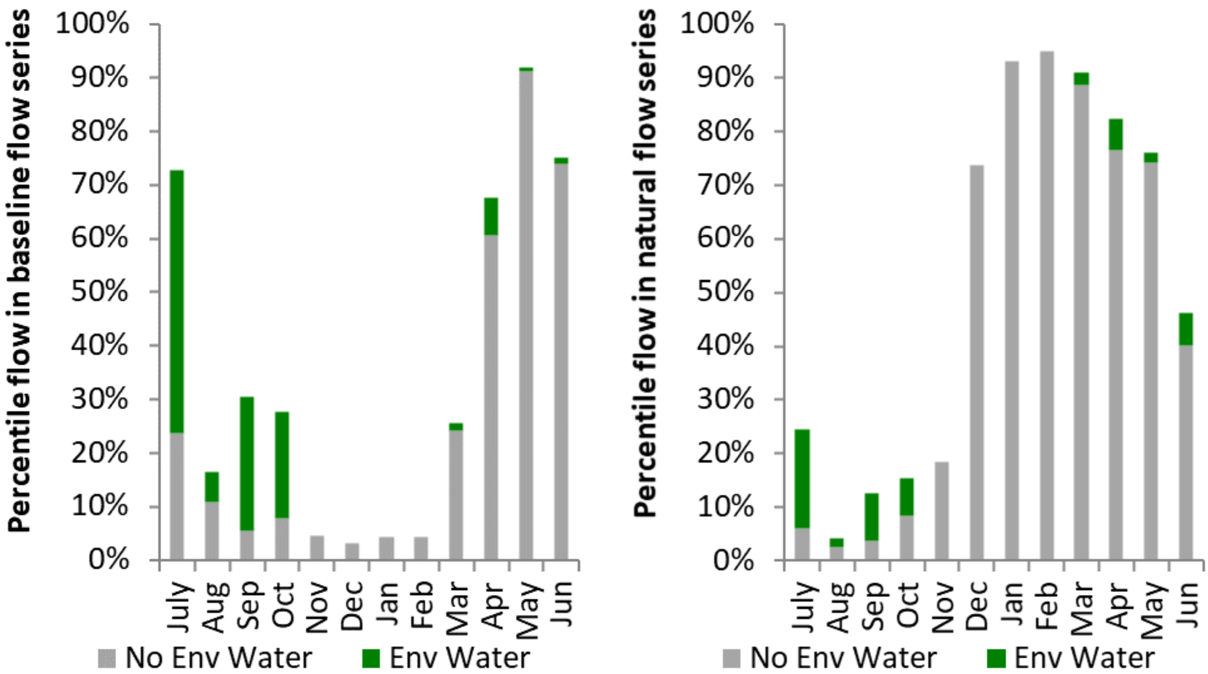


Figure GLB5: Contribution of environmental water delivery at Trawool as percentiles in the natural and baseline flow series.

13.5.3 Murchison

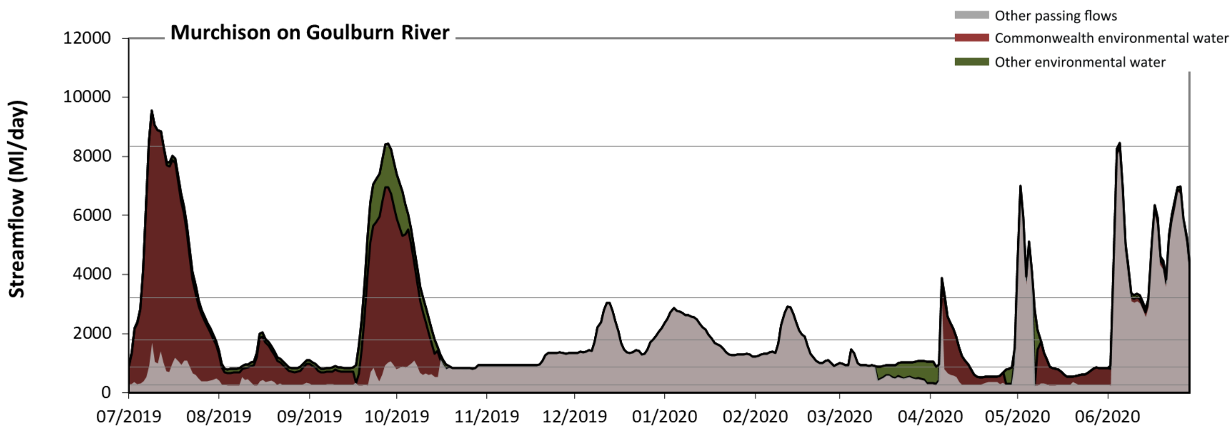
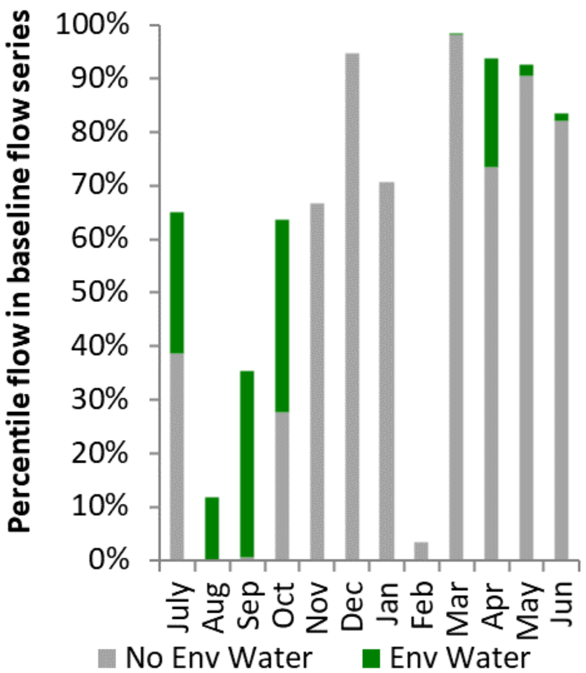


Figure GLB6: Contribution of environmental water delivery at Murchison. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Murchison on Goulburn River environmental water contributed 43% of the total streamflow volume (most of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 62% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 250 ML/day) in the periods July to September and April to June would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 7% to 0% of the year, with greatest influence in the periods July to September and April to June. Similarly, without environmental water, the durations of low flows (i.e. < 870 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 46% to 18% of the year, with greatest influence in the period July to September. Environmental water increased the magnitude of flows below this low flow threshold with the result that low flows were generally far below the low flow threshold. Commonwealth environmental water equally shared responsibility with other environmental water holders for these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 1800 ML/day) in the periods October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the periods July to September (from 0 days to 28 days) and October to December (from 8 days to 14 days). Commonwealth environmental water was almost entirely responsible for these increased durations of low freshes. In the absence of environmental water there would have been at least one medium fresh (i.e. > 3200 ML/day) in the period April to June. Environmental water increased the duration of the longest medium fresh during the periods July to September (from 0 days to 19 days) and October to December (from 0 days to 9 days). Commonwealth environmental water was entirely responsible for these increased durations of medium freshes. Environmental water increased the duration of the longest high fresh (i.e. > 8300 ML/day) during the periods July to September (from 0 days to 5 days) and April to June (from 0 days to 1 days). Commonwealth environmental water equally shared responsibility with other environmental water holders for these increased durations of high freshes.



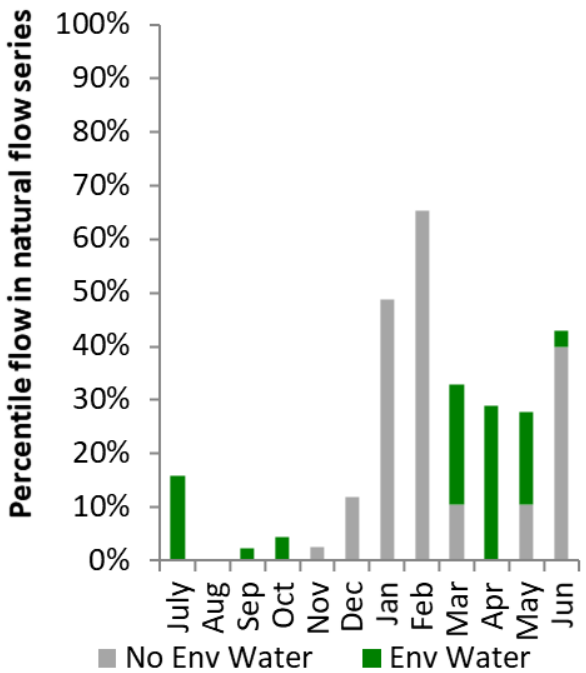


Figure GLB7: Contribution of environmental water delivery at Murchison as percentiles in the natural and baseline flow series.

13.5.4 McCoys

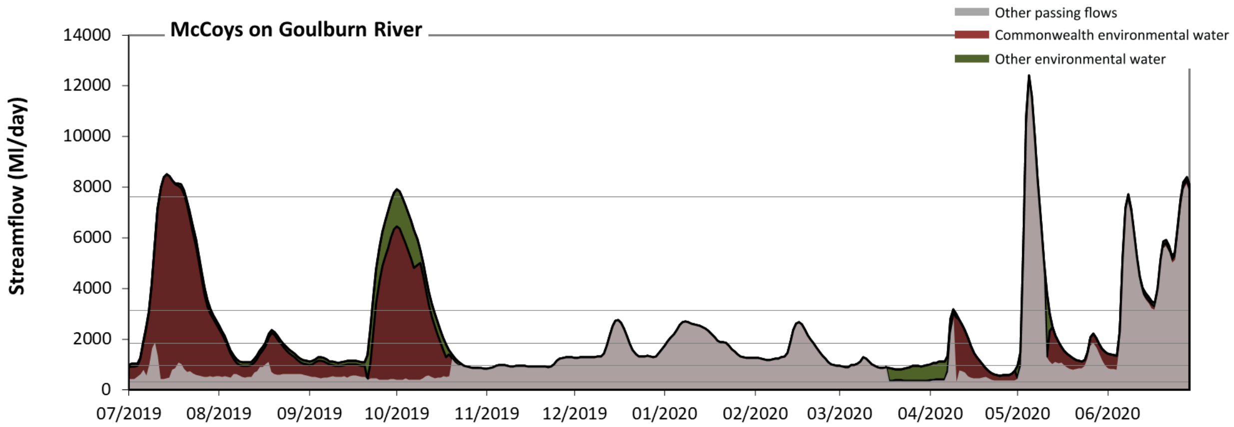


Figure GLB8: Contribution of environmental water delivery at McCoys. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At McCoys on Goulburn River environmental water contributed 41% of the total streamflow volume (most of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 63% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 310 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the durations of low flows (i.e. < 960 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 54% to 17% of the year, with greatest influence in the period July to September. Commonwealth environmental water made the dominant contribution to these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 1800 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the periods July to September (from 1 days to 30 days) and October to December (from 7 days to 17 days). Commonwealth environmental water was almost entirely responsible for these increased durations of low freshes. In the absence of environmental water there would have been at least one medium fresh (i.e. > 3100 ML/day) in the period April to June. Environmental water increased the duration of the longest medium fresh during the periods July to September (from 0 days to 21 days) and October to December (from 0 days to 13 days). Commonwealth environmental water was entirely responsible for these increased durations of medium freshes. In the absence of environmental water there would have been at least one high fresh in the period April to June. Environmental water increased the duration of the longest high fresh during the periods July to September (from 0 days to 9 days) and October to December (from 0 days to 2 days). Commonwealth environmental water equally shared responsibility with other environmental water holders for these increased durations of high freshes.

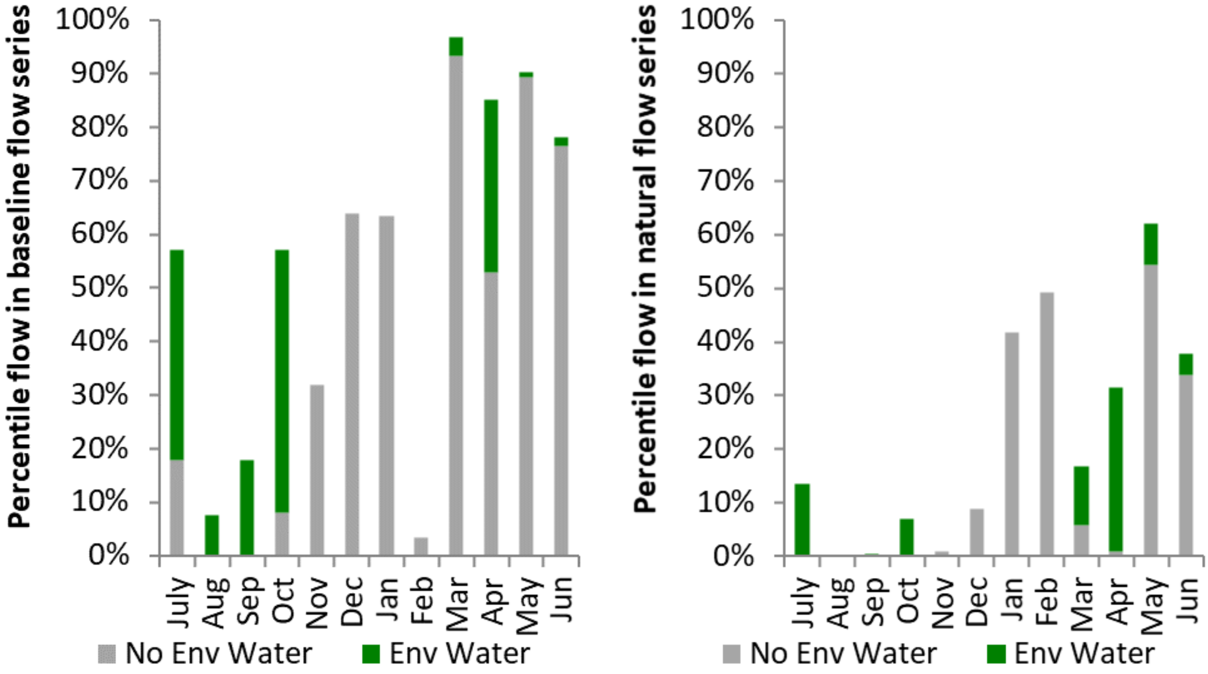


Figure GLB9: Contribution of environmental water delivery at McCoys as percentiles in the natural and baseline flow series.

14 Broken Valley

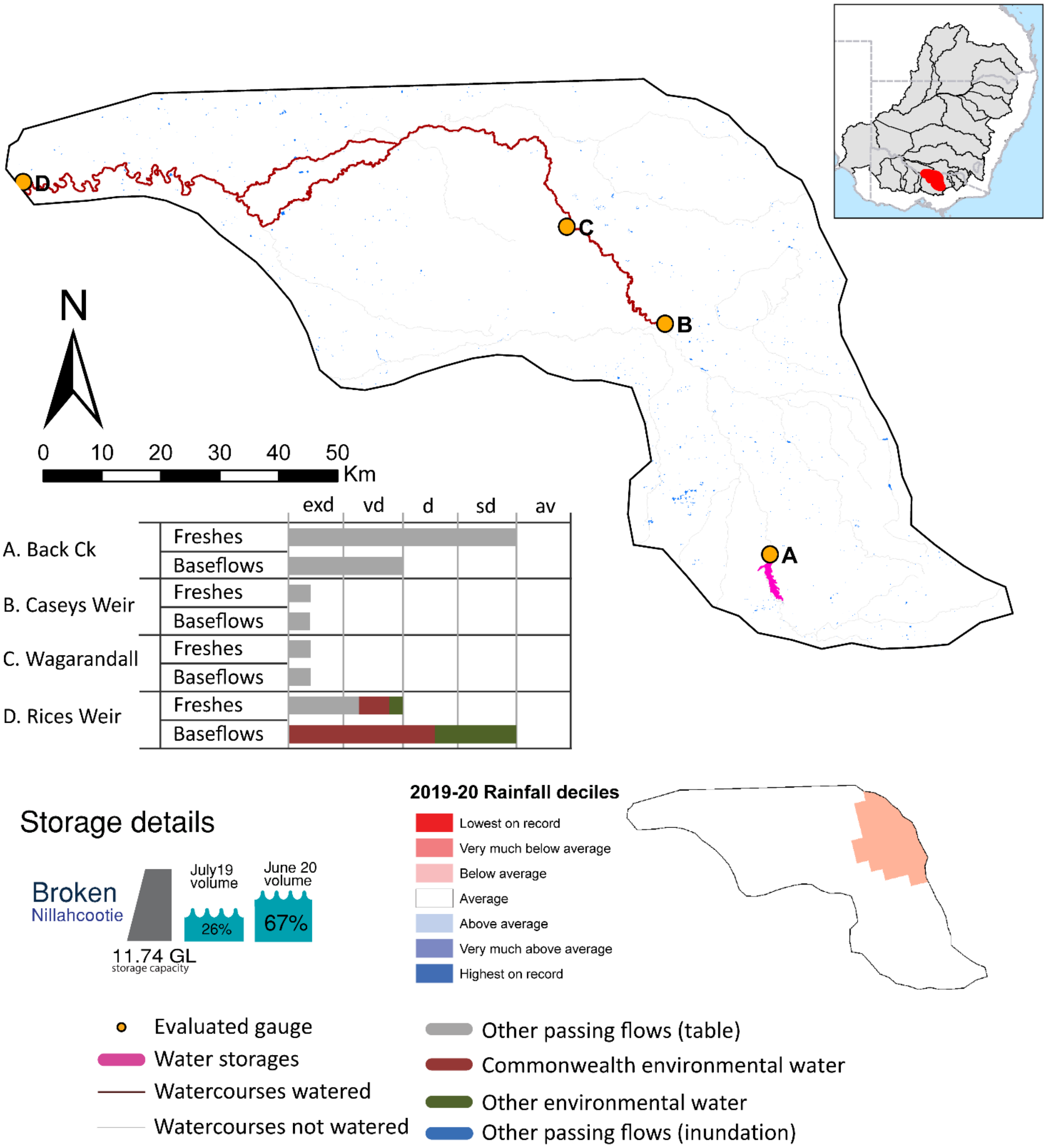


Figure BRK1: Watercourses influenced, areas inundated (where applicable) and gauge stations evaluated in the Broken valley during the 2019–20 water year. Inset bar graphs report the condition of annual flow regimes by showing the improvements in hydrological condition with the addition of environmental water as well as the hypothetical scenario in 'grey' (if no environmental flow had been delivered). Rainfall conditions (rainfall deciles) and trend in storage levels for the water year are also shown. The classified bands are: exd = extremely dry, vd=very dry, sd=somewhat dry and av=average.

14.1 Summary

The volume of environmental water delivery for the 2019–20 year in the Broken valley is quantified using data for 4 sites. This evaluation only considers the contribution of held environmental water, which is a primary focus for the Commonwealth. The contributions of planned environmental water (e.g. passing flows), unregulated tributary inflows and clever use of irrigation flows for environmental benefits can all be very important but these are outside the scope of this report. Environmental watering actions lasted on average 149 days over the course of the year. The volume of environmental water at these 4 sites was between 0% and 30% of the total streamflow. Commonwealth environmental water contributed on average 43% of this environmental water. The contribution of environmental water delivery to improved flow regimes is evaluated using data for 4 sites. Ideally, baseflows should be maintained and long periods of excessively low flows avoided. In this valley, the baseflow regime was generally considered to be extremely dry relative to the pre-development flow regime. In our analysis, a low fresh refers to a period of increased flow, when the water level rises at least one eighth of the way up the river bank (above the low flow level). These low freshes are a regular part of the natural flow regime and support a range of natural processes. In the Broken valley, in terms of the occurrence and duration of low freshes, the year was assessed as being dry. In our analysis, a medium fresh refers to a period of increased flow, when the water level rises at least one quarter of the way up the river bank. These medium freshes are not as frequent as low freshes but are also a regular and important part of the natural flow regime. In the Broken valley, in terms of the occurrence of medium freshes, the year was assessed as being very dry. In our analysis, a high fresh refers to a period of increased flow, when the water level rises more than half way up the river. A high fresh may not occur every year but they are still important and long periods without major freshes can have serious consequences for floodplains and their contribution to river ecosystem health. Delivering environmental high in channel flows normally requires that all risks to riparian landholders and infrastructure have been resolved. In the Broken valley, in terms of the occurrence of high freshes, the year was assessed as being extremely dry.

14.2 Water delivery context

During the 2019–20 water year, the Commonwealth Environmental Water Holder (CEWH) held water entitlements of up to 538 ML for environmental use in the Broken valley. Each year, water utilities allocate water entitlement holders a percentage of water based on their holding, licence type and carryover (the exact rules vary among Jurisdictions and licence type). In 2019–20, the Broken entitlements held by the CEWH were allocated 11 ML of water, representing 4% of the Long term average annual yield for the Broken valley (305 ML). Information and data relating to the portfolio of held Commonwealth environmental water is shown in Table BRK1.

The 2019–20 water allocation (11 ML) together with the carryover volume of 208 ML of water meant the CEWH had 218 ML of water available for delivery. A total of 113 ML of Commonwealth environmental water was delivered in the Broken valley. A total of 105.2 ML (48%) of available Broken valley Commonwealth environmental water was carried over for environmental use into the 2020–21 water year.

14.3 Environmental conditions and resource availability

The water available for environmental delivery combined with the present and antecedent environmental conditions are key inputs used by environmental water managers in planning and implementing watering actions. *Post hoc*, this information provides important context when evaluating the effectiveness and appropriateness of environmental water use with respect to hydrological outputs.

The rainfall conditions in the Broken valley were classified as average, based on rainfall percentile data for the entire record held by the Bureau of Meteorology for this valley. The water held in major storages in the Broken valley decreased over the water year, for example Nilahcootie dam was 26.0% full at the beginning of the water year and 67.2% full by the end of the year (Figure BRK1).

The CEWO calculates resource availability scenarios (RAS) to guide the use and prioritisation of held environmental water. The RAS are progressively calculated over the year as part of the continual adaptive management planning processes. The RAS are based on the availability of held environmental water (including progressive licence acquisitions and allocations) as well as the potential for unregulated or planned environmental flows. The outcome is then used to determine the demand for environmental water across the Basin.

In 2019–20, the resource availability of held Commonwealth environmental water in the Broken was classified as low to high, whilst the overall demand for environmental water was classified as high to moderate. The physical conditions meant that the CEWO was managing to protect and improve the aquatic and riparian vegetation and native fish and other biota via habitat provision.

14.4 Watering actions

A total of 3 watering actions were delivered over the 2019–20 water year, the duration of these actions varied (range of individual actions: 48–64 days) and Commonwealth environmental water was delivered for a total of 163 days. The number of water actions commencing in each season included, summer (0), autumn (0), winter (2), spring (1). Similarly, the count of flow component types delivered in the Broken valley were; (3) baseflow, (0) baseflow-fresh, (0) baseflow-fresh-bankfull, (0) baseflow-fresh-overbank-wetland, (0) fresh, (0) fresh-wetland, (0) bankfull, (0) overbank, (0) wetland and (0) wetland-overbank.

In the Broken, watering actions were delivered for water quality, biota, fish and vegetation purposes, but water was also delivered for other purposes too. The percentage of watering actions delivered across the nine main themes included fish (30%), vegetation (30%), waterbirds (0.0%), frogs (0.0%), other biota (20%), connectivity (0.0%), process (0.0%), resilience (0.0%) and water quality (20%).

Table BRK1. Commonwealth environmental water accounting information for the Broken valley over 2019–20 water year.

Total registered volume (ML)	Allocated volume (ML)	Carry over + allocated volume (ML)	Delivered (ML)	LTAAY (ML)	Carried over to 2020–21
538	11	218	113	305	105

14.5 Contribution of Commonwealth environmental water to flow regimes

14.5.1 Rices

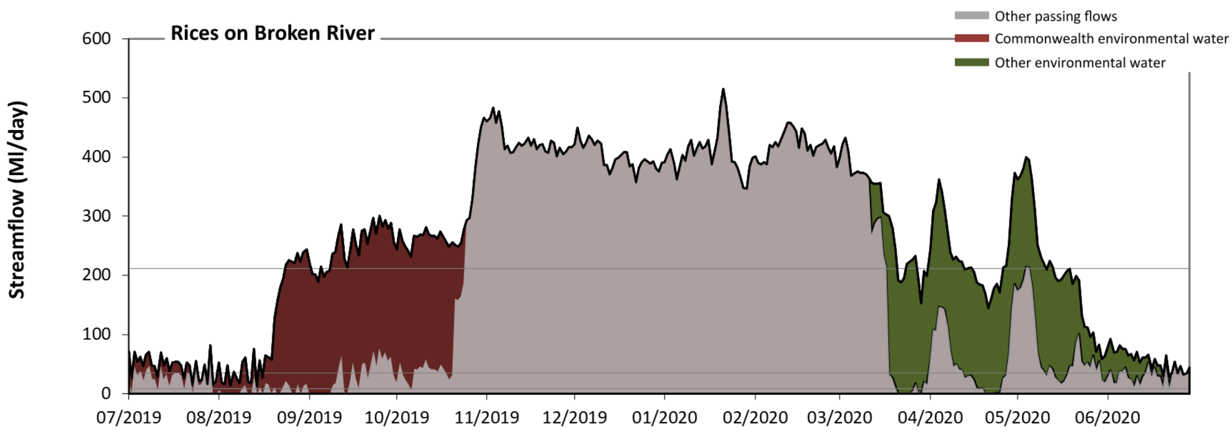


Figure BRK2: Contribution of environmental water delivery at Rices. Horizontal lines indicate thresholds for very low flows, low flows and low freshes (from lowest to highest).

At Rices on Broken River environmental water contributed 30% of the total streamflow volume (with approximately half contributed by Commonwealth environmental water). Environmental watering actions affected streamflows for 60% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 7.5 ML/day) in the periods July to September, January to March and April to June would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 13% to 0% of the year, with greatest influence in the period July to September. Similarly, without environmental water, the durations of low flows (i.e. < 34 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 35% to 6% of the year, with greatest influence in the periods July to September and April to June. Commonwealth environmental water equally shared responsibility with other environmental water holders for these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 210 ML/day) in the periods October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the periods July to September (from 0 days to 22 days), October to December (from 68 days to 92 days) and April to June (from 2 days to 15 days). Commonwealth environmental water made the dominant contribution to these increased durations of low freshes. There was no medium or high freshes this year.

14.5.2 BackCk

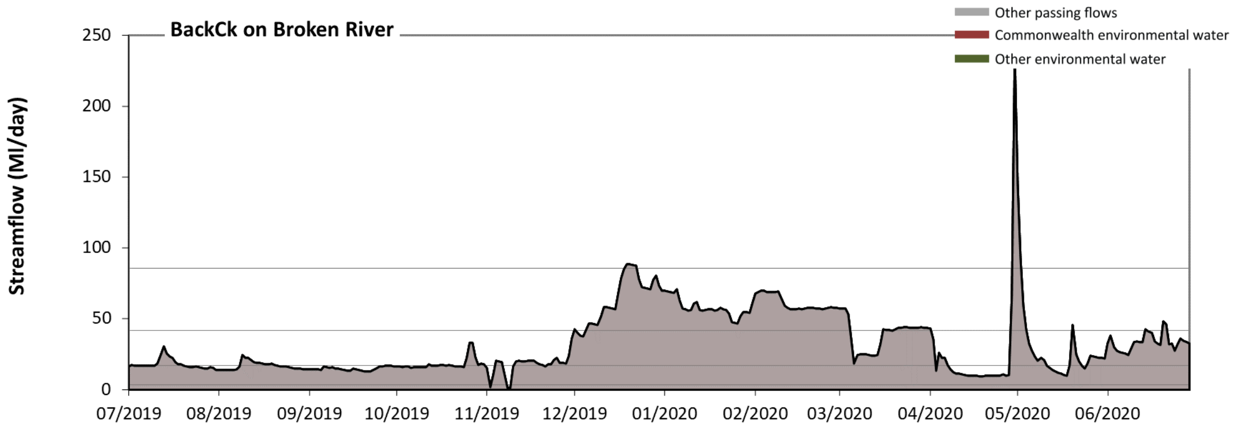
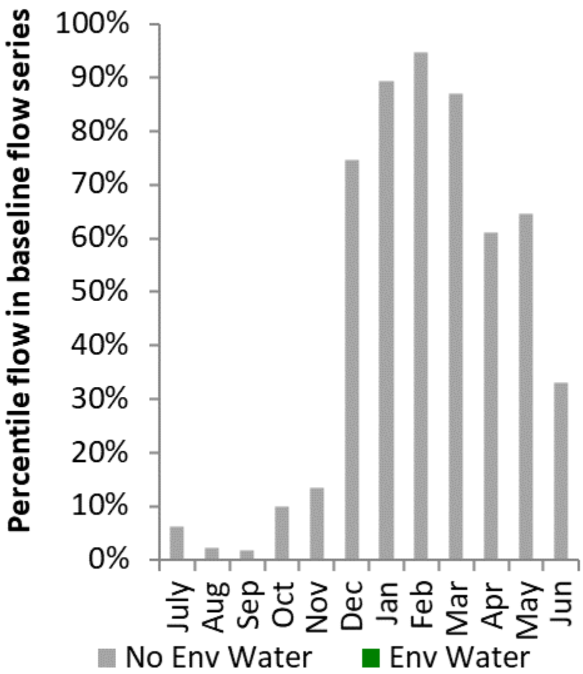


Figure BRK4: Contribution of environmental water delivery at BackCk. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

There was no environmental water delivered at BackCk on Broken River. Flow regulation does not substantially increase the duration of very low flows (i.e. < 3.4 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the durations of low flows (i.e. < 17 ML/day) in the periods July to September and October to December was substantially in excess of durations expected in an average year in the natural flow regime. There was at least one low fresh (i.e. > 42 ML/day) in the periods October to December, January to March and April to June. There was at least one medium fresh (i.e. > 85 ML/day) in the periods October to December and April to June. There was no high freshes (i.e. > 260 ML/day) this year.



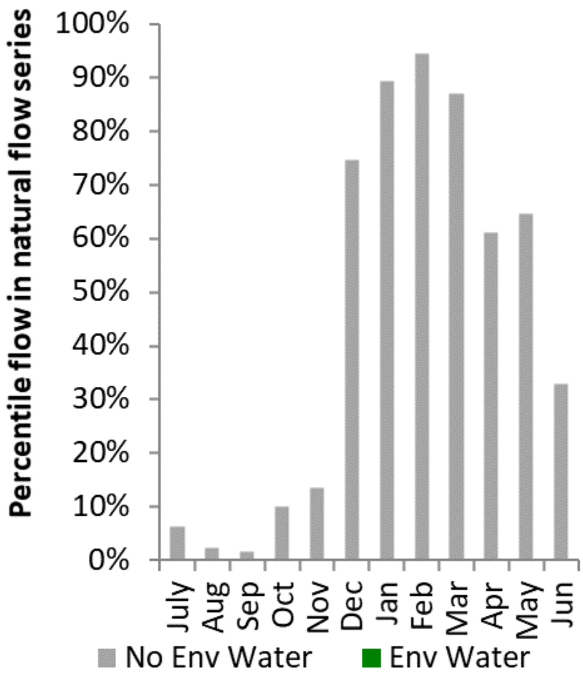


Figure BRK5: Contribution of environmental water delivery at BackCk as percentiles in the natural and baseline flow series.

14.5.3 CaseysWeir

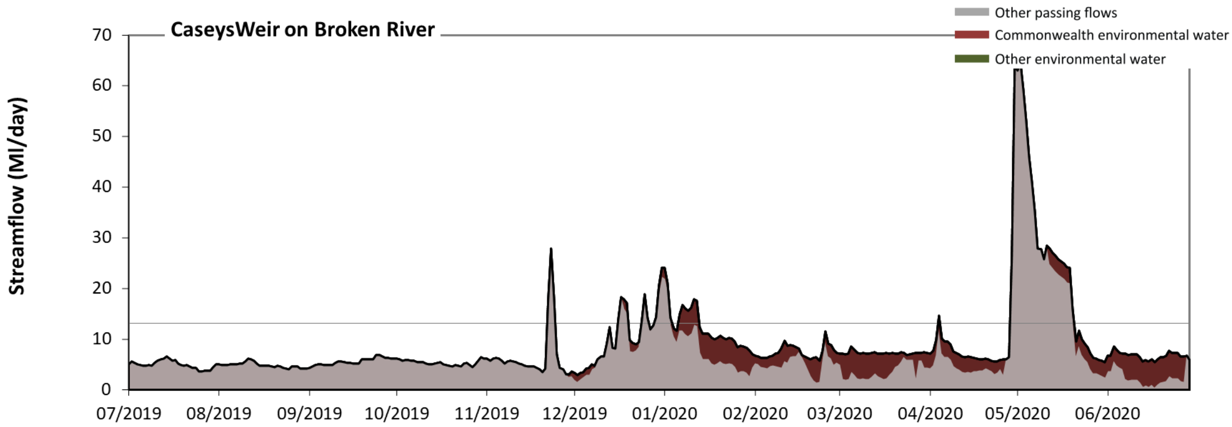


Figure BRK6: Contribution of environmental water delivery at CaseysWeir. Horizontal lines indicate thresholds for very low flows and low flows (from lowest to highest).

At CaseysWeir on Broken River environmental water contributed 18% of the total streamflow volume (all of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 52% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 13 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 90% to 87% of the year, with greatest influence in the period January to March. Similarly, without environmental water, the durations of low flows (i.e. < 65 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these low flows, which occurred for 100% of the year. Commonwealth environmental water was entirely responsible for these enhancements of environmental baseflows at this site.

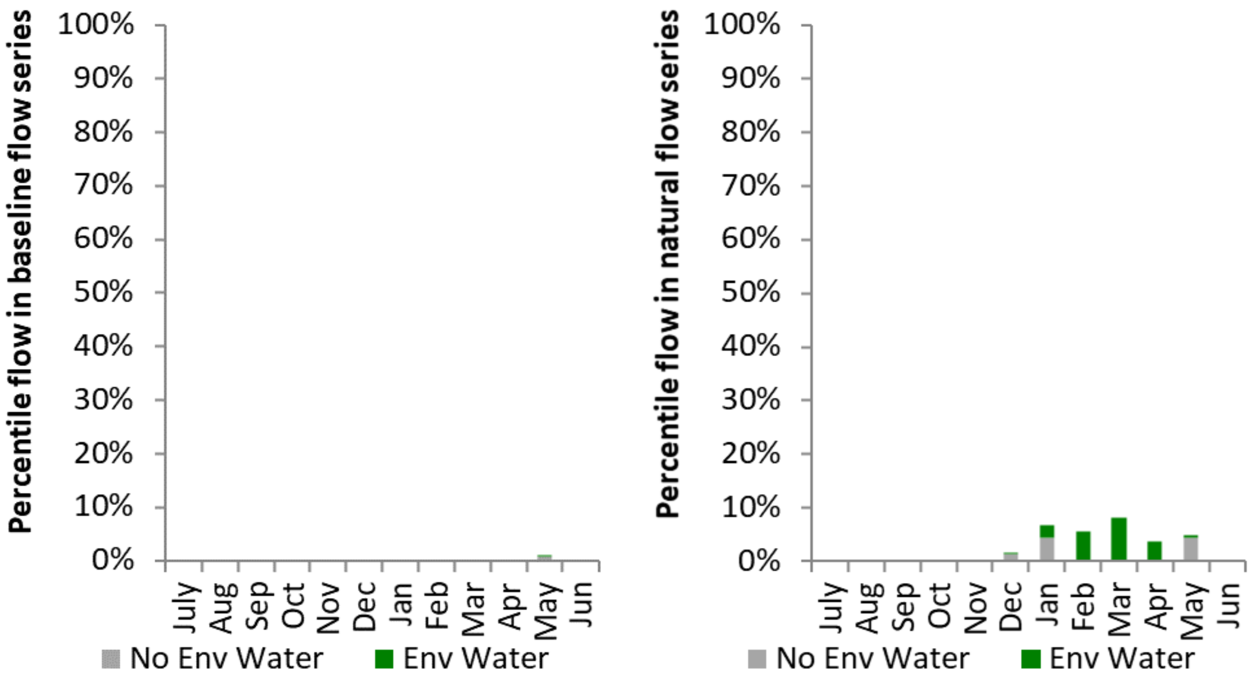


Figure BRK7: Contribution of environmental water delivery at CaseysWeir as percentiles in the natural and baseline flow series.

14.5.4 Wagarandall

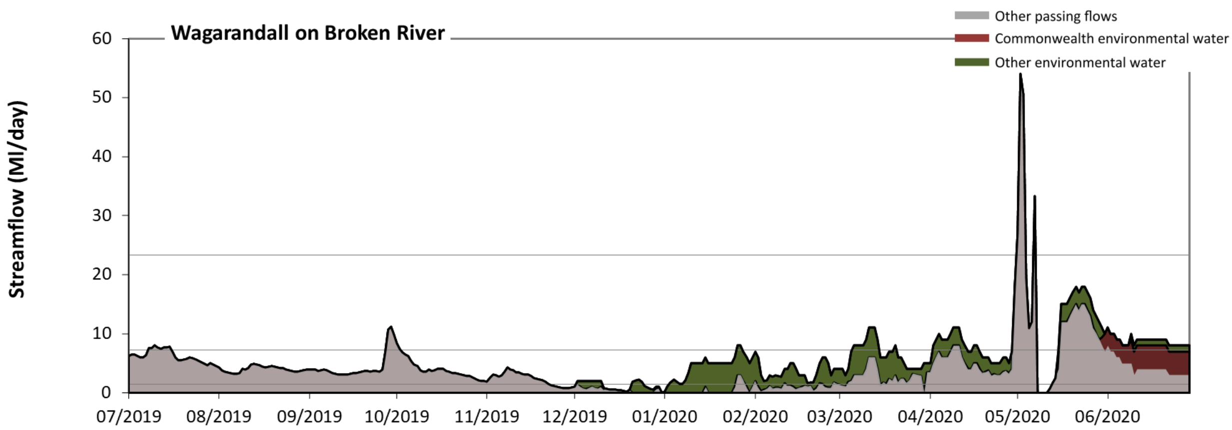


Figure BRK8: Contribution of environmental water delivery at Wagarandall. Horizontal lines indicate thresholds for very low flows, low flows and low freshes (from lowest to highest).

At Wagarandall on Broken River environmental water contributed 29% of the total streamflow volume (with a relatively small contribution of Commonwealth environmental water). Environmental watering actions affected streamflows for 52% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 1.4 ML/day) in the periods October to December, January to March and April to June would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 27% to 9% of the year, with greatest influence in the period January to March. Similarly, without environmental water, the durations of low flows (i.e. < 7.2 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 89% to 75% of the year, with greatest influence in the period April to June. Commonwealth environmental water made a modest contribution to these enhancements of environmental baseflows at this site. There was at least one low fresh (i.e. > 23 ML/day) in the period April to June. Environmental water made no change to the duration of these low freshes. There was no medium or high freshes this year.

15 Ovens Valley

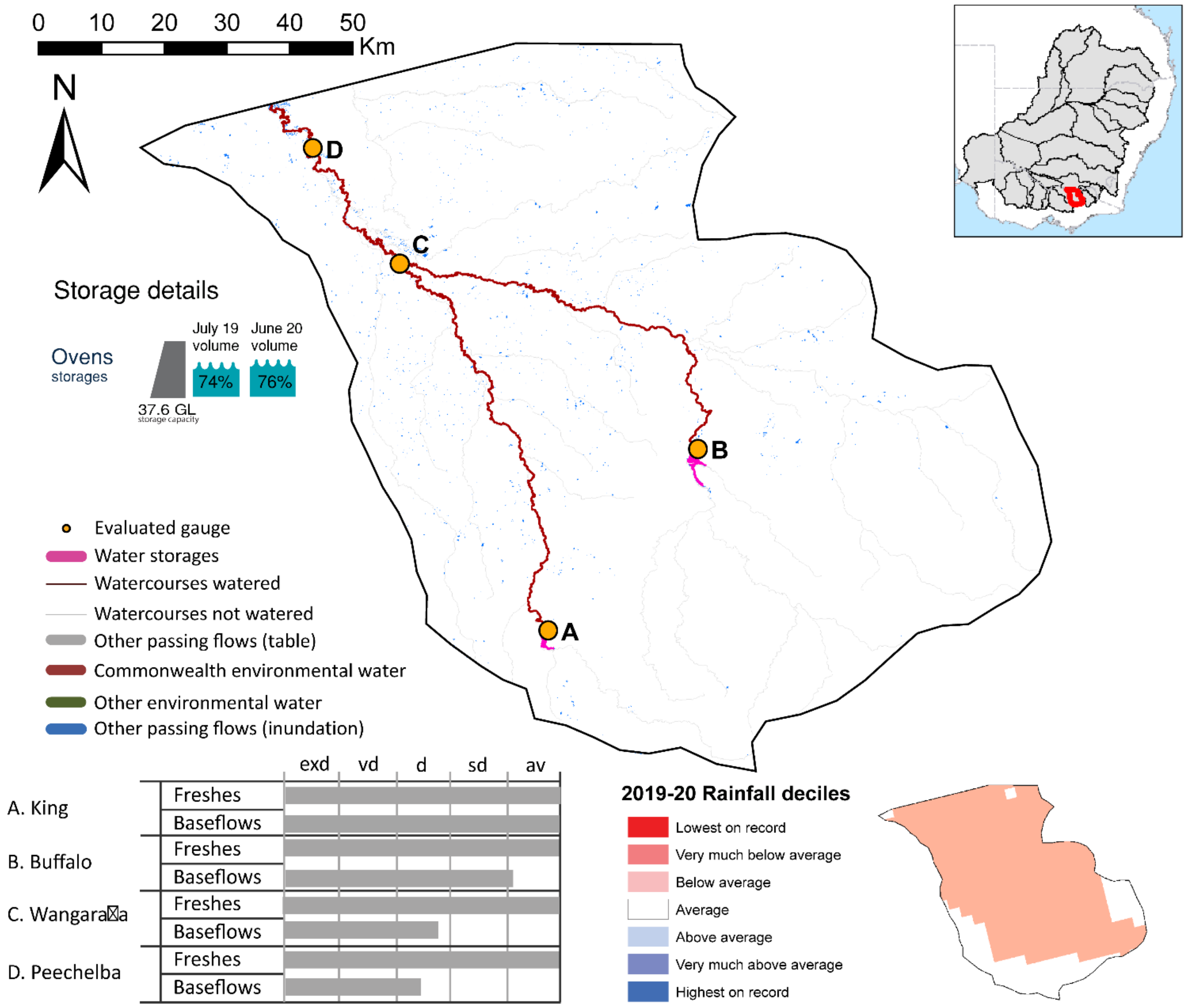


Figure OVN1: Watercourses influenced, areas inundated (where applicable) and gauge stations evaluated in the Ovens valley during the 2019–20 water year. Inset bar graphs report the condition of annual flow regimes by showing the improvements in hydrological condition with the addition of environmental water as well as the hypothetical scenario in 'grey' (if no environmental flow had been delivered). Rainfall conditions (rainfall deciles) and trend in storage levels for the water year are also shown. The classified bands are: exd = extremely dry, vd=very dry, sd=somewhat dry and av=average

15.1 Summary

The volume of environmental water delivery for the 2019–20 year in the Ovens valley is quantified using data for 4 sites. This evaluation only considers the contribution of held environmental water, which is a primary focus for the Commonwealth. The contributions of planned environmental water (e.g. passing flows), unregulated tributary inflows and clever use of irrigation flows for environmental benefits can all be very important but these are outside the scope of this report. Environmental watering actions lasted on average 1 days over the course of the year. The volume of environmental water at these 4 sites was between 0% and 0% of the total streamflow. Commonwealth environmental water contributed on average 64% of this environmental water. The contribution of environmental water delivery to improved flow regimes is evaluated using data for 4 sites. Ideally, baseflows should be maintained and long periods of excessively low flows avoided. In this valley, the baseflow regime was generally considered to be somewhat dry relative to the pre-development flow regime. In our analysis, a low fresh refers to a period of increased flow, when the water level rises at least one eighth of the way up the river bank (above the low flow level). These low freshes are a regular part of the natural flow regime and support a range of natural processes. In the Ovens valley, in terms of the occurrence and duration of low freshes, the year was assessed as being average. In our analysis, a medium fresh refers to a period of increased flow, when the water level rises at least one quarter of the way up the river bank. These medium freshes are not as frequent as low freshes but are also a regular and important part of the natural flow regime. In the Ovens valley, in terms of the occurrence of medium freshes, the year was assessed as being average. In our analysis, a high fresh refers to a period of increased flow, when the water level rises more than half way up the river. A high fresh may not occur every year but they are still important and long periods without major freshes can have serious consequences for floodplains and their contribution to river ecosystem health. Delivering environmental high in channel flows normally requires that all risks to riparian landholders and infrastructure have been resolved. In the Ovens valley, in terms of the occurrence of high freshes, the year was assessed as being average.

15.2 Water delivery context

During the 2019–20 water year, the Commonwealth Environmental Water Holder (CEWH) held water entitlements of up to 123 ML for environmental use in the Ovens valley. Each year, water utilities allocate water entitlement holders a percentage of water based on their holding, licence type and carryover (the exact rules vary among Jurisdictions and licence type). In 2019–20, the Ovens entitlements held by the CEWH were allocated 123 ML of water, representing 222% of the Long term average annual yield for the Ovens valley (55 ML). Information and data relating to the portfolio of held Commonwealth environmental water is shown in Table OVN1.

The 2019–20 water allocation (123 ML) together with the carryover volume of 0 ML of water meant the CEWH had 123 ML of water available for delivery. A total of 123 ML of Commonwealth environmental water was delivered in the Ovens valley. No Commonwealth environmental water was carried over for environmental use into the 2020–21 water year.

15.3 Environmental conditions and resource availability

The water available for environmental delivery combined with the present and antecedent environmental conditions are key inputs used by environmental water managers in planning and implementing watering actions. *Post hoc*, this information provides important context when evaluating the effectiveness and appropriateness of environmental water use with respect to hydrological outputs.

The rainfall conditions in the Ovens valley were classified as below average, based on rainfall percentile data for the entire record held by the Bureau of Meteorology for this valley. The water held in major storages in the Ovens valley decreased over the water year, for example Buffalo and William Hovell dam was 73.5% full at the beginning of the water year and 75.6% full by the end of the year (Figure OVN1).

The CEWO calculates resource availability scenarios (RAS) to guide the use and prioritisation of held environmental water. The RAS are progressively calculated over the year as part of the continual adaptive management planning processes. The RAS are based on the availability of held environmental water (including progressive licence acquisitions and allocations) as well as the potential for unregulated or planned environmental flows. The outcome is then used to determine the demand for environmental water across the Basin.

In 2019–20, the resource availability of held Commonwealth environmental water in the Ovens was classified as low to high, whilst the overall demand for environmental water was classified as high to moderate. The physical conditions meant that the CEWO was managing to protect and improve the aquatic and riparian vegetation and native fish and other biota via habitat provision.

15.4 Watering actions

A total of 4 watering actions were delivered over the 2019–20 water year. The duration of these actions went for less than one day and cumulatively Commonwealth environmental water was delivered for a total of 2 days. The number of water actions commencing in each season included, summer (2), autumn (2), winter (0), spring (0). Similarly, the count of flow component types delivered in the Ovens valley were; (1) baseflow, (0) baseflow-fresh, (0) baseflow-fresh-bankfull, (0) baseflow-fresh-overbank-wetland, (1) fresh, (0) fresh-wetland, (0) bankfull, (0) overbank, (2) wetland and (0) wetland-overbank.

In the Ovens, watering actions were delivered for water quality, connectivity, fish and vegetation purposes, but water was also delivered for other purposes too. The percentage of watering actions delivered across the nine main themes included fish (37.5%), vegetation (25%), waterbirds (0.0%), frogs (0.0%), other biota (0.0%), connectivity (12.5%), process (0.0%), resilience (0.0%) and water quality (25%).

Table OVN1. Commonwealth environmental water accounting information for the Ovens valley over 2019–20 water year.

Total registered volume (ML)	Allocated volume (ML)	Carry over + allocated volume (ML)	Delivered (ML)	LTAAY (ML)	Carried over to 2020–21
123	123	123	123	55	0

15.5 Contribution of Commonwealth environmental water to flow regimes

15.5.1 King

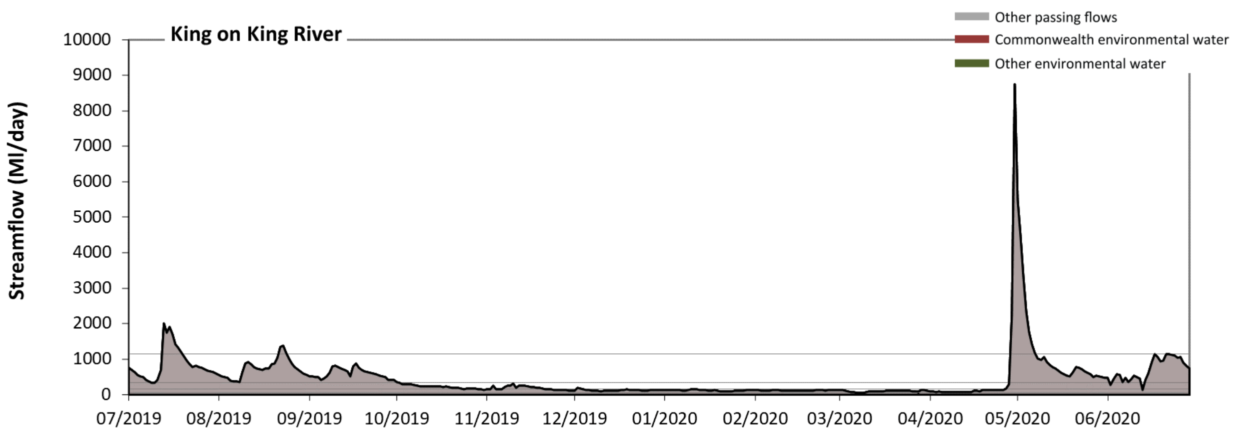


Figure OVN2: Contribution of environmental water delivery at King. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At King on King River environmental water contributed 0% of the total streamflow volume (with approximately half contributed by Commonwealth environmental water). Environmental watering actions affected streamflows for 0% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 10 ML/day) compared to an average year in the natural flow regime. Flow regulation does not substantially increase the duration of low flows (i.e. < 50 ML/day) compared to an average year in the natural flow regime. There was at least one low fresh (i.e. > 150 ML/day) in the periods July to September, October to December and April to June. Environmental water made no change to the duration of these low freshes. There was at least one medium fresh (i.e. > 330 ML/day) in the periods July to September, October to December and April to June. Environmental water made no change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the periods July to September and April to June. Environmental water made no change to the duration of these high freshes.

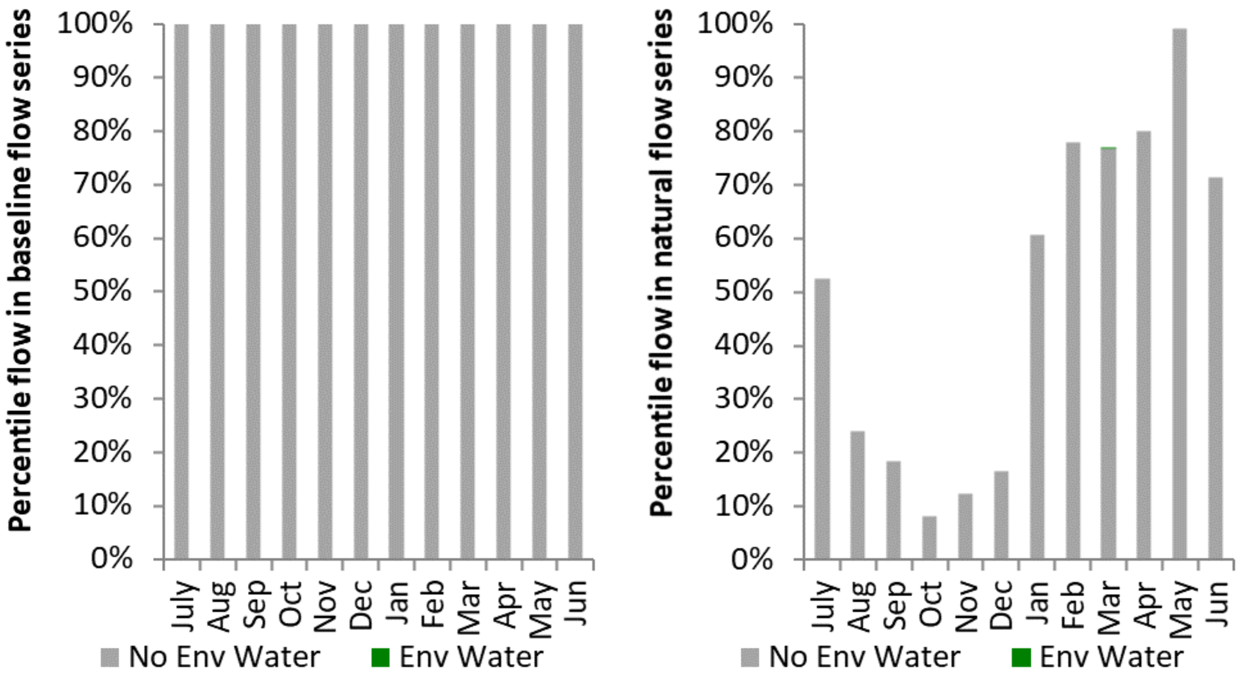


Figure OVN3: Contribution of environmental water delivery at King as percentiles in the natural and baseline flow series.

15.5.2 Wangaratta

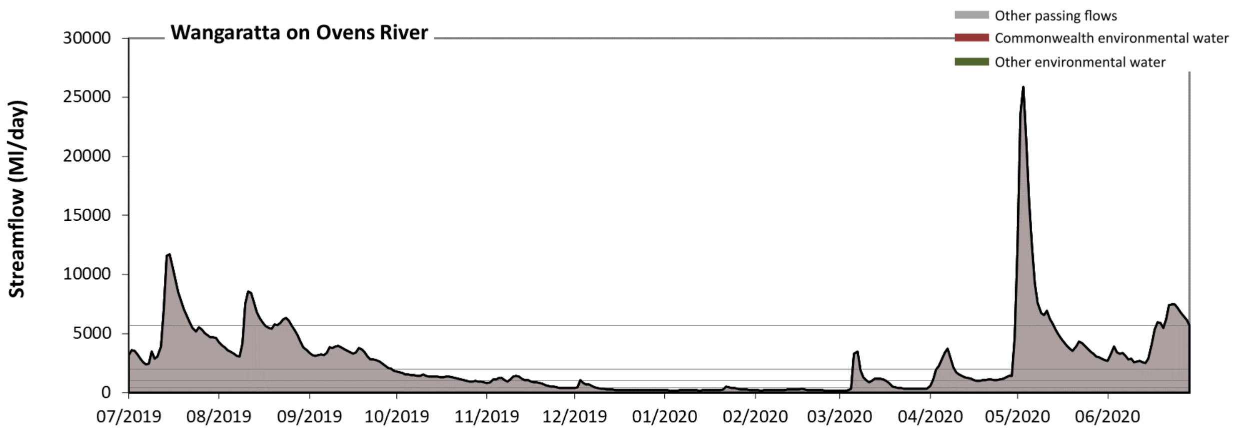


Figure OVN4: Contribution of environmental water delivery at Wangaratta. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Wangaratta on Ovens River environmental water contributed 0% of the total streamflow volume (all of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 1% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 86 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the durations of low flows (i.e. < 430 ML/day) in the periods October to December and January to March would have substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these low flows, which occurred for 29% of the year. There was at least one low fresh (i.e. > 1000 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water made no change to the duration of these low freshes. There was at least one medium fresh (i.e. > 2000 ML/day) in the periods July to September, January to March and April to June. Environmental water made no change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the periods July to September and April to June. Environmental water made no change to the duration of these high freshes.

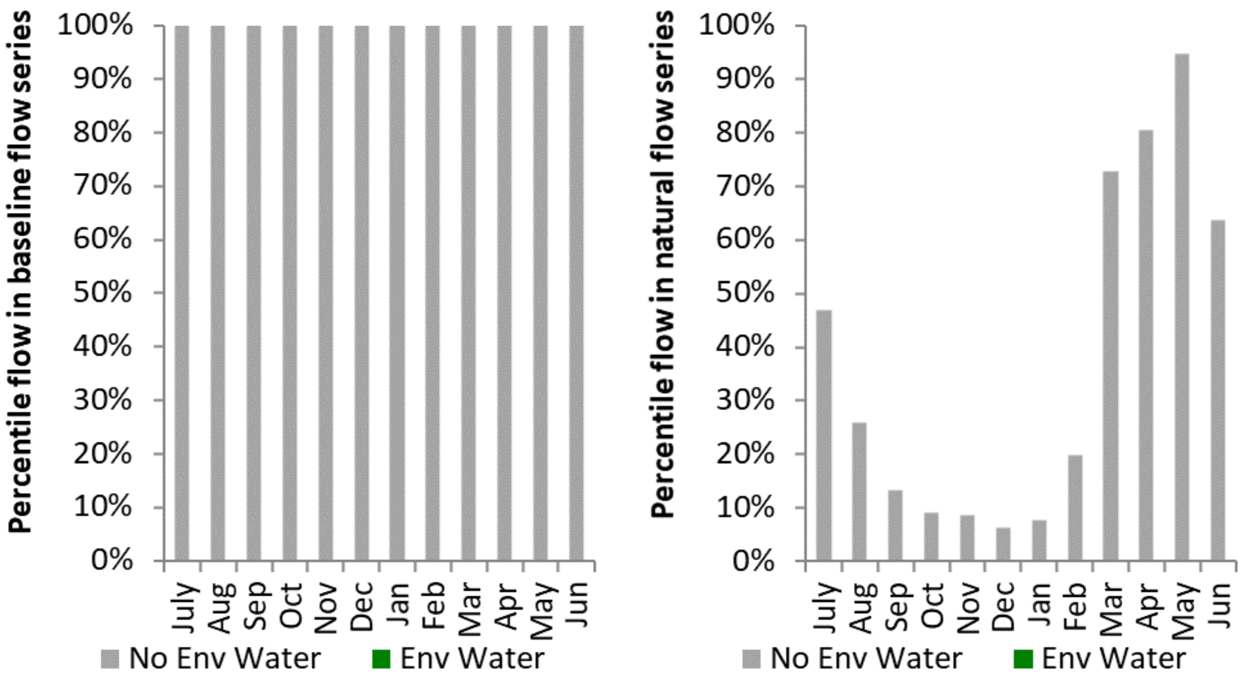


Figure OVN5: Contribution of environmental water delivery at Wangaratta as percentiles in the natural and baseline flow series.

15.5.3 Buffalo

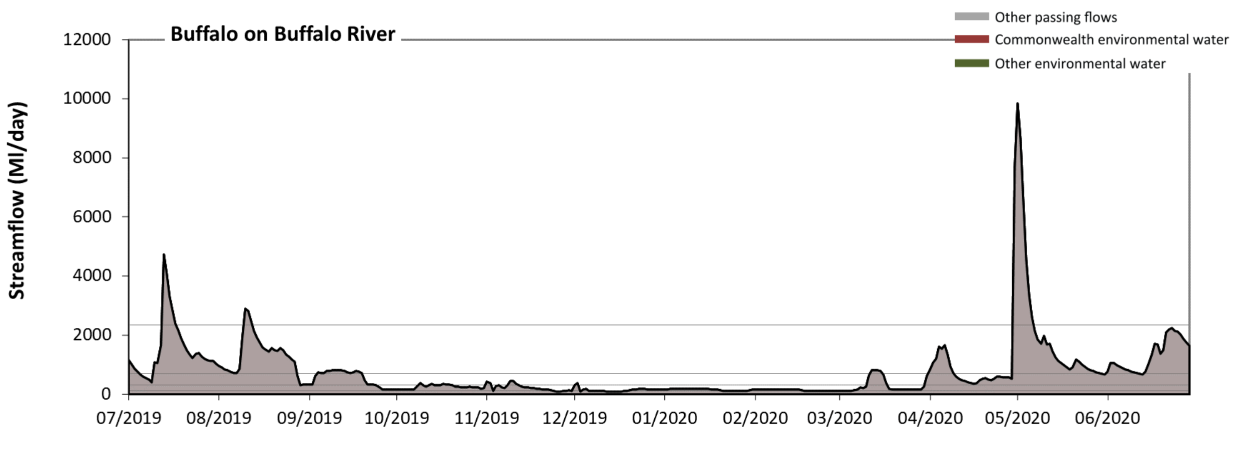


Figure OVN6: Contribution of environmental water delivery at Buffalo. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Buffalo on Buffalo River environmental water contributed 0% of the total streamflow volume (all of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 1% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 22 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the duration of low flows (i.e. < 110 ML/day) in the period October to December would have substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these low flows, which occurred for 10% of the year. There was at least one low fresh (i.e. > 310 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water made no change to the duration of these low freshes. There was at least one medium fresh (i.e. > 700 ML/day) in the periods July to September, January to March and April to June. Environmental water made no change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the periods July to September and April to June. Environmental water made no change to the duration of these high freshes.

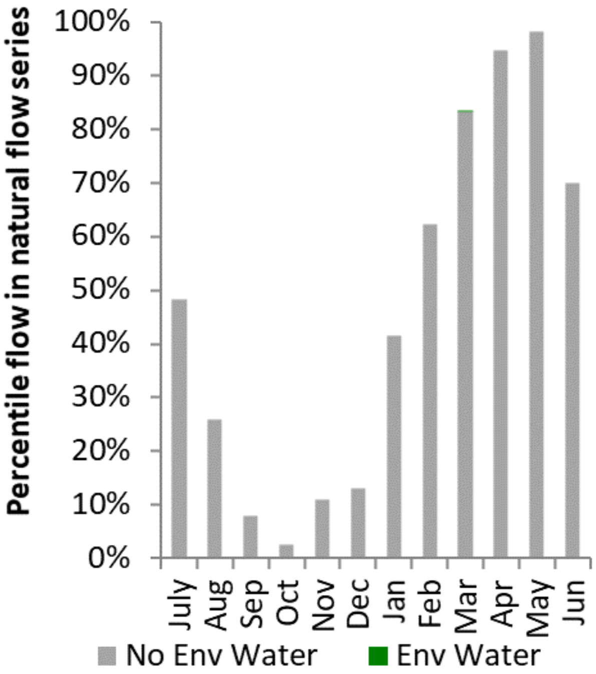


Figure OVN7: Contribution of environmental water delivery at Buffalo as percentiles in the natural flow series.

15.5.4 Peechelba

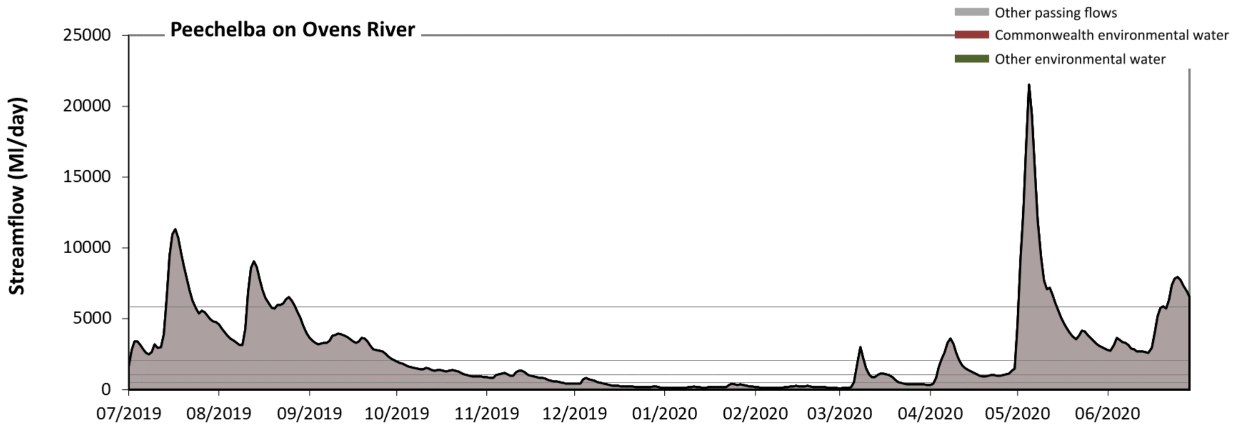


Figure OVN8: Contribution of environmental water delivery at Peechelba. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

There was no environmental water delivered at Peechelba on Ovens River. Flow regulation does not substantially increase the duration of very low flows (i.e. < 94 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the durations of low flows (i.e. < 470 ML/day) in the periods October to December and January to March was substantially in excess of durations expected in an average year in the natural flow regime. There was at least one low fresh (i.e. > 1100 ML/day) in the periods July to September, October to December, January to March and April to June. There was at least one medium fresh (i.e. > 2100 ML/day) in the periods July to September, January to March and April to June. In the absence of environmental water there was at least one high fresh in the periods July to September and April to June.

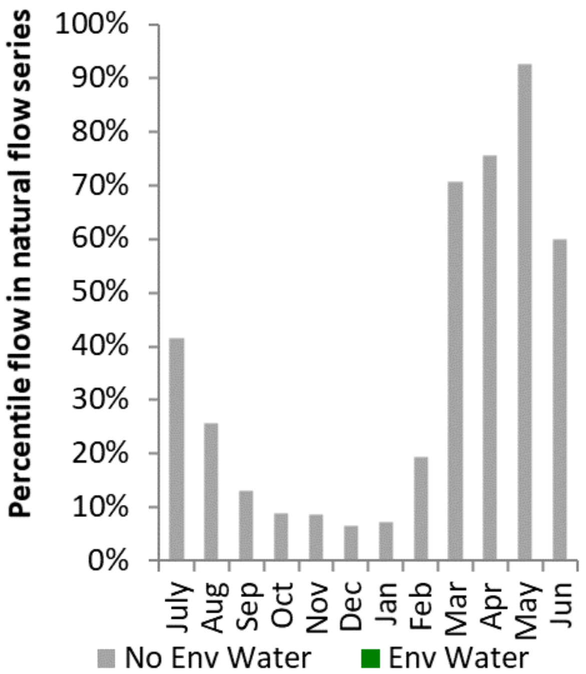


Figure OVN9: Contribution of environmental water delivery at Peechelba as percentiles in the natural flow series.

16 Campaspe Valley

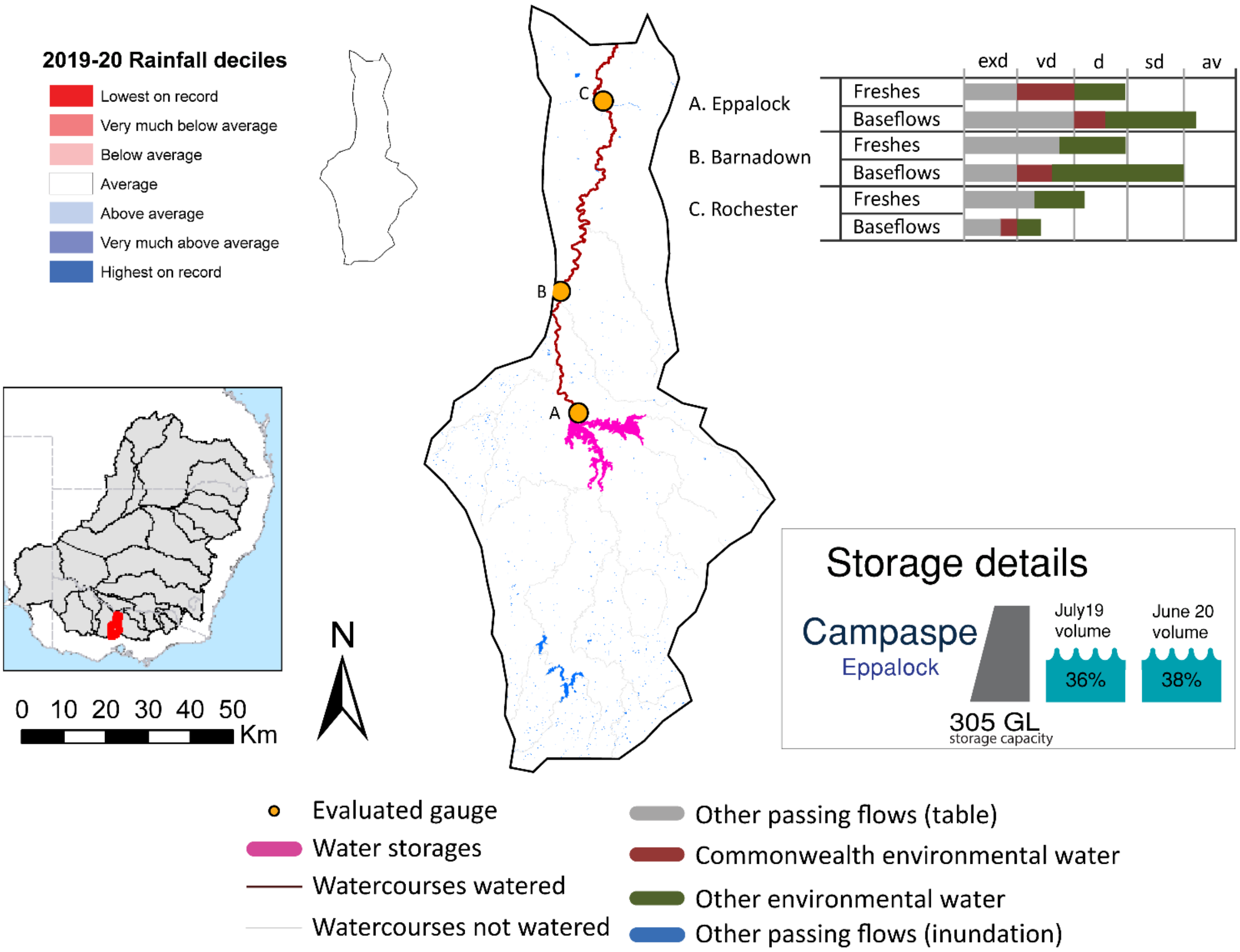


Figure CMP1: Watercourses influenced, areas inundated (where applicable) and gauge stations evaluated in the Campaspe valley during the 2019–20 water year. Inset bar graphs report the condition of annual flow regimes by showing the improvements in hydrological condition with the addition of environmental water as well as the hypothetical scenario in 'grey' (if no environmental flow had been delivered). Rainfall conditions (rainfall deciles) and trend in storage levels for the water year are also shown. The classified bands are: exd = extremely dry, vd=very dry, sd=somewhat dry and av=average.

16.1 Summary

The volume of environmental water delivery for the 2019–20 year in the Campaspe valley is quantified using data for 3 sites; Eppalock, Barnadown and Rochester. This evaluation only considers the contribution of held Commonwealth environmental water, which is a primary focus for the CEWH. The contributions of planned environmental water (e.g. passing flows), unregulated tributary inflows and clever use of irrigation flows for environmental benefits can all be very important but these are outside the scope of this report. Environmental watering actions lasted on average 237 days over the course of the year. The volume of environmental water at these 3 sites was between 40% and 46% of the total streamflow. Commonwealth environmental water contributed on average 18% of this environmental water. The contribution of environmental water delivery to improved flow regimes is evaluated using data for 3 sites. Ideally, baseflows should be maintained and long periods of excessively low flows avoided. In this valley, the baseflow regime was generally considered to be dry relative to the pre-development flow regime. In our analysis, a low fresh refers to a period of increased flow, when the water level rises at least one eighth of the way up the river bank (above the low flow level). These low freshes are a regular part of the natural flow regime and support a range of natural processes. In the Campaspe valley, in terms of the occurrence and duration of low freshes, the year was assessed as being somewhat dry. In our analysis, a medium fresh refers to a period of increased flow, when the water level rises at least one quarter of the way up the river bank. These medium freshes are not as frequent as low freshes but are also a regular and important part of the natural flow regime. In the Campaspe valley, in terms of the occurrence of medium freshes, the year was assessed as being average. In our analysis, a high fresh refers to a period of increased flow, when the water level rises more than half way up the river. A high fresh may not occur every year but they are still important and long periods without major freshes can have serious consequences for floodplains and their contribution to river ecosystem health. Delivering environmental high in channel flows normally requires that all risks to riparian landholders and infrastructure have been resolved. In the Campaspe valley, in terms of the occurrence of high freshes, the year was assessed as being extremely dry.

16.2 Water delivery context

During the 2019–20 water year, the Commonwealth Environmental Water Holder (CEWH) held water entitlements of up to 7,020 ML for environmental use in the Campaspe valley. Each year, water utilities allocate water entitlement holders a percentage of water based on their holding, licence type and carryover (the exact rules vary among Jurisdictions and licence type). In 2019–20, the Campaspe entitlements held by the CEWH were allocated 5,306 ML of water, representing 81% of the Long term average annual yield for the Campaspe valley (6,514 ML). Information and data relating to the portfolio of held Commonwealth environmental water is shown in Table CMP1.

The 2019–20 water allocation (5,306 ML) together with the carryover volume of 2,898 ML of water meant the CEWH had 8,204 ML of water available for delivery. A total of 3,643.5 ML of Commonwealth environmental water was delivered in the Campaspe valley. A total of 376 ML of available Commonwealth environmental water was carried over for environmental use into the 2020–21 water year.

16.3 Environmental conditions and resource availability

The water available for environmental delivery combined with the present and antecedent environmental conditions are key inputs used by environmental water managers in planning and implementing watering actions. *Post hoc*, this information provides important context when evaluating the effectiveness and appropriateness of environmental water use with respect to hydrological outputs.

The rainfall conditions in the Campaspe valley were classified as average, based on rainfall percentile data for the entire record held by the Bureau of Meteorology for this valley. The water held in major storages in the Campaspe valley decreased over the water year, for example Eppalock dam was 36.1% full at the beginning of the water year and 37.7% full by the end of the year (Figure CMP1).

The CEWO calculates resource availability scenarios (RAS) to guide the use and prioritisation of held environmental water. The RAS are progressively calculated over the year as part of the continual adaptive management planning processes. The RAS are based on the availability of held environmental water (including progressive licence acquisitions and allocations) as well as the potential for unregulated or planned environmental flows. The outcome is then used to determine the demand for environmental water across the Basin.

In 2019–20, the resource availability of held Commonwealth environmental water in the Campaspe was classified as low to high, whilst the overall demand for environmental water was classified as high to moderate. The physical conditions meant that the CEWO was managing to protect and improve the aquatic and riparian vegetation and native fish and other biota via habitat provision.

16.4 Watering actions

A total of 5 watering actions were delivered over the 2019–20 water year, the duration of these actions varied (range of individual actions: 7 - 179 days) and Commonwealth environmental water was delivered for a total of 280 days. The number of water actions commencing in each season included, summer (1), autumn (3), winter (0), spring (1). Similarly, the count of flow component types delivered in the Campaspe valley were; (2) baseflow, (0) baseflow-fresh, (0) baseflow-fresh-bankfull, (0) baseflow-fresh-overbank-wetland, (3) fresh, (0) fresh-wetland, (0) bankfull, (0) overbank, (0) wetland and (0) wetland-overbank.

In the Campaspe, watering actions were delivered for ecosystem processes, biota, fish and vegetation purposes, but water was also delivered for other purposes too. The percentage of watering actions delivered across the nine main themes included fish (36.36%), vegetation (18.18%), waterbirds (0.0%), frogs (0.0%), other biota (36.36%), connectivity (0.0%), process (9.09%), resilience (0.0%) and water quality (0.0%).

Table CMP1. Commonwealth environmental water accounting information for the Campaspe valley over 2019–20 water year.

Total registered volume (ML)	Allocated volume (ML)	Carry over + allocated volume (ML)	Delivered (ML)	LTAAY (ML)	Carried over to 2020–21
7,020	5,306	8,204	3,643.5	6,514	376

16.5 Contribution of Commonwealth environmental water to flow regimes

16.5.1 Eppalock

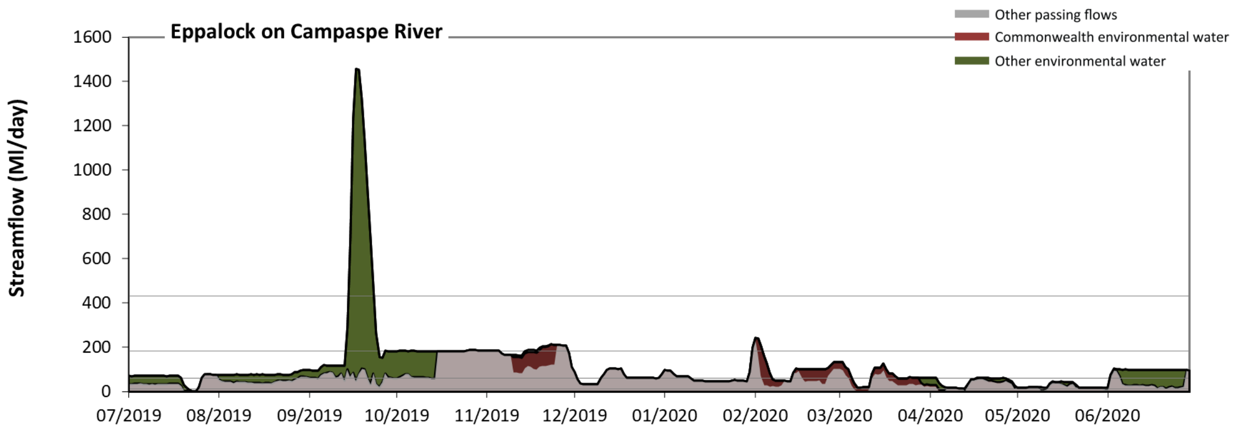


Figure CMP2: Contribution of environmental water delivery at Eppalock. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Eppalock on Campaspe River environmental water contributed 46% of the total streamflow volume (with a relatively small contribution of Commonwealth environmental water). Environmental watering actions affected streamflows for 64% of days between 1 July 2019 and 30 June 2020. Without environmental water, the duration of very low flows (i.e. < 12 ML/day) in the period July to September would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water reduced the cumulative duration of very low flow spells from 5% to 1% of the year, with greatest influence in the periods January to March and April to June. Similarly, without environmental water, the durations of low flows (i.e. < 61 ML/day) in the periods July to September and April to June would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 60% to 28% of the year, with greatest influence in the periods July to September and April to June. Commonwealth environmental water made a modest contribution to these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 180 ML/day) in the periods October to December and January to March. Environmental water increased the duration of the longest low fresh during the periods July to September (from 0 days to 11 days), October to December (from 6 days to 14 days) and January to March (from 2 days to 4 days). Commonwealth environmental water made the dominant contribution to these increased durations of low freshes. In the absence of environmental water there would have been no medium freshes. Environmental water increased the duration of the longest medium fresh during the period July to September (from 0 days to 9 days). There were no high freshes (i.e. > 1541 ML/day) this year.

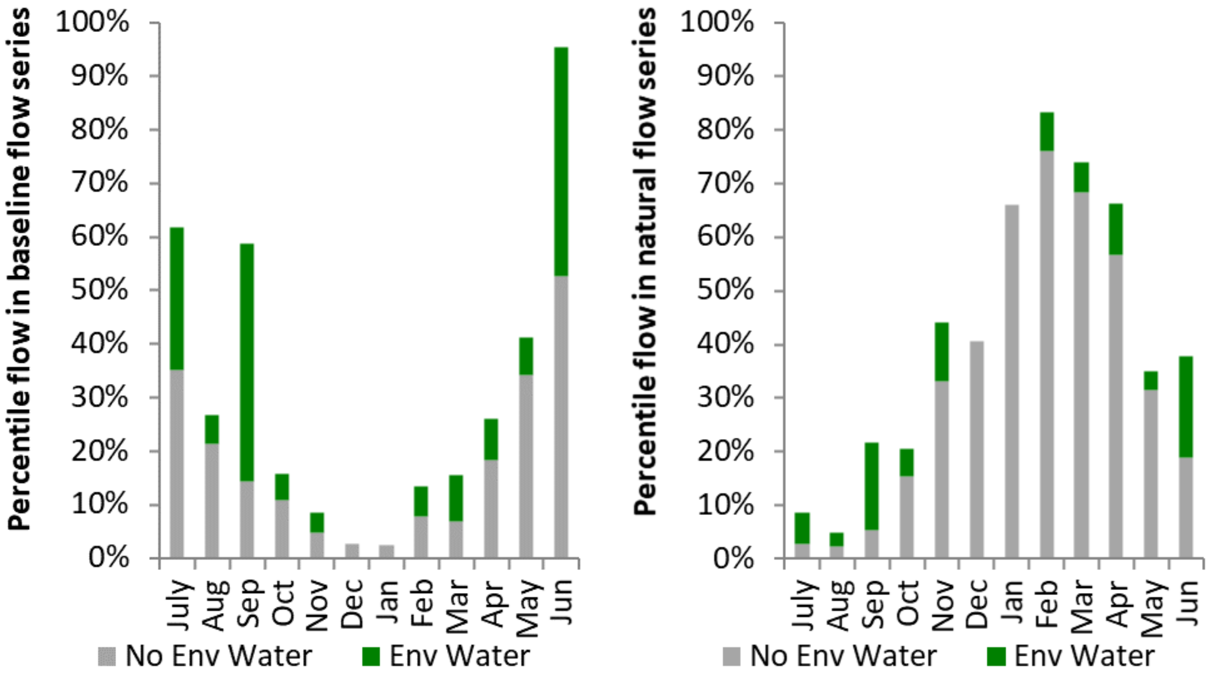


Figure CMP3: Contribution of environmental water delivery at Eppalock as percentiles in the natural and baseline flow series.

16.5.2 Barnadown

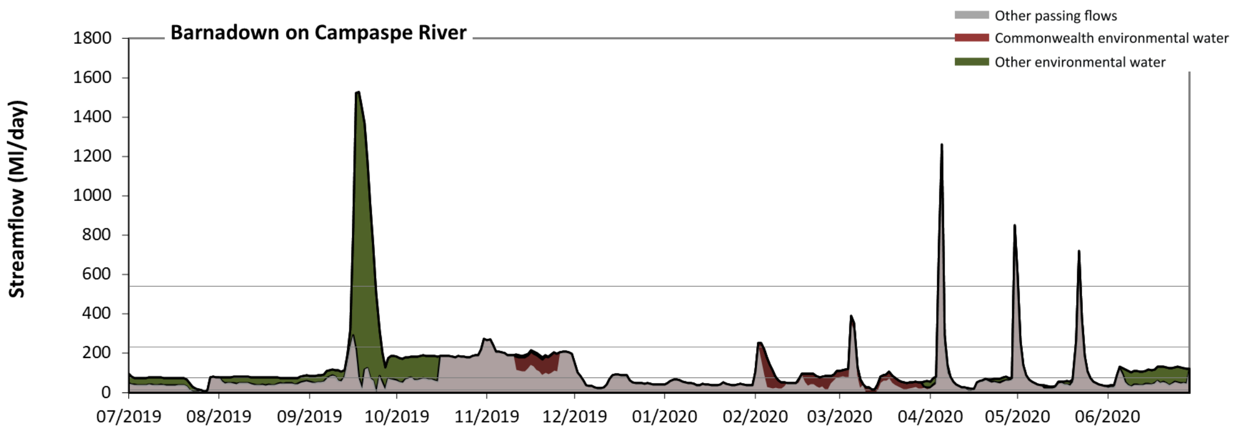


Figure CMP4: Contribution of environmental water delivery at Barnadown. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Barnadown on Campaspe River environmental water contributed 40% of the total streamflow volume (with a relatively small contribution of Commonwealth environmental water). Environmental watering actions affected streamflows for 65% of days between 1 July 2019 and 30 June 2020. Without environmental water, the duration of very low flows (i.e. < 15 ML/day) in the period July to September would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 4% to 1% of the year, with greatest influence in the periods July to September and January to March. Similarly, without environmental water, the durations of low flows (i.e. < 77 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 72% to 43% of the year, with greatest influence in the period July to September. Commonwealth environmental water made a modest contribution to these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 230 ML/day) in the periods July to September, October to December, January to March and April to June. Environmental water increased the duration of the longest low fresh during the period July to September (from 1 days to 11 days). Commonwealth environmental water made little or no contribution to these increased durations of low freshes. In the absence of environmental water there would have been at least one medium fresh (i.e. > 540 ML/day) in the period April to June. Environmental water increased the duration of the longest medium fresh during the period July to September (from 0 days to 8 days). Commonwealth environmental water made little or no contribution to these increased durations of medium freshes. There were no high freshes (i.e. > 1900 ML/day) this year.

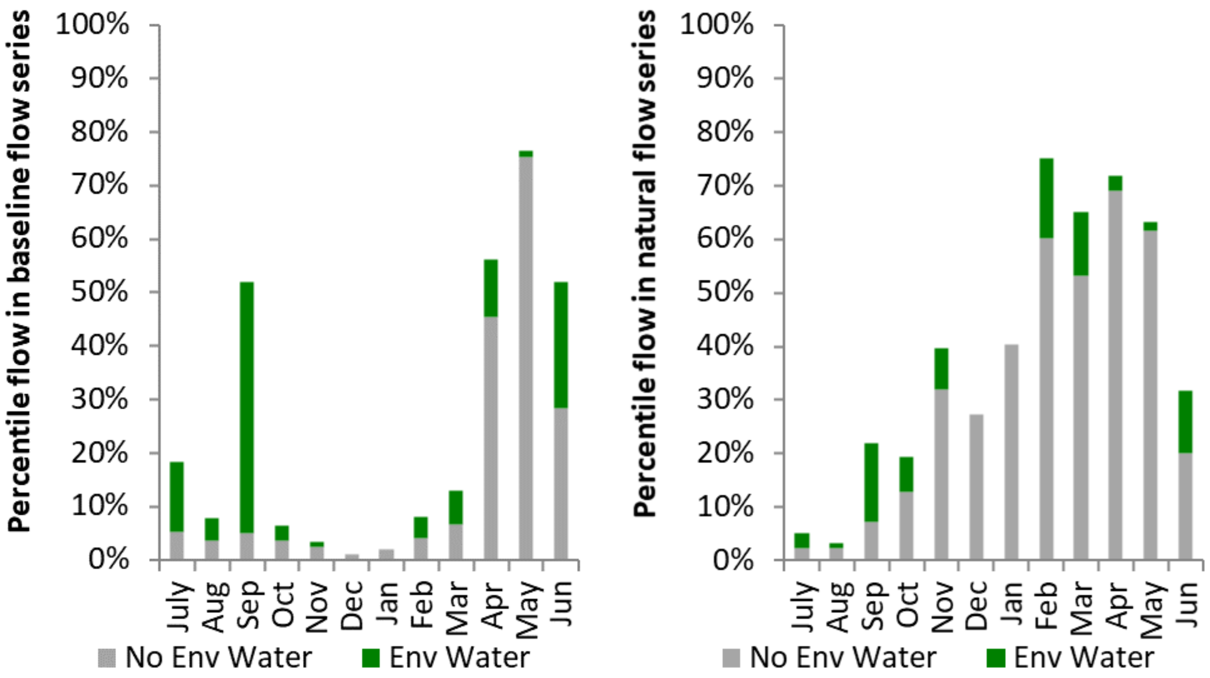


Figure CMP5: Contribution of environmental water delivery at Barnadown as percentiles in the natural and baseline flow series.

16.5.3 Rochester

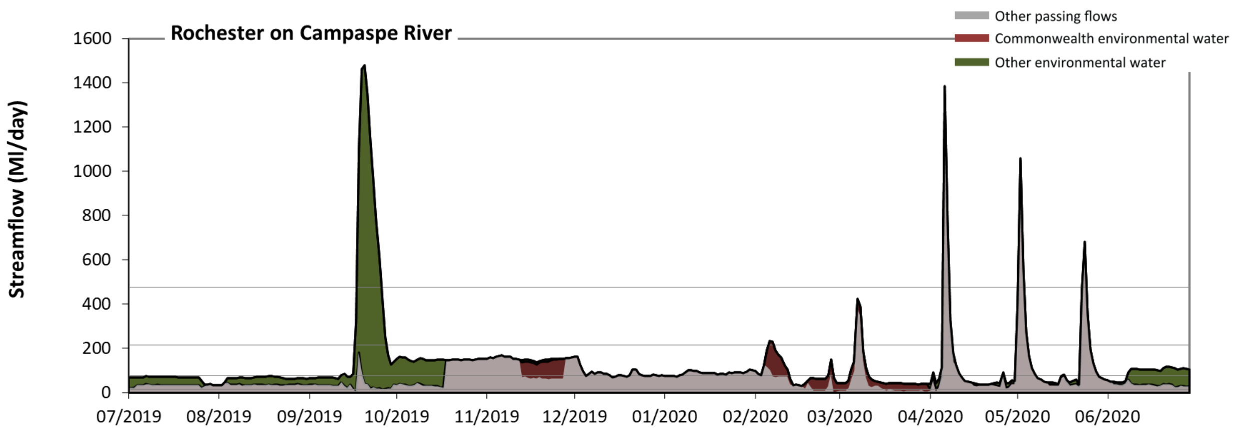


Figure CMP6: Contribution of environmental water delivery at Rochester. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Rochester on Campaspe River environmental water contributed 42% of the total streamflow volume (with a relatively small contribution of Commonwealth environmental water). Environmental watering actions affected streamflows for 65% of days between 1 July 2019 and 30 June 2020. Flow regulation does not substantially increase the duration of very low flows (i.e. < 15 ML/day) compared to an average year in the natural flow regime. However, without environmental water, the durations of low flows (i.e. < 77 ML/day) in the periods July to September, October to December and April to June would have substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 69% to 47% of the year, with greatest influence in the periods October to December and April to June. Commonwealth environmental water equally shared responsibility with other environmental water holders for these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 210 ML/day) in the periods January to March and April to June. Environmental water increased the duration of the longest low fresh during the period July to September (from 0 days to 11 days). Commonwealth environmental water made little or no contribution to these increased durations of low freshes. In the absence of environmental water there would have been at least one medium fresh (i.e. > 480 ML/day) in the period April to June. Environmental water increased the duration of the longest medium fresh during the period July to September (from 0 days to 8 days). Commonwealth environmental water made little or no contribution to these increased durations of medium freshes. There were no high freshes (i.e. > 1600 ML/day) this year.

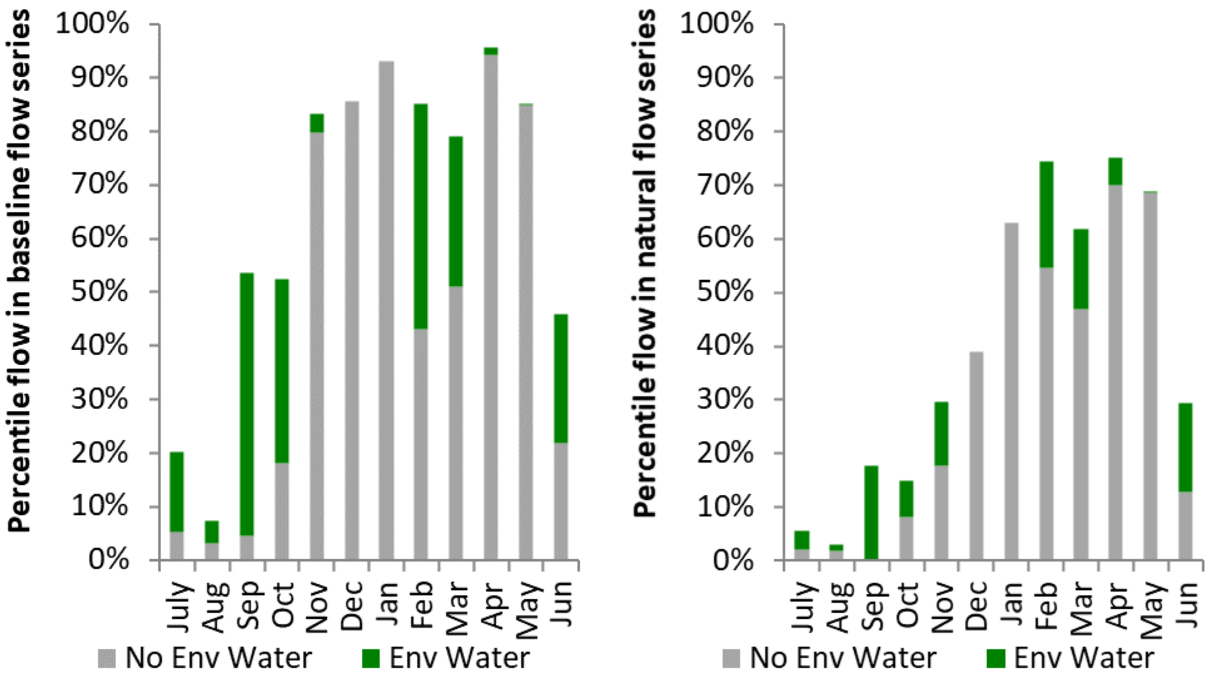


Figure CMP7: Contribution of environmental water delivery at Rochester as percentiles in the natural and baseline flow series.

17 Warrego Valley

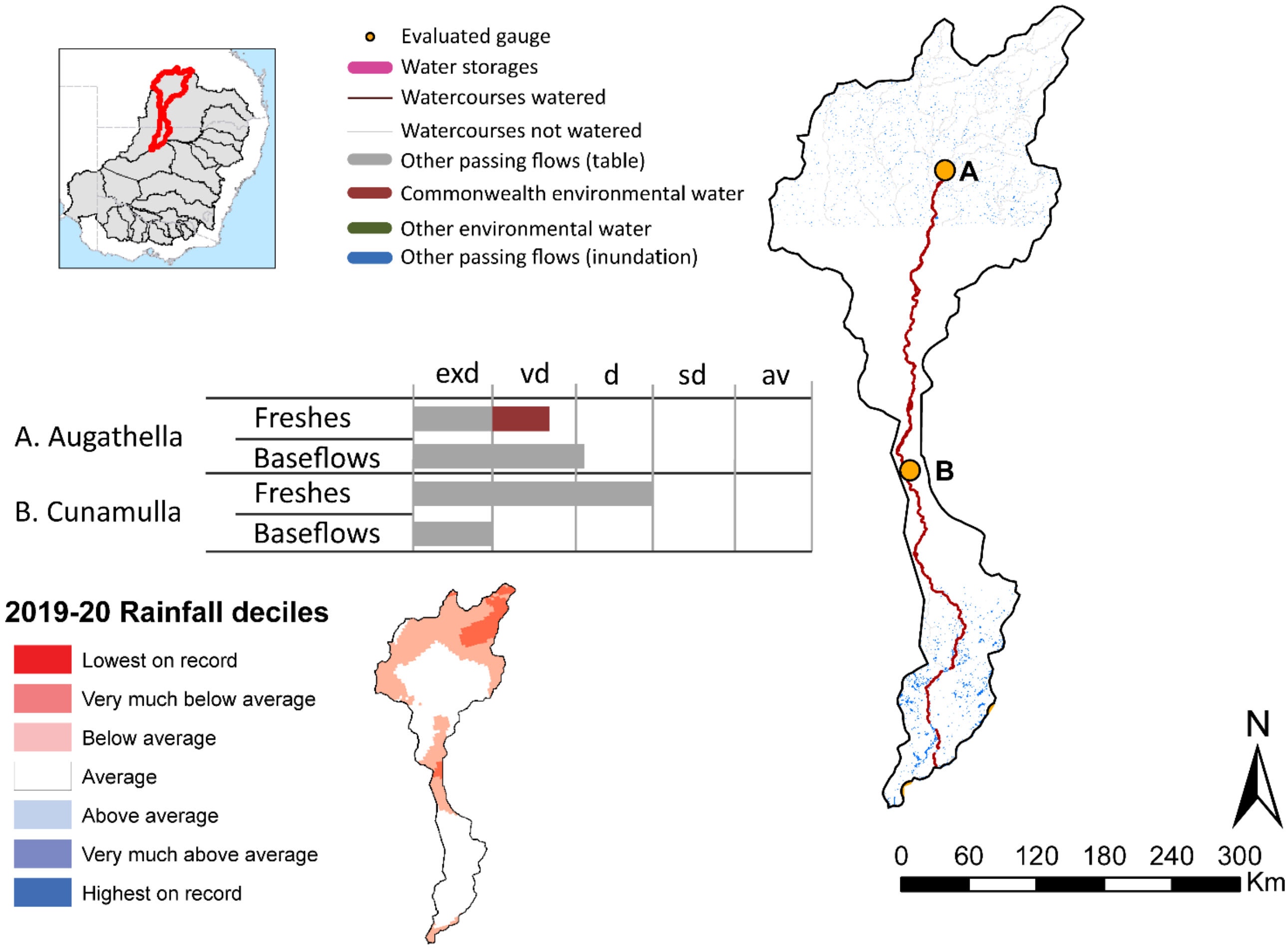


Figure WAR1: Watercourses influenced, areas inundated (where applicable) and gauge stations evaluated in the Warrego valley during the 2019–20 water year. Inset bar graphs report the condition of annual flow regimes by showing the improvements in hydrological condition with the addition of environmental water as well as the hypothetical scenario in 'grey' (if no environmental flow had been delivered). Rainfall conditions (rainfall deciles) and trend in storage levels for the water year are also shown. The classified bands are: exd = extremely dry, vd=very dry, sd=somewhat dry and av=average.

17.1 Summary

The volume of environmental water delivery for the 2019–20 year in the Warrego valley is quantified using data for 2 sites. This evaluation only considers the contribution of held environmental water, which is a primary focus for the Commonwealth. The contributions of planned environmental water (e.g. passing flows), unregulated tributary inflows and clever use of irrigation flows for environmental benefits can all be very important but these are outside the scope of this report. Environmental watering actions lasted on average 23 days over the course of the year. The volume of environmental water at these 2 sites was between 2% and 11% of the total streamflow. Commonwealth environmental water contributed on average 100% of this environmental water. The contribution of environmental water delivery to improved flow regimes is evaluated using data for 2 sites. Ideally, baseflows should be maintained and long periods of excessively low flows avoided. In this valley, the baseflow regime was generally considered to be very dry relative to the pre-development flow regime. In our analysis, a low fresh refers to a period of increased flow, when the water level rises at least one eighth of the way up the river bank (above the low flow level). These low freshes are a regular part of the natural flow regime and support a range of natural processes. In the Warrego valley, in terms of the occurrence and duration of low freshes, the year was assessed as being very dry. In our analysis, a medium fresh refers to a period of increased flow, when the water level rises at least one quarter of the way up the river bank. These medium freshes are not as frequent as low freshes but are also a regular and important part of the natural flow regime. In the Warrego valley, in terms of the occurrence of medium freshes, the year was assessed as being dry. In our analysis, a high fresh refers to a period of increased flow, when the water level rises more than half way up the river. A high fresh may not occur every year but they are still important and long periods without major freshes can have serious consequences for floodplains and their contribution to river ecosystem health. Delivering environmental high in channel flows normally requires that all risks to riparian landholders and infrastructure have been resolved. In the Warrego valley, in terms of the occurrence of high freshes, the year was assessed as being dry.

17.2 Water delivery context

During the 2019–20 water year, the Commonwealth Environmental Water Holder (CEWH) held water entitlements of up to 57,281 ML for environmental use in the Warrego valley. A total of 33,914 ML of Commonwealth environmental water was delivered in the Warrego valley.

17.3 Environmental conditions and resource availability

The water available for environmental delivery combined with the present and antecedent environmental conditions are key inputs used by environmental water managers in planning and implementing watering actions. *Post hoc*, this information provides important context when evaluating the effectiveness and appropriateness of environmental water use with respect to hydrological outputs.

The rainfall conditions in the Warrego valley were classified as average, based on rainfall percentile data for the entire record held by the Bureau of Meteorology for this valley.

17.4 Watering actions

A total of 3 watering actions were delivered over the 2019–20 water year, the duration of these actions varied (range of individual actions: 167 - 365 days) and Commonwealth environmental water was delivered for a total of 365 days. The number of water actions commencing in each season included, summer (0), autumn (0), winter (3), spring (0). Similarly, the count of flow component types delivered in the Warrego valley were; (2) baseflow, (0) baseflow-fresh, (0) baseflow-fresh-bankfull, (0) baseflow-fresh-overbank-wetland, (1) fresh, (0) fresh-wetland, (0) bankfull, (0) overbank, (0) wetland and (0) wetland-overbank.

In the Warrego, watering actions were delivered for water quality, connectivity and fish purposes, but water was also delivered for other purposes too. The percentage of watering actions delivered across the nine main themes included fish (40%), vegetation (0.0%), waterbirds (0.0%), frogs (0.0%), other biota (0.0%), connectivity (20%), process (0.0%), resilience (0.0%) and water quality (40%).

Table WAR1. Commonwealth environmental water accounting information for the Warrego valley over 2019–20 water year.

Total registered volume (ML)	Allocated volume (ML)	Carry over + allocated volume (ML)	Delivered (ML)	LTAAY (ML)	Carried over to 2020–21
57,281	0	0	33,914	33,869	0

17.5 Contribution of Commonwealth environmental water to flow regimes

17.5.1 Augathella

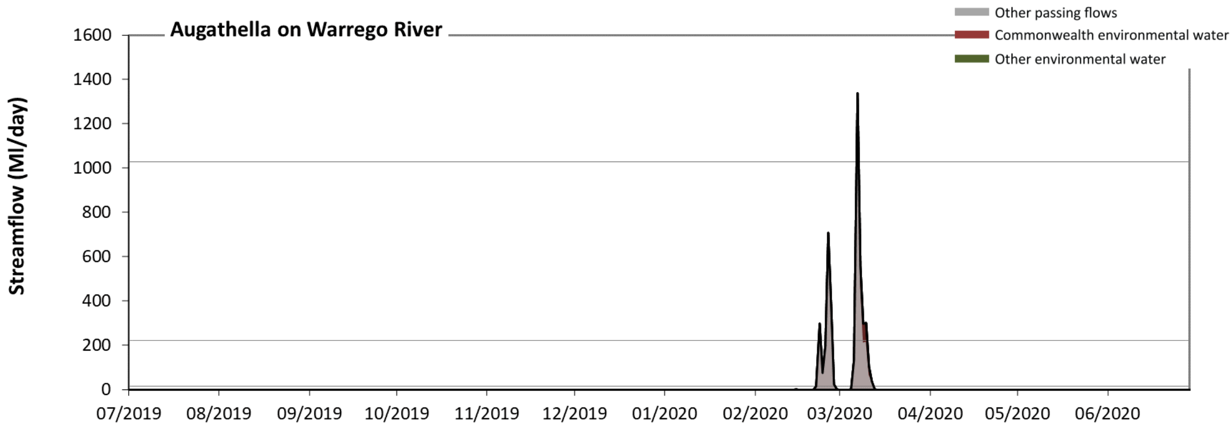


Figure WAR2: Contribution of environmental water delivery at Augathella. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Augathella on Warrego River environmental water contributed 11% of the total streamflow volume (all of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 2% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 2.7 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these very low flows, which occurred for 96% of the year. Similarly, without environmental water, the durations of low flows (i.e. < 14 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these low flows, which occurred for 96% of the year. In the absence of environmental water there would have been at least one low fresh (i.e. > 220 ML/day) in the period January to March. Environmental water increased the duration of the longest low fresh during the period January to March (from 2 days to 4 days). Commonwealth environmental water was entirely responsible for these increased durations of low freshes. There was at least one medium fresh (i.e. > 1000 ML/day) in the period January to March. Environmental water made no change to the duration of these medium freshes. There was no high freshes (i.e. > 6900 ML/day) this year.

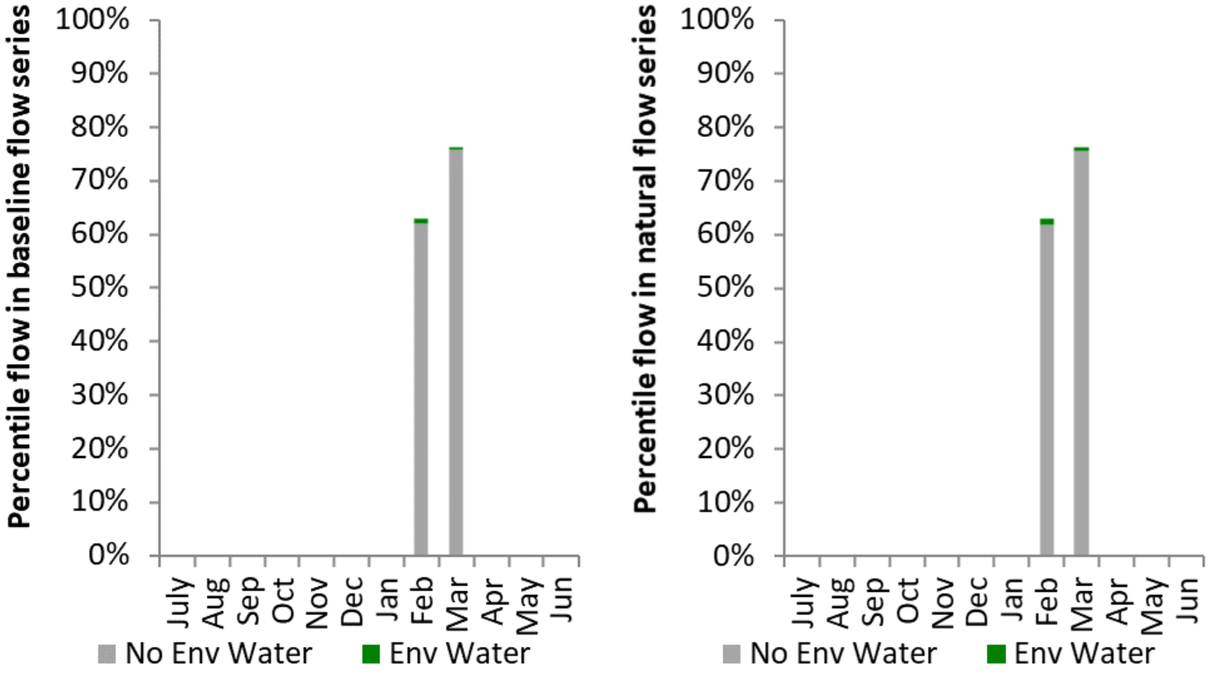


Figure WAR3: Contribution of environmental water delivery at Augathella as percentiles in the natural and baseline flow series.

17.5.2 Cunnamulla

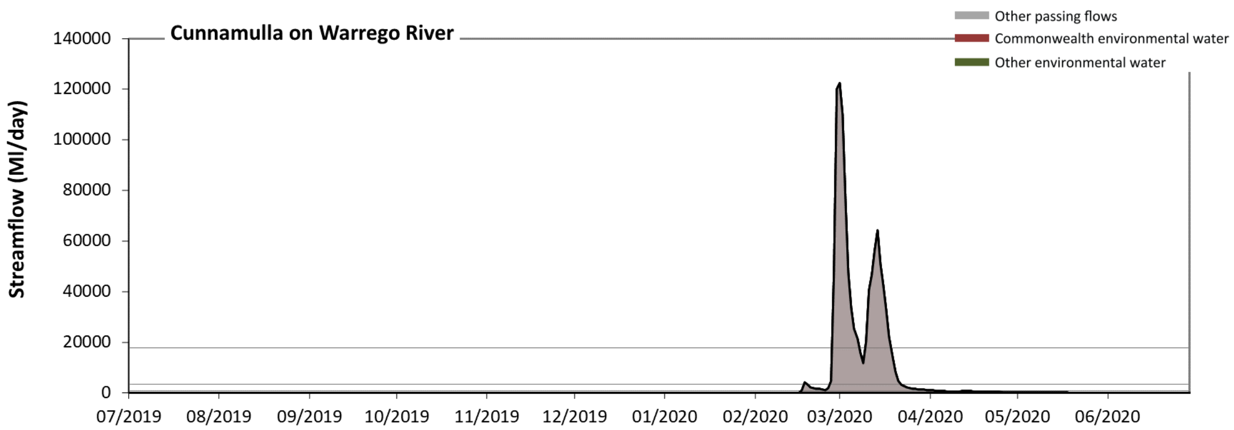


Figure WAR4: Contribution of environmental water delivery at Cunnamulla. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Cunnamulla on Warrego River environmental water contributed 2% of the total streamflow volume (all of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 10% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 20 ML/day) in the periods July to September, October to December and January to March would have substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these very low flows, which occurred for 75% of the year. Similarly, without environmental water, the durations of low flows (i.e. < 99 ML/day) in the periods July to September, October to December and January to March would have substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these low flows, which occurred for 77% of the year. There was at least one low fresh (i.e. > 840 ML/day) in the periods January to March and April to June. Environmental water made little change to the duration of these low freshes. There was at least one medium fresh (i.e. > 3200

ML/day) in the period January to March. Environmental water made little change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the period January to March. Environmental water made no change to the duration of these high freshes.

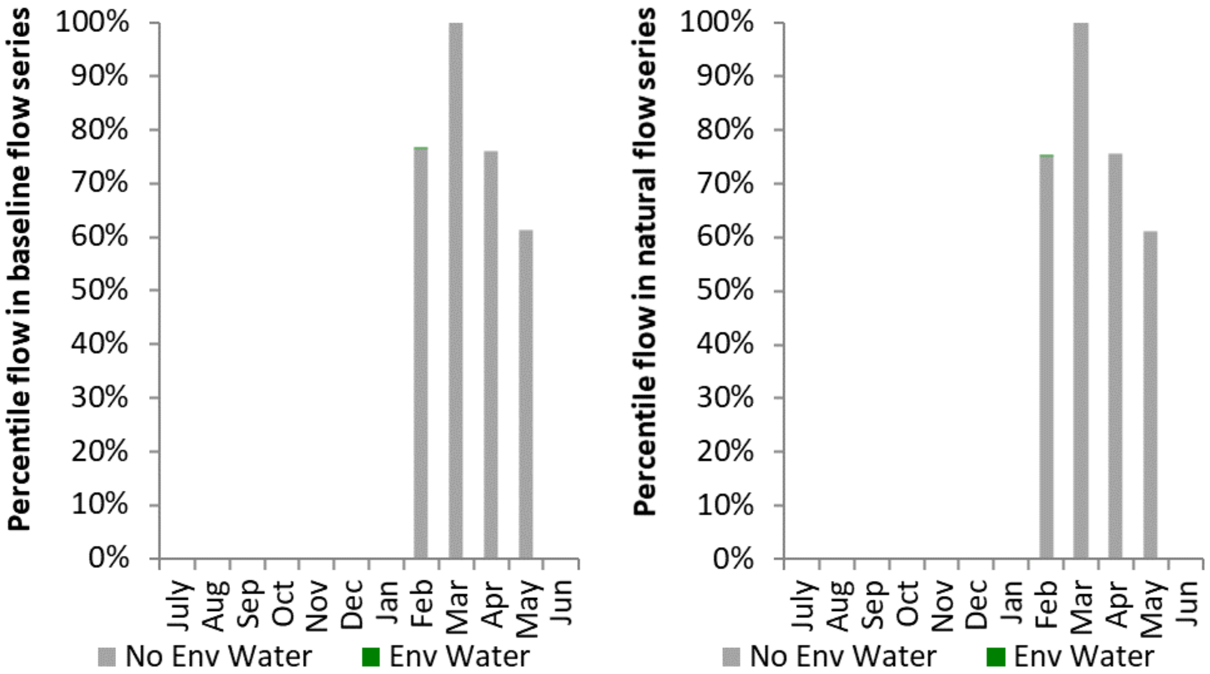


Figure WAR5: Contribution of environmental water delivery at Cunnamulla as percentiles in the natural and baseline flow series.

18 Wimmera Valley

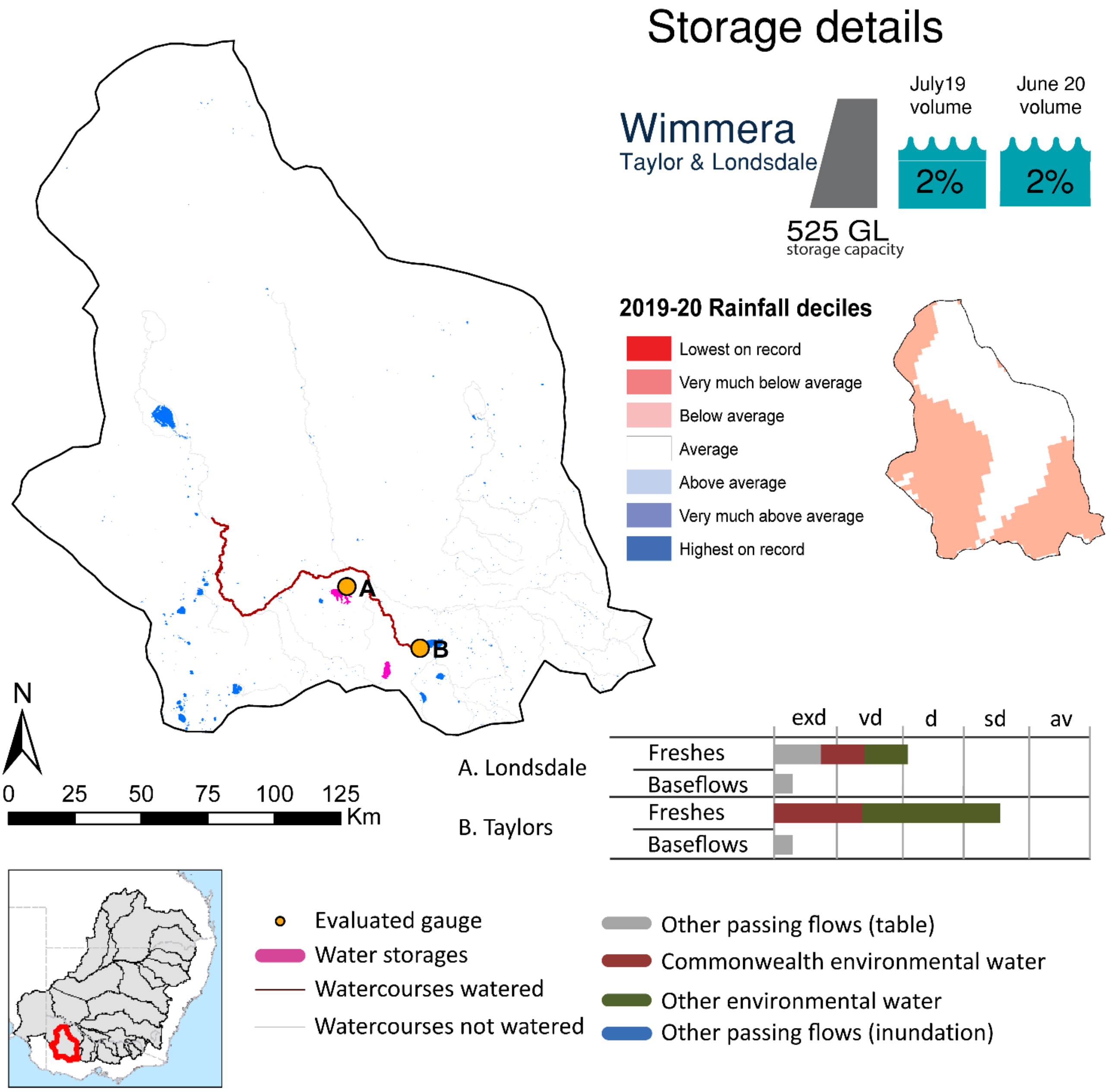


Figure WIM1: Watercourses influenced, areas inundated (where applicable) and gauge stations evaluated in the Wimmera valley during the 2019–20 water year. Inset bar graphs report the condition of annual flow regimes by showing the improvements in hydrological condition with the addition of environmental water as well as the hypothetical scenario in 'grey' (if no environmental flow had been delivered). Rainfall conditions (rainfall deciles) and trend in storage levels for the water year are also shown. The classified bands are: exd = extremely dry, vd=very dry, sd=somewhat dry and av=average.

18.1 Summary

The volume of environmental water delivery for the 2019–20 year in the Wimmera valley is quantified using data for 2 sites. This evaluation only considers the contribution of held environmental water, which is a primary focus for the Commonwealth. The contributions of planned environmental water (e.g. passing flows), unregulated tributary inflows and clever use of irrigation flows for environmental benefits can all be very important but these are outside the scope of this report. Environmental watering actions lasted on average 99 days over the course of the year. The volume of environmental water at these 2 sites was between 70% and 99% of the total streamflow. Commonwealth environmental water contributed on average 23% of this environmental water. The contribution of environmental water delivery to improved flow regimes is evaluated using data for 2 sites. Ideally, baseflows should be maintained and long periods of excessively low flows avoided. In this valley, the baseflow regime was generally considered to be extremely dry relative to the pre-development flow regime. In our analysis, a low fresh refers to a period of increased flow, when the water level rises at least one eighth of the way up the river bank (above the low flow level). These low freshes are a regular part of the natural flow regime and support a range of natural processes. In the Wimmera valley, in terms of the occurrence and duration of low freshes, the year was assessed as being average. In our analysis, a medium fresh refers to a period of increased flow, when the water level rises at least one quarter of the way up the river bank. These medium freshes are not as frequent as low freshes but are also a regular and important part of the natural flow regime. In the Wimmera valley, in terms of the occurrence of medium freshes, the year was assessed as being somewhat dry. In our analysis, a high fresh refers to a period of increased flow, when the water level rises more than half way up the river. A high fresh may not occur every year but they are still important and long periods without major freshes can have serious consequences for floodplains and their contribution to river ecosystem health. Delivering environmental high in channel flows normally requires that all risks to riparian landholders and infrastructure have been resolved. In the Wimmera valley, in terms of the occurrence of high freshes, the year was assessed as being extremely dry.

18.2 Water delivery context

During the 2019–20 water year, the Commonwealth Environmental Water Holder (CEWH) held water entitlements of up to 28,000 ML for environmental use in the Wimmera valley. Each year, water utilities allocate water entitlement holders a percentage of water based on their holding, licence type and carryover (the exact rules vary among Jurisdictions and licence type). In 2019–20, the Wimmera entitlements held by the CEWH were allocated 0 ML of water, representing 0% of the Long term average annual yield for the Wimmera valley (23,184 ML). Information and data relating to the portfolio of held Commonwealth environmental water is shown in Table WIM1.

The 2019–20 water allocation (0 ML) together with the carryover volume of 1,561 ML of water meant the CEWH had 1,561 ML of water available for delivery. A total of 1,562 ML of Commonwealth environmental water was delivered in the Wimmera valley. No Commonwealth environmental water was carried over for environmental use into the 2020–21 water year.

18.3 Environmental conditions and resource availability

The water available for environmental delivery combined with the present and antecedent environmental conditions are key inputs used by environmental water managers in planning and implementing watering actions. *Post hoc*, this information provides important context when evaluating the effectiveness and appropriateness of environmental water use with respect to hydrological outputs.

The rainfall conditions in the Wimmera valley were classified as average, based on rainfall percentile data for the entire record held by the Bureau of Meteorology for this valley. The water held in major storages in the Wimmera valley increased over the water year, for example Lake Taylor and Lake Lonsdale dam was 2.5% full at the beginning of the water year and 2.1% full by the end of the year (Figure WIM1).

The CEWO calculates resource availability scenarios (RAS) to guide the use and prioritisation of held environmental water. The RAS are progressively calculated over the year as part of the continual adaptive management planning processes. The RAS are based on the availability of held environmental water (including progressive licence acquisitions and allocations) as well as the potential for unregulated or planned environmental flows. The outcome is then used to determine the demand for environmental water across the Basin.

In 2019–20, the resource availability of held Commonwealth environmental water in the Wimmera was classified as low to high, whilst the overall demand for environmental water was classified as critical to high. The physical conditions meant that the CEWO was managing to avoid damage to environmental assets by mitigating water quality issues and managing drought refuge pools throughout the system.

18.4 Watering actions

A total of 2 watering actions were delivered over the 2019–20 water year, the duration of these actions varied (range of individual actions: 30 - 144 days) and Commonwealth environmental water was delivered for a total of 174 days. The number of water actions commencing in each season included, summer (1), autumn (1), winter (0), spring (0). Similarly, the count of flow component types delivered in the Wimmera valley were; (0) baseflow, (0) baseflow-fresh, (0) baseflow-fresh-bankfull, (0) baseflow-fresh-overbank-wetland, (2) fresh, (0) fresh-wetland, (0) bankfull, (0) overbank, (0) wetland and (0) wetland-overbank.

In the Wimmera, watering actions were delivered for water quality, biota, fish and vegetation purposes, but water was also delivered for other purposes too. The percentage of watering actions delivered across the nine main themes included fish (25%), vegetation (25%), waterbirds (0.0%), frogs (0.0%), other biota (25%), connectivity (0.0%), process (0.0%), resilience (0.0%) and water quality (25%).

Table WIM1. Commonwealth environmental water accounting information for the Wimmera valley over 2019–20 water year.

Total registered volume (ML)	Allocated volume (ML)	Carry over + allocated volume (ML)	Delivered (ML)	LTAAY (ML)	Carried over to 2020–21
28,000	0	1,561	1,562	23,184	0

18.5 Contribution of Commonwealth environmental water to flow regimes

18.5.1 Londsdale

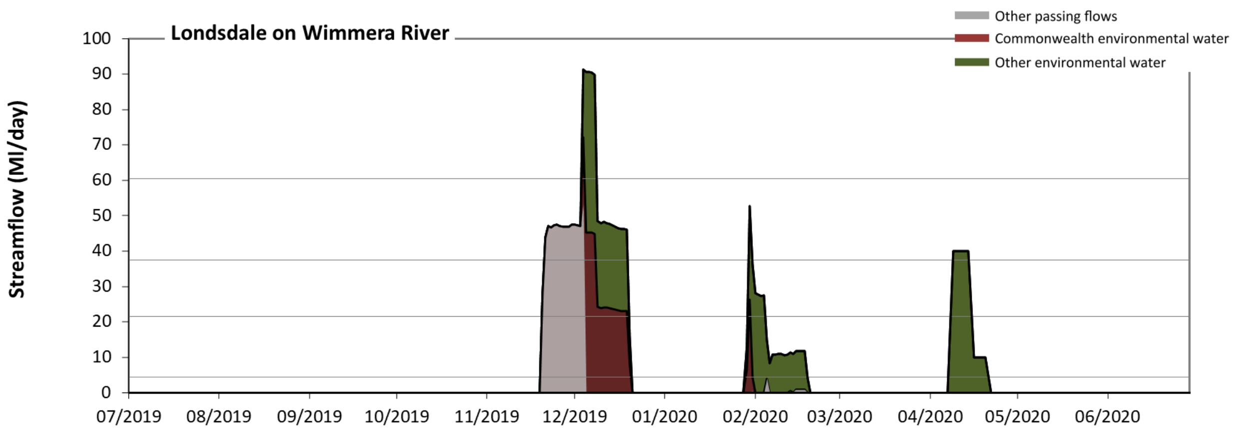


Figure WIM2: Contribution of environmental water delivery at Londsdale. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Londsdale on Wimmera River environmental water contributed 70% of the total streamflow volume (with a medium contribution of Commonwealth environmental water). Environmental watering actions affected streamflows for 15% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 4.3 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 96% to 82% of the year, with greatest influence in the periods October to December, January to March and April to June. Similarly, without environmental water, the durations of low flows (i.e. < 22 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 96% to 88% of the year, with greatest influence in the periods October to December and April to June. Commonwealth environmental water made a modest contribution to these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 37 ML/day) in the period October to December. Environmental water increased the duration of the longest low fresh during the periods October to December (from 14 days to 29 days), January to March (from 0 days to 1 days) and April to June (from 0 days to 6 days). Commonwealth environmental water equally shared responsibility with other environmental water holders for these increased durations of low freshes. In the absence of environmental water there would have been no medium freshes this year. Environmental water increased the duration of the longest medium fresh during the period October to December (from 0 days to 5 days). Commonwealth environmental water equally shared responsibility with other environmental water holders for these increased durations of medium freshes.

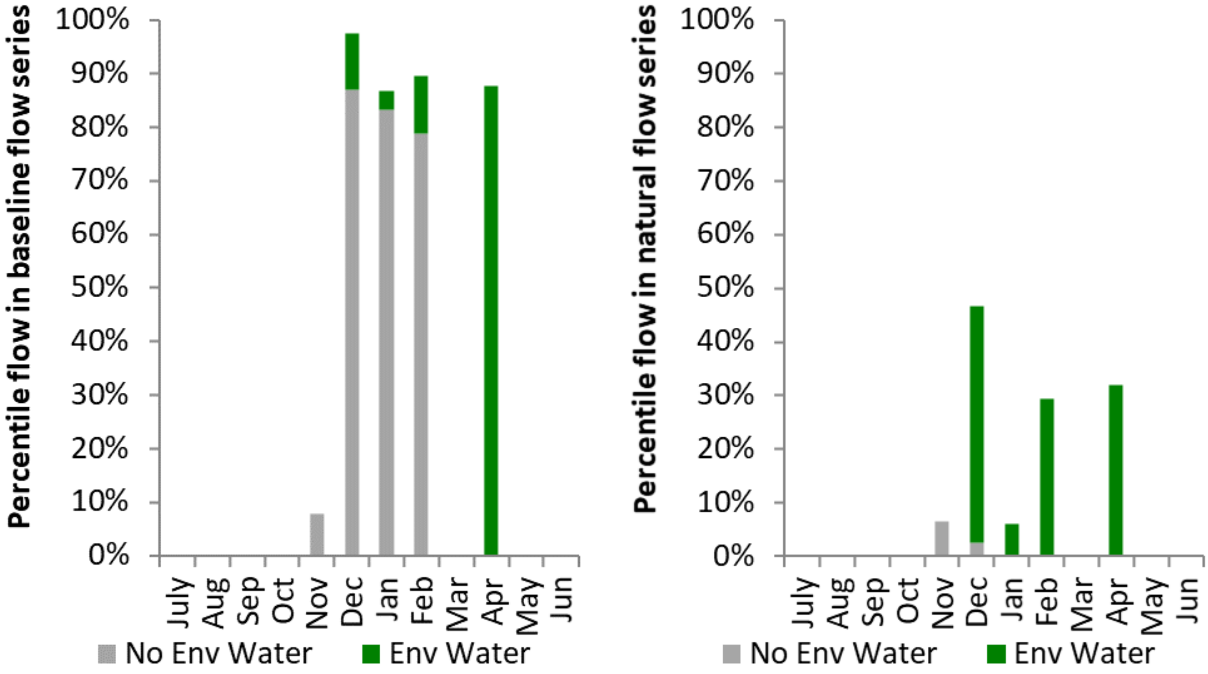


Figure WIM3: Contribution of environmental water delivery at Londsdale as percentiles in the natural and baseline flow series.

18.5.2 Taylors

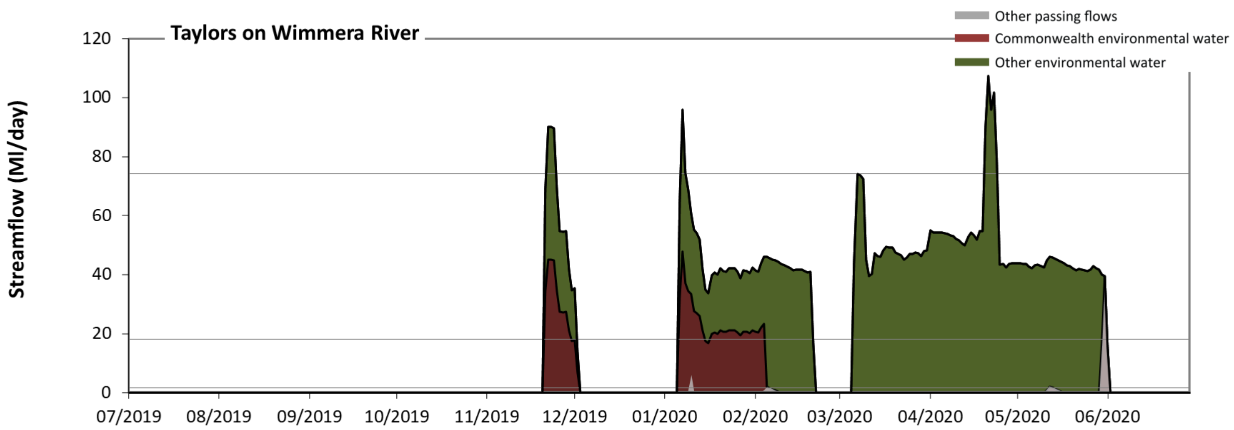


Figure WIM4: Contribution of environmental water delivery at Taylors. Horizontal lines indicate thresholds for very low flows, low flows, low freshes and medium freshes (from lowest to highest).

At Taylors on Wimmera River environmental water contributed 99% of the total streamflow volume (with a relatively small contribution of Commonwealth environmental water). Environmental watering actions affected streamflows for 40% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 0.33 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 96% to 60% of the year, with greatest influence in the periods January to March and April to June. Similarly, without environmental water, the durations of low flows (i.e. < 1.7 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 98% to 60% of the year, with greatest influence in the periods January to March and April to

June. Commonwealth environmental water made a modest contribution to these enhancements of environmental baseflows at this site. In the absence of environmental water there would have been at least one low fresh (i.e. > 18 ML/day) in the period April to June. Environmental water increased the duration of the longest low fresh during the periods October to December (from 0 days to 11 days), January to March (from 0 days to 46 days) and April to June (from 1 days to 62 days). Commonwealth environmental water made a modest contribution to these increased durations of low freshes. In the absence of environmental water there would have been no medium freshes this year. Environmental water increased the duration of the longest medium fresh during the periods October to December (from 0 days to 3 days), January to March (from 0 days to 2 days) and April to June (from 0 days to 5 days). Commonwealth environmental water equally shared responsibility with other environmental water holders for these increased durations of medium freshes.

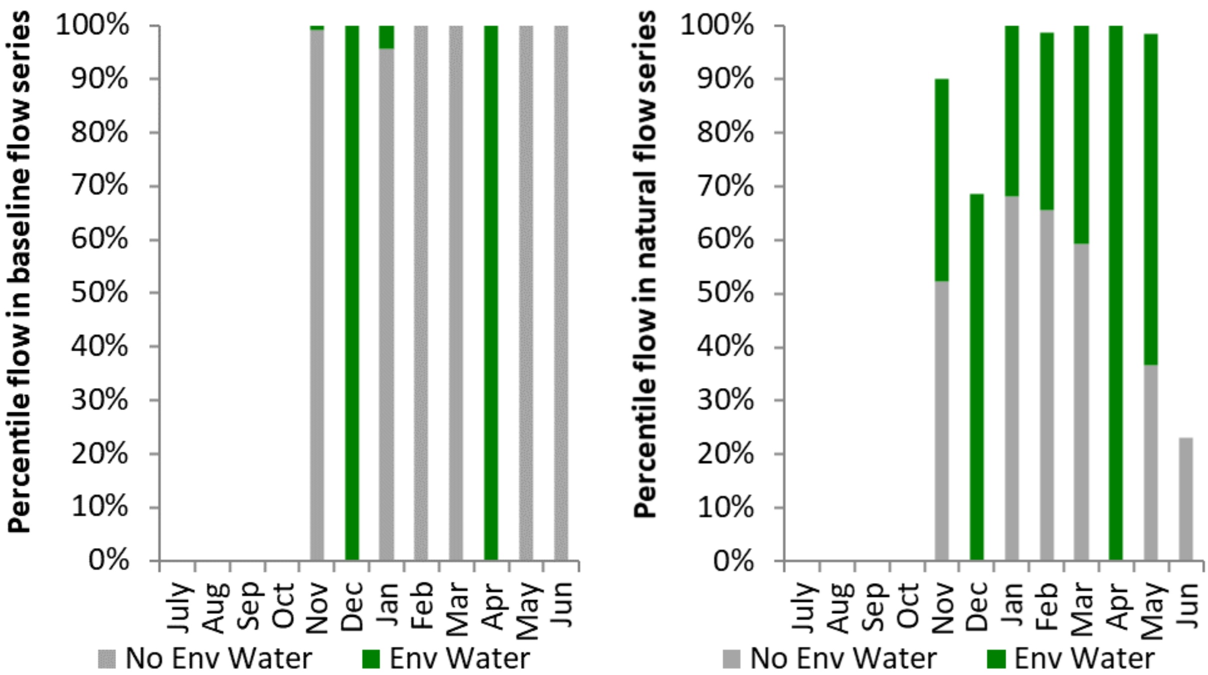


Figure WIM5: Contribution of environmental water delivery at Taylors as percentiles in the natural and baseline flow series.

19 Condamine Balonne Valley

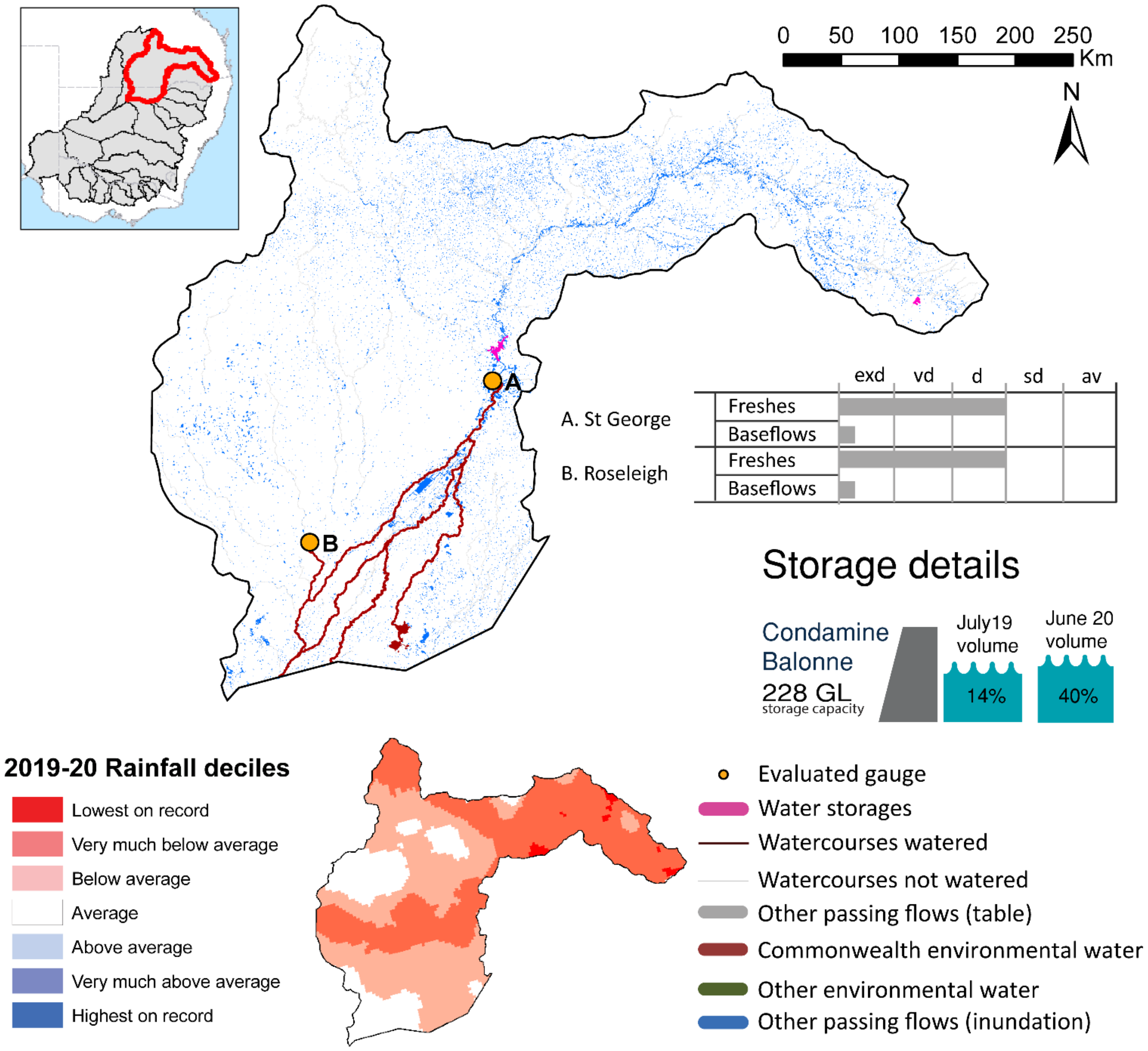


Figure CON1: Watercourses influenced, areas inundated (where applicable) and gauge stations evaluated in the Condamine Balonne valley during the 2019–20 water year. Inset bar graphs report the condition of annual flow regimes by showing the improvements in hydrological condition with the addition of environmental water as well as the hypothetical scenario in 'grey' (if no environmental flow had been delivered). Rainfall conditions (rainfall deciles) and trend in storage levels for the water year are also shown. The classified bands are: exd = extremely dry, vd=very dry, sd=somewhat dry and av=average

19.1 Summary

The volume of environmental water delivery for the 2019–20 year in the Condamine Balonne valley is quantified using data for 2 sites. This evaluation only considers the contribution of held environmental water, which is a primary focus for the Commonwealth. The contributions of planned environmental water (e.g. passing flows), unregulated tributary inflows and clever use of irrigation flows for environmental benefits can all be very important but these are outside the scope of this report. Environmental watering actions lasted on average 19 days over the course of the year. The volume of environmental water at these 2 sites was between 7% and 11% of the total streamflow. Commonwealth environmental water contributed on average 100% of this environmental water. The contribution of environmental water delivery to improved flow regimes is evaluated using data for 2 sites. Ideally, baseflows should be maintained and long periods of excessively low flows avoided. In this valley, the baseflow regime was generally considered to be extremely dry relative to the pre-development flow regime. In our analysis, a low fresh refers to a period of increased flow, when the water level rises at least one eighth of the way up the river bank (above the low flow level). These low freshes are a regular part of the natural flow regime and support a range of natural processes. In the Condamine Balonne valley, in terms of the occurrence and duration of low freshes, the year was assessed as being very dry. In our analysis, a medium fresh refers to a period of increased flow, when the water level rises at least one quarter of the way up the river bank. These medium freshes are not as frequent as low freshes but are also a regular and important part of the natural flow regime. In the Condamine Balonne valley, in terms of the occurrence of medium freshes, the year was assessed as being dry. In our analysis, a high fresh refers to a period of increased flow, when the water level rises more than half way up the river. A high fresh may not occur every year but they are still important and long periods without major freshes can have serious consequences for floodplains and their contribution to river ecosystem health. Delivering environmental high in channel flows normally requires that all risks to riparian landholders and infrastructure have been resolved. In the Condamine Balonne valley, in terms of the occurrence of high freshes, the year was assessed as being average.

19.2 Water delivery context

During the 2019–20 water year, the Commonwealth Environmental Water Holder (CEWH) held water entitlements of up to 172,926 ML for environmental use in the Condamine Balonne valley. Each year, water utilities allocate water entitlement holders a percentage of water based on their holding, licence type and carryover (the exact rules vary among Jurisdictions and licence type). In 2019–20, the Condamine Balonne entitlements held by the CEWH were allocated 34 ML of water, representing 0% of the Long term average annual yield for the Condamine Balonne valley (91,241 ML). Information and data relating to the portfolio of held Commonwealth environmental water is shown in Table CON1.

The 2019–20 water allocation (34 ML) together with the carryover volume of 25 ML of water meant the CEWH had 59 ML of held water available for delivery. However, unregulated entitlements triggered a total of 165,729 ML of Commonwealth environmental water for use, all of which was delivered. A total 40 ML (69%) of held Commonwealth environmental water was carried over for environmental use into the 2020–21 water year.

19.3 Environmental conditions and resource availability

The water available for environmental delivery combined with the present and antecedent environmental conditions are key inputs used by environmental water managers in planning and implementing watering actions. *Post hoc*, this information provides important context when evaluating the effectiveness and appropriateness of environmental water use with respect to hydrological outputs.

The rainfall conditions in the Condamine Balonne valley were classified as below average, based on rainfall percentile data for the entire record held by the Bureau of Meteorology for this valley. The water held in major storages in the Condamine Balonne valley decreased over the water year, for example Leslie, Cooby, Chinchilla, Beardmore and Jack Taylor dam was 14.0% full at the beginning of the water year and 40.2% full by the end of the year (Figure CON1).

The watering strategy in the Condamine Balonne relies on passive management as water delivery is dependent on the natural flows triggering the licence condition to take water.

19.4 Watering actions

A total of 2 watering actions were delivered over the 2019–20 water year, the duration of these actions varied (range of individual actions: 167 days) and Commonwealth environmental water was delivered for a total of 334 days. The number of water actions commencing in each season included, summer (0), autumn (0), winter (2), spring (0). Similarly, the count of flow component types delivered in the Condamine Balonne valley were; (2) baseflow, (0) baseflow-fresh, (0) baseflow-fresh-bankfull, (0) baseflow-fresh-overbank-wetland, (0) fresh, (0) fresh-wetland, (0) bankfull, (0) overbank, (0) wetland and (0) wetland-overbank.

In the Condamine Balonne, watering actions were delivered for connectivity and vegetation purposes, but water was also delivered for other purposes too. The percentage of watering actions delivered across the nine main themes included fish (0.0%), vegetation (50%), waterbirds (0.0%), frogs (0.0%), other biota (0.0%), connectivity (50%), process (0.0%), resilience (0.0%) and water quality (0.0%).

Table CON1. Commonwealth environmental water accounting information for the Condamine Balonne valley over 2019–20 water year.

Total registered volume (ML)	Allocated volume (ML)	Carry over + allocated volume (ML)	Delivered (ML)	LTAAY (ML)	Carried over to 2020–21
172,926	34	59	165,729	91,241	40

19.5 Contribution of Commonwealth environmental water to flow regimes

19.5.1 St George

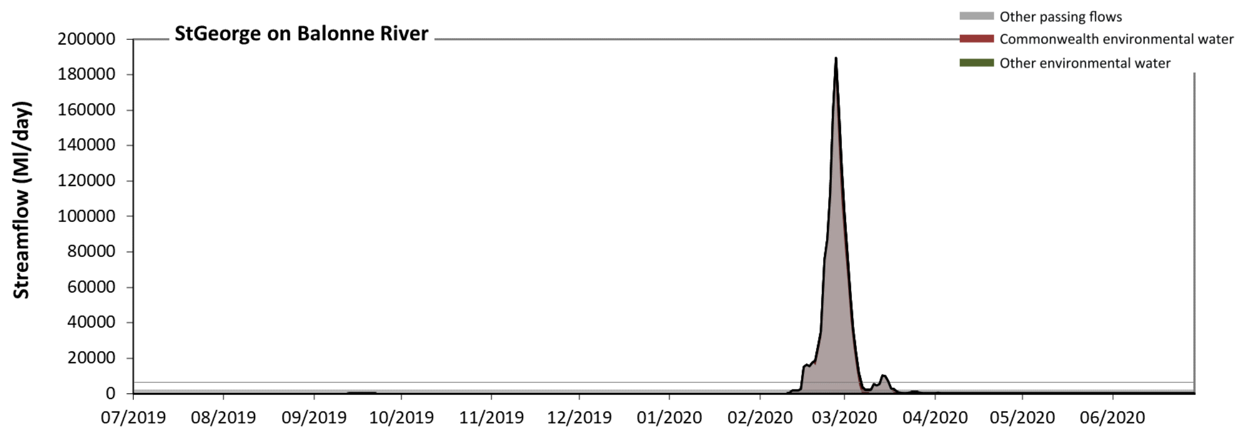
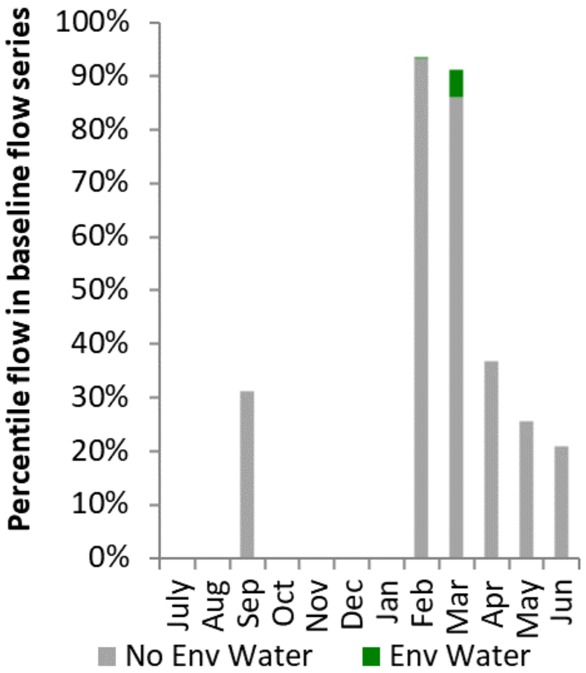


Figure CON2: Contribution of environmental water delivery at St George. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At St George on Balonne River environmental water contributed 11% of the total streamflow volume (all of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 8% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 71 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of very low flow spells from 87% to 86% of the year, with greatest influence in the period January to March. Similarly, without environmental water, the durations of low flows (i.e. < 350 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. Environmental water mitigated these impacts by reducing the cumulative duration of low flow spells from 89% to 88% of the year, with greatest influence in the period January to March. In the absence of environmental water there would have been at least one low fresh (i.e. > 920 ML/day) in the period January to March. Environmental water increased the duration of the longest low fresh during the period January to March (from 24 days to 37 days). Commonwealth environmental water was entirely responsible for these increased durations of low freshes. In the absence of environmental water there would have been at least one medium fresh (i.e. > 2000 ML/day) in the period January to March. Environmental water increased the duration of the longest medium fresh during the period January to March (from 21 days to 33 days). Commonwealth environmental water was entirely responsible for these increased durations of medium freshes. In the absence of environmental water there would have been at least one high fresh in the period January to March. Environmental water made little change to the duration of these high freshes.



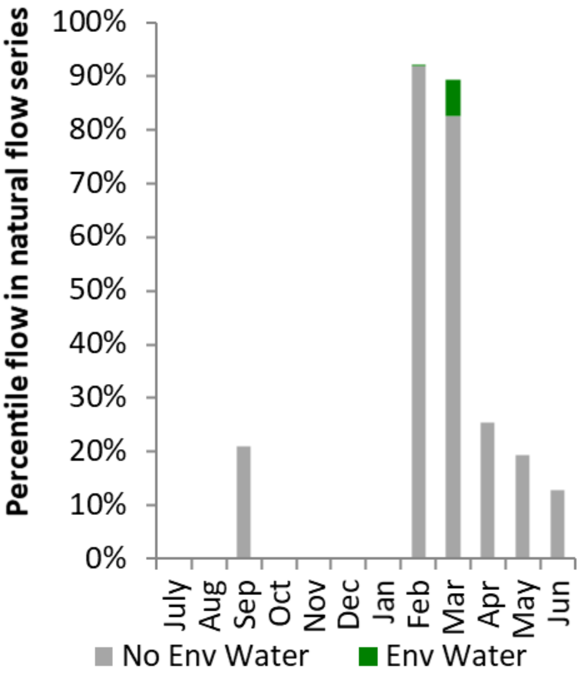


Figure CON3: Contribution of environmental water delivery at St George as percentiles in the natural and baseline flow series.

19.5.2 Roseleigh

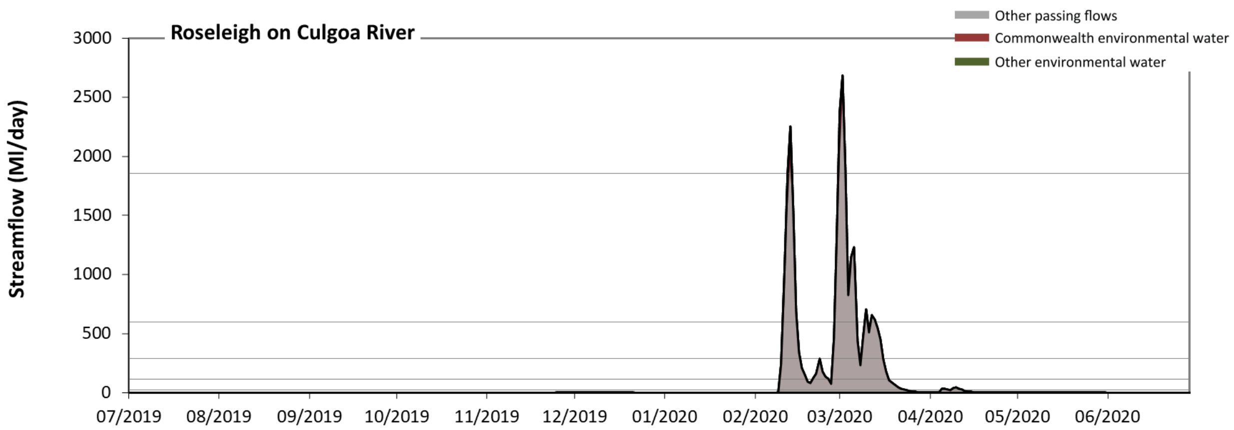


Figure CON4: Contribution of environmental water delivery at Roseleigh. Horizontal lines indicate thresholds for very low flows, low flows, low freshes, medium freshes and high freshes (from lowest to highest).

At Roseleigh on Culgoa River environmental water contributed 7% of the total streamflow volume (all of which was Commonwealth environmental water). Environmental watering actions affected streamflows for 2% of days between 1 July 2019 and 30 June 2020. Without environmental water, the durations of very low flows (i.e. < 23 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these very low flows, which occurred for 86% of the year. Similarly, without environmental water, the durations of low flows (i.e. < 110 ML/day) in the periods July to September, October to December, January to March and April to June would have all substantially exceeded durations expected in an average year in the natural flow regime. However, environmental water had little effect on the duration of these low flows, which occurred for 91% of the year. There was at least one low fresh (i.e. > 290 ML/day) in the period January to March. Environmental water made no change to the duration of these low freshes. There was at least one medium fresh (i.e. > 600 ML/day) in the period January to March. Environmental water made no change to the duration of these medium freshes. In the absence of environmental water there would have been at least one high fresh in the period January to March. Environmental water made no change to the duration of these high freshes.

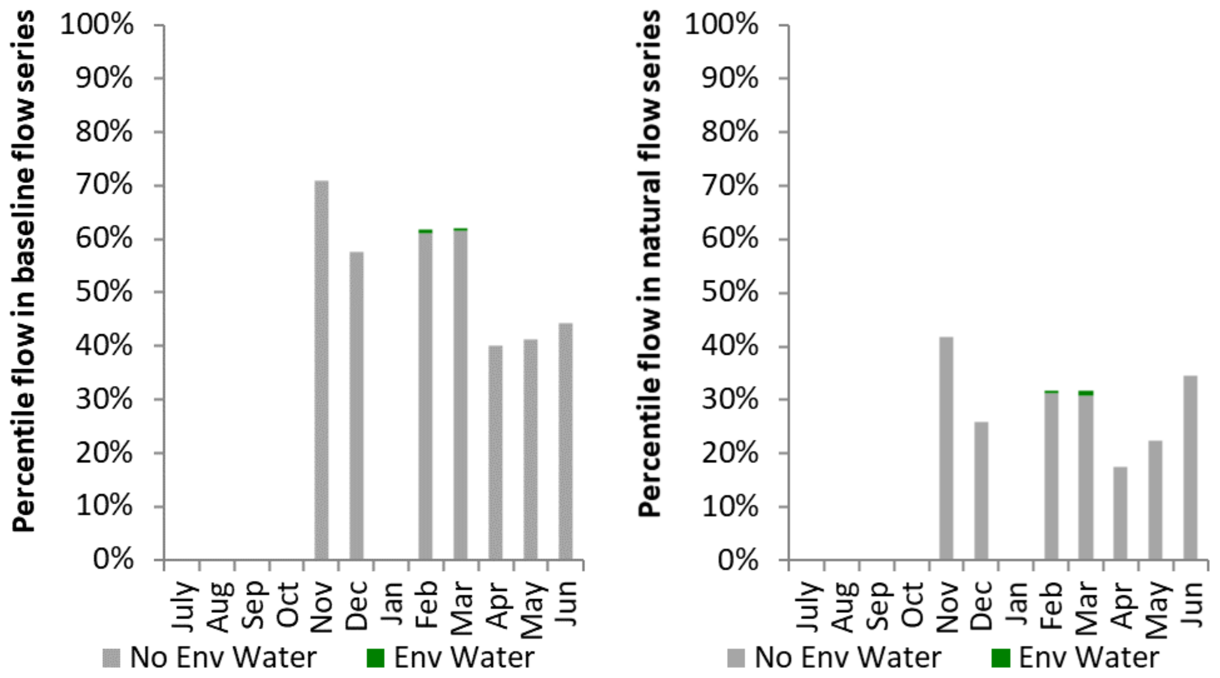


Figure CON5: Contribution of environmental water delivery at Roseleigh as percentiles in the natural and baseline flow series

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Stewardson MJ, Guarino F (2020) 2018–19 Basin-scale evaluation of Commonwealth environmental water — Hydrology: Annex A Valley Report Cards. Final Report prepared for the Commonwealth Environmental Water Office by La Trobe University, Publication 253/2020, July, 258pp.

https://flow-mer.org.au

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SARDI South Australian Research and Development Institute

une University of New England

NSW Government Department of Primary Industries

ARRC Australian River Restoration Centre