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# Murrumbidgee Bulk Entitlement Delivery Trials 2016 & 2017

Environmental watering trials in the Murrumbidgee River

June 2022





# Acknowledgement of Country

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# Preface

Two large-scale environmental watering trials to deliver environmental water were conducted in the Murrumbidgee River system in 2016 and 2017. These included Held Environmental Water (HEW) and Planned Environmental Water (PEW).

The trials included the following two events:

- Murrumbidgee “Native Fish Event” (2016/17).
- Murrumbidgee “Wetlands Reconnection Event” (2017/18).

Both trials were reviewed to document and evaluate the processes used and to inform future environmental water delivery and the ongoing development of Prerequisite Policy Measures (PPMs). Recommendations from the review have been made to inform future events.

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# Introduction

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## Background

Held environmental water (HEW) entitlements in the Murrumbidgee Regulated water source are held by various entities including the NSW Department of Environment – Environment and Heritage Group (E&HG), the Commonwealth Environmental Water Holder (CEWH) and other entities under The Living Murray (TLM) initiative. These (held) environmental water entitlements are managed by E&HG, as the NSW environmental water manager, on behalf of the respective water holders.

In addition to these volumes of HEW, the *Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2016* provides for three Environmental Water Allowances (EWA1, 2, and 3) that are credited with water under certain conditions. These rules-based accounts can be called upon by environmental water managers for use during environmental watering events. Such events have been undertaken at various times since 1997/98 when the first of these rules-based accounts were established.

Prerequisite policy measures (PPMs) are a Basin Plan requirement and formalise arrangements for the efficient and effective use of HEW to maximise the beneficial outcomes of water recovered for the environment under the Basin Plan.

In the Murrumbidgee Regulated River water source, PPMs apply only to HEW. PPMs allow the use of HEW at multiple sites along the length of the river, and between rivers (environmental flow reuse), and provides for HEW to be ordered from a headwater storage during unregulated flow events (piggybacking). In NSW, PPMs were determined as being in effect from 1 July 2019.

Two large-scale environmental watering trials were undertaken in the Murrumbidgee River in the 2016-17 and 2017-18 water years. These trials relied on operational and accounting arrangements which were similar to the mechanisms to be provided for under PPMs.

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## Climate overview 2016 – 2018

The 2016 – 2018 water years commenced with a very wet winter and spring period that saw the first high flow events occur in many years across the Basin. Since that period, two dry winter/spring periods in succession meant most areas in the southern connected Basin slowly returned to drought conditions.

Figures 1 to 4 show the volume in Murrumbidgee River storages and the flows at Wagga Wagga to provide context for the review of the 2016 and 2017 environmental watering events.

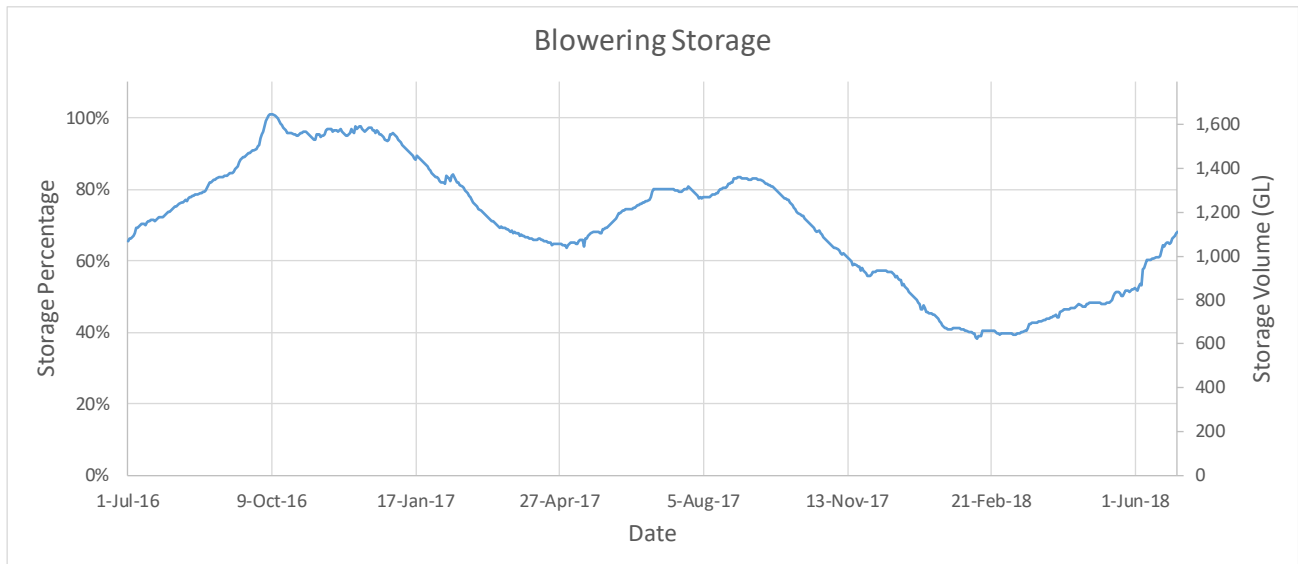


Figure 1. Blowering Dam storage levels (2016/17 and 2017/18)

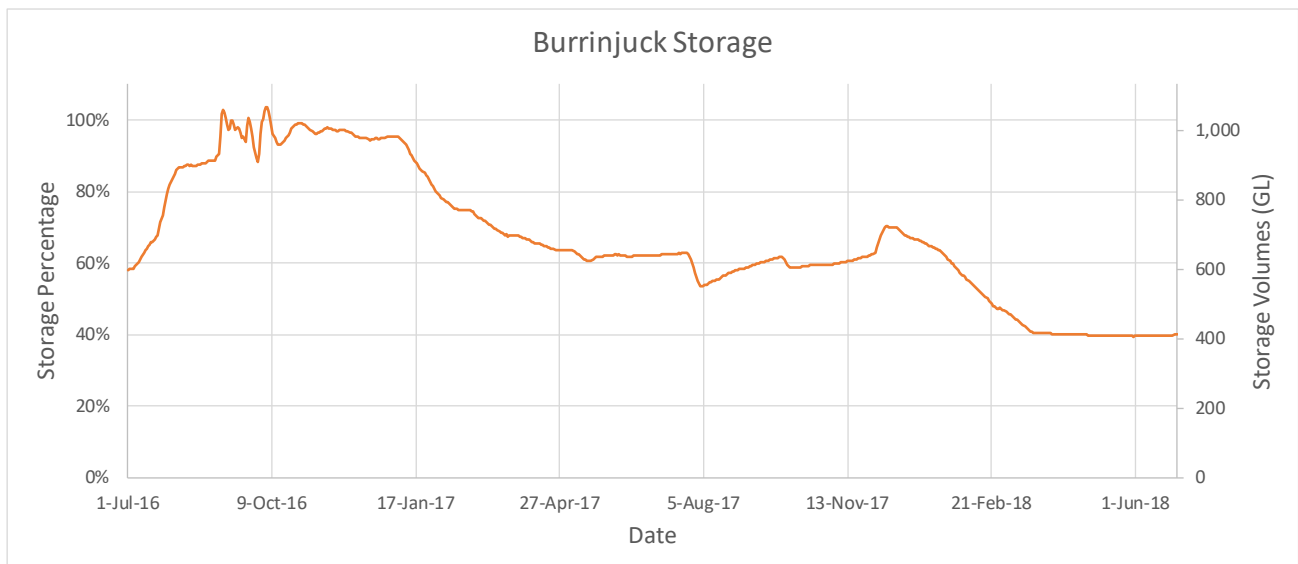


Figure 2. Burrinjuck Dam storage levels (2016/17 and 2017/18)

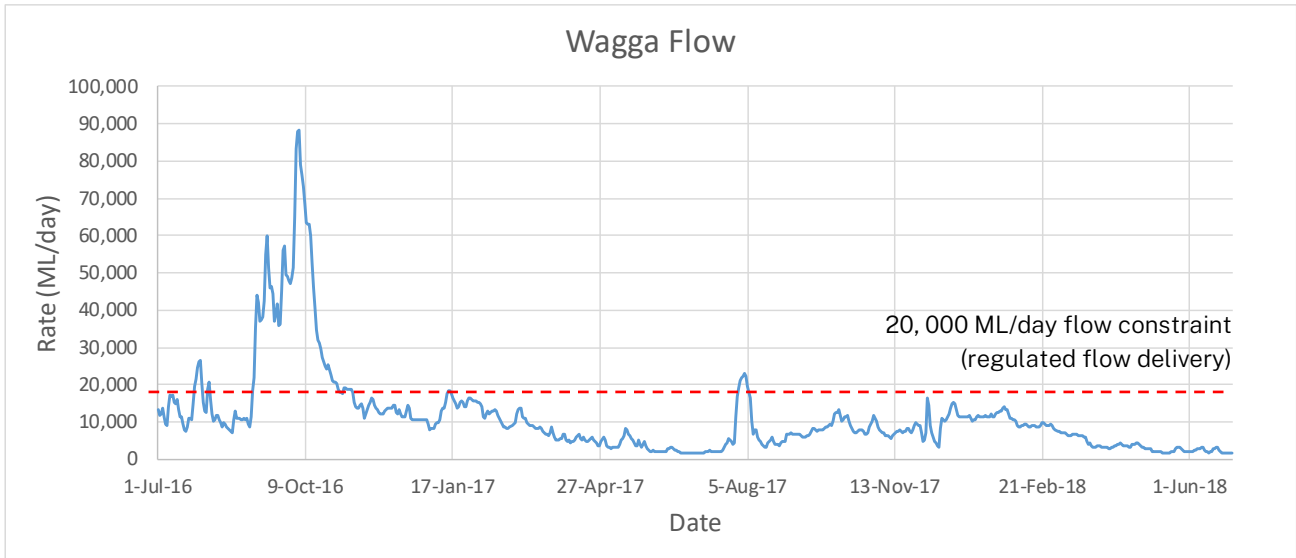


Figure 3. Daily flows at Wagga Wagga (2016/17 and 2017/18)

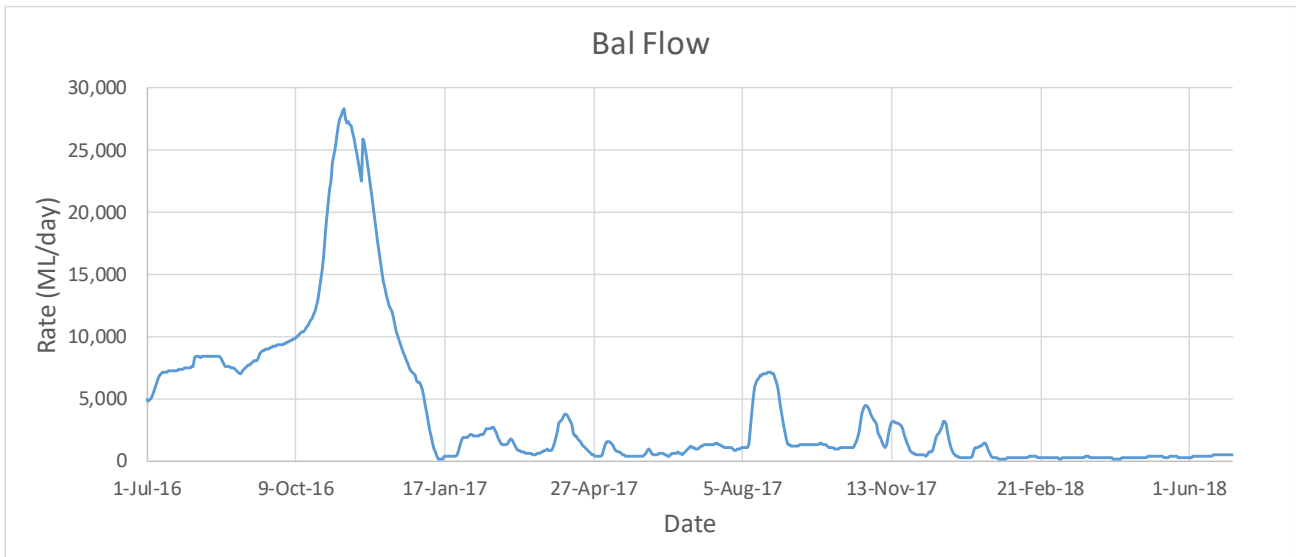


Figure 4. Daily flows at Balranald (2016/17 and 2017/18)



# Murrumbidgee “Native Fish Event” (2016/17)

This event extended the recession of flows in the Murrumbidgee River following natural flooding during the winter and spring of 2016 to provide beneficial flows for native fish and to dilute de-oxygenated water (“blackwater”) returning from the floodplains in the lower Murrumbidgee and Murray. This event was referred to as the “Blackwater” or “Native Fish” event (E&HG event reference MBG16/17-07 Lowbidgee Fresh).

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## Event summary

- A total of 371 GL was delivered, consisting of 135 GL of EWA and 236 GL of HEW (85 GL of TLM and 151 GL of CEWH account water)
- environmental water orders were made for target flow rates (with +10% variability) and constrained by a total event volume split across the different licences. Releases were made to target the following flows:
  - 20 GL/day at Wagga Wagga, commencing 29 October, for 11 days
  - target flow moved to downstream (d/s) Gogeldrie Weir on 13 Nov, at 8 GL/day
  - target flow moved to d/s Maude Weir from 27 November to 5 January, commencing at 7 GL/day and reducing to 400 ML/day
- releases were made on the tail of a previous natural high flow event. Airspace operations were conducted in September/October in both the major storages. On the back of flows at Tumut peaking at around 2.4 metres and dropping below minor flood level (minor at 2.0 m, moderate at 2.6 m), releases from Blowering and Burrinjuck Dams were made to support the environmental targets. Note:
  - these environmental flow orders brought to an end the ongoing supplementary access (30 Oct). Supplementary event flows are in excess of those required to meet end-of-system targets, EWA orders, and orders by access licences of categories other than supplementary water or supplementary water (Lowbidgee). In this event, the environmental water managers were keen to preserve the hydrograph to avoid a rapid decrease in flow rates which can be detrimental to native fish and vegetation communities, hence the shifting target flow rate and order point. The environmental water managers were debited for water in the river from tributaries that was achieving their outcome. The “trade-off” here is that the action would have boosted regulated water available resources but reduced what might be considered historical access of supplementary water users
  - this watering action affected supplementary access because of the change in dam operations. Without the environmental order, it is likely that there would have been only releases from Burrinjuck and Blowering Dams for airspace requirements for a relatively

short period (possibly 1-2 weeks), followed by flows required to meet irrigation demand and system minimum flow targets. As this occurred on the back of a long period of access, it is unlikely to be of substantial impact.

- additional flow of HEW to the Murray valley was managed under a Bulk Entitlement Delivery (BED) trial. Leading up to this watering event, retail trade out of the Murrumbidgee River was closed because the Inter-Valley Trade (IVT) balance was at its maximum limit of 100 GL. The then OEH (now E&HG) and the CEWH did not have sufficient account volumes to undertake the watering event, and water from TLM entitlements was required. However, TLM could only be contributed if it could be subsequently recognised and used downstream in the Murray system to provide benefits to downstream environments such as TLM Icon sites.

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## Operational implementation

The balance of storage (between Blowering and Burrinjuck Dams) and late season deliverability were considered in the planning phase of this event. From a resource perspective, both the storage levels and time of the year were the key drivers under the harmony rules. Blowering Dam was running at full capacity (around 9-10 GL/day at Brungle Bridge), so Burrinjuck Dam was meeting any demand that Blowering could not.

Releases were made based on the target flows at Wagga, d/s Gogeldrie Weir and d/s Maude Weir, with each subsequent target flow commencing after the upstream target flow, with an allowance for the travel time between the two locations. Overall, the delivery of water against these target requirements was generally considered to have been successful, as follows:

- observed flows at Wagga were generally below the target flows (20 GL/day), but typically within 10% of the target flows
- conversely, flows at d/s Gogeldrie (8 GL/day) were generally above target, initially by up to 50%. This reflects the effects of channel storage delaying the reduction in releases made at the dams through attenuation. However, a gradual reduction in flows provides a range of benefits, including avoiding the potential for bank-slumping
- the orders at d/s Gogeldrie were placed based on “normal” travel times and flow attenuation was ignored. While the releases from storages were cut to meet the new target of 8 GL/day at Gogeldrie, the water released to meet the 20 GL/day target at Wagga caused increased flows at Gogeldrie greater than the required target. While this was likely caused by attenuation of water already debited against environmental water accounts, the implications on restrictions on rates of cut at upper Murrumbidgee storages should be considered for future deliveries and agreed upon during the planning phase
- the observed flows at d/s Maude Weir were generally within 5% of the target flows, except for a period of about 10 days in late December 2016 where observed flows were significantly above target. This was due to diversions by consumptive water users falling significantly below the ordered volumes as localised rainfall reduced their demand.

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## Accounting

Environmental water use was taken to be the incremental increase in flow required at the target flow location compared to the flow that would have been required to meet consumptive demands. This volume was calculated as the difference between the observed flow and the consumptive flow requirement at Wagga, estimated from CAIRO (i.e. the MDBA’s hydrologic model).

For environmental water targets (and delivery) to Wagga Wagga, the initial debit advice (during the event) was calculated using consumptive flow requirement from CAIRO each day, including forecast downstream use and required transmission losses. The “final” consumptive flow requirement from CAIRO was calculated one to two weeks later and included the observed diversions by the irrigation corporations and some observed unaccounted flow differences (an estimate for transmission losses). The estimates were communicated to the environmental water holders before the debits were applied. The ‘final’ consumptive flow requirement was used for debiting purposes.

To provide some protection from operational (forecasting) uncertainty for the periods when the target flows were placed well downstream of the major storages (that is, at d/s Gogeldrie Weir and d/s Maude Weir), the calculation of debits was limited by using the lesser of:

- the target flow +10% minus required operational flow, or
- the observed flow minus required operational flow.

At no point during this event did the flow drop significantly below the target flow. Therefore, situations where the flow is well below ordered flow, or even below operational requirements (shortfall conditions), have not been tested through this event.

WaterNSW noted that on some days the consumptive order from CAIRO was dominated by the estimated unaccounted differences that were high due to high flows/recessions, and therefore warranted the use of observed information (for the actual unaccounted differences) following the event to revise the calculated account debits for environmental water use (Table 1).

Table 1. Volumes of accounted environmental water use (ML) – Murrumbidgee

Flow target	EWA	CEW	TLM
<b>Wagga</b>	125,070	0	0
<b>Gogeldrie</b>	0	56,978	0
<b>Maude</b>	9,791	94,000	85,000
<b>Total</b>	134,861	150,978	85,000

As natural high flows ceased through the system and environmental water orders dominated flow requirements, unreconciled (raw) water orders for river pumpers were used to estimate the consumptive flow requirement at Gogeldrie and Maude and were not subsequently updated with actual use estimates. These volumes of consumptive water use were much smaller than the water use by the irrigation corporations, and this was considered to be a reasonable approach. WaterNSW noted that for future events, CARM (i.e. WaterNSW’s hydrologic model- Computer Aided River Management system) could now provide telemetry of pumping use to replace unreconciled raw orders each day.

The EWA debits were made during the early stages of the event as there was a large EWA3 account balance that was about to be partially forfeited on 1 November.

An overview of environmental water accounting for the period of flow targets at Wagga Wagga and Maude Weir are provided in Figure 5 and Figure 6. The detailed daily accounting for each of the three different target flow points is provided in Attachment A.

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## Yanco

The hypoxic blackwater event at Wagga Wagga occurred between 29/10/2016 and 8/11/ 2016. The higher levels in the Murrumbidgee River at Yanco Weir caused increased diversion into Yanco Creek. All the water diverted into Yanco Creek was included as required flow at Wagga and no further debit was made on the account additional losses in the Yanco Creek.

A separate delivery was made to meet the orders by environmental water holders to address the hypoxic blackwater impacts in the Yanco Creek. The orders were placed at Yanco Offtake starting from 20/11/2016 to 10/12/2016. The consumptive flow requirements were calculated from CAIRO in a manner similar to the Murrumbidgee River event described above.

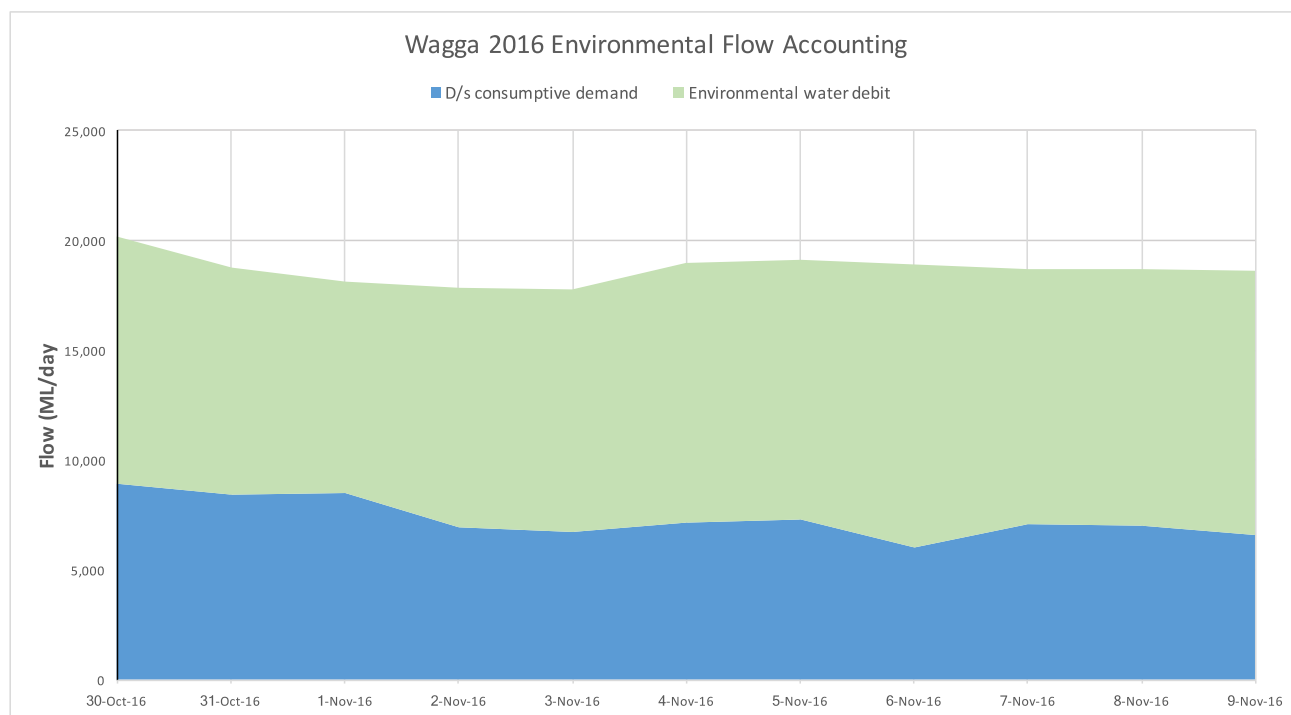


Figure 5. Environmental water accounting for the Native Fish Event (Wagga Wagga)

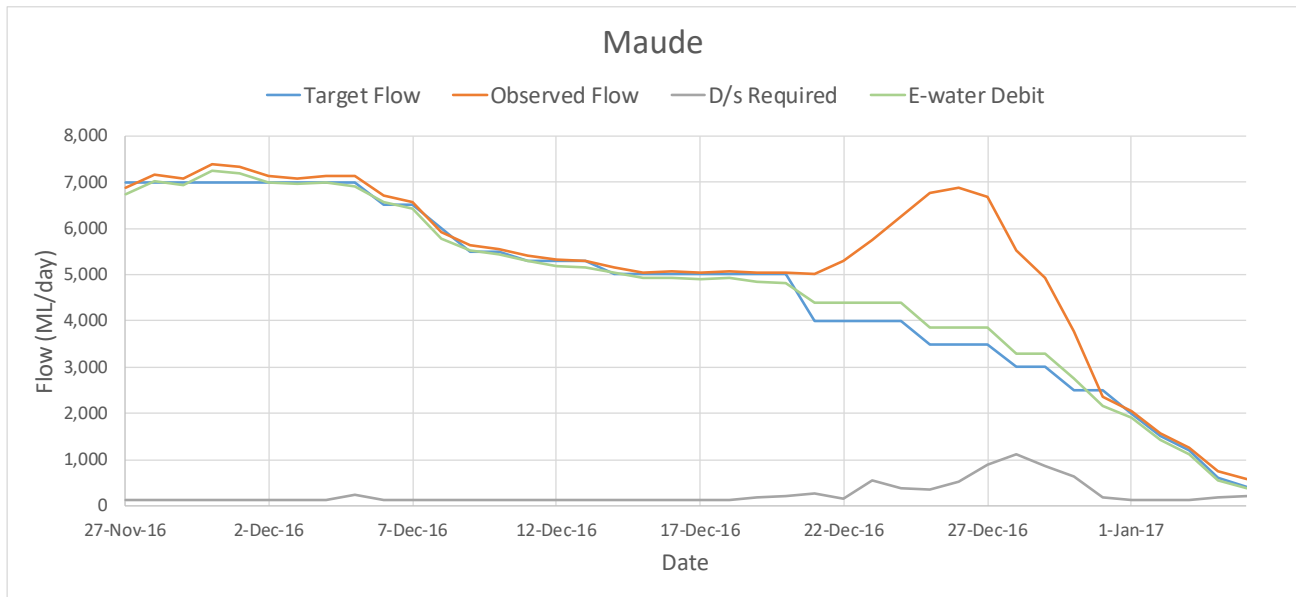


Figure 6. Environmental water accounting for the Native Fish Event (Maude Weir)

The consumptive use calculated and used for the above estimations at the Yanco Offtake included a portion of the water debits at Warriston Weir (Forest Creek) by the environmental water holders.

The delivery at Warriston Weir started on 16/11/2016 and finished on 4/1/2017. Environmental water holders were regularly consulted and advice was sought on the split of use between HEW and PEW accounts.

Table 2 summarises the volumes and composition of environmental water used in the Yanco Creek system. Approximately 5,839 ML was used by environmental water holders at Warriston Weir and approximately 3,447 ML was debited at Yanco Offtake.

Table 2. Volumes of accounted environmental water use (ML) – Yanco Creek

Flow Target	EWA	CEW	TLM
Yanco Offtake	3,447	0	0
Warriston Weir	839	5,000	0
<b>Total</b>	<b>4,286</b>	<b>5000</b>	<b>0</b>

## Protection of environmental flows below the target flow location

WaterNSW indicated that it was intending to restrict consumptive water users to travel time-ahead (forecast) orders +/- operational flexibility (e.g. from re-regulatory storages along the river) to protect environmental flows. This approach would have protected flows operationally rather than through a policy measure, by minimising take greater than customer orders, and therefore allowing the portion of flows which could be attributed to environmental orders to travel to the end of the system. As it transpired, the major irrigation corporations did not take the forecast water orders at times, and there was a surplus of flows at Gogeldrie Weir.

WaterNSW considered that potential variability of take by river pumpers (from that forecast) would be low, and the magnitude of take was small compared to the size of the flow event. As such, no specific action was taken to manage their water use. No comparison of forecast and actual pumped water use has been undertaken to determine whether this assumption was reasonable.

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## Bulk Entitlement Delivery trial

Under the 'Bulk Entitlement Delivery' (BED) trial, NSW uses Clause 98 (MDBA's Role in the Operation of Storages) of the Murray-Darling Basin Agreement to direct the MDBA to operate River Murray storages to deliver a bulk volume of NSW water to South Australia.

NSW authorised the MDBA via a letter in December 2016 (BN16/9562) to extend the use of the BED process to inflows from the Murrumbidgee in 2016/17. This request built on an earlier request in May 2016 to use a 2016-17 BED trial for directed releases from Hume Dam.

The BED trial involved formal notification from NSW to the MDBA that a portion of the flows from the Murrumbidgee valley was to be recognised as environmental water in the River Murray and delivered to the South Australian border as a "bulk delivery" of NSW water. The only volume of water flowing from the Murrumbidgee Valley during this event to be recognized as environmental was the TLM-debited releases, and no formal recognition was given to the CEWH account water delivered to the Murray River.

The delivery of TLM account water was accounted during the period when the target flow was at Maude, to minimize uncertainty in volume of water physically reaching Murray (and being accounted as such).

This BED trial mainly occurred in conjunction with large return flows from Lowbidgee, so no additional actions to protect HEW were taken for the Murray. Similarly, the recognition for CEWH account water delivered to the Murray would not have altered flow outcomes in the Murray River. As a result of these circumstances, the BED trial was only a test of the administrative arrangements rather than the recognition of volumes flowing to the Murray, and their subsequent protection.

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## Documentation

This event was largely organised verbally or via emails, and no significant contemporary documentation occurred. Attachment A is an extract from the CAIRO model and includes spreadsheets provided by WaterNSW. It shows post-event accounting at Wagga Wagga, the difference in what CAIRO forecast the actual unaccounted differences (AUDs) to be (affected by large natural flows), what AUDs were assumed, sets out the calculation of account debits, and compares actual and target flows.



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## Assessment of risks to other water users

The debiting method adopted for this trial added the tributary inflows above Wagga Wagga to the dam releases when assessing the total water supplied to Wagga Wagga (from which the downstream consumptive demands were subtracted), rather than only debiting for the additional releases from storages. Effectively this means that the downstream tributary inflows were used to meet the environmental water orders, and there was not any risk of impact to reliability of supply for all water users by not utilising downstream tributaries (as could potentially be the case for a piggybacking release which is released on top of tributary inflows).

The event targeted within-channel flows for both the Murrumbidgee and Murray, and losses would be expected to be within the normal range for regulated delivery of water.

The Murray River was experiencing unregulated flow conditions at the commencement of this event. However, by the time the Murrumbidgee e-flows were to reach Balranald (about three weeks from release) they were not forecast to contribute to any overbank flows in the Murray, nor exceed operational flow limits at the South Australia border (upper limit of 80,000 ML/day). The lower Murray River was expected to be in regulated conditions by then, or close to it (unregulated conditions ceased on the morning of 31 December 2016 at the South Australia border).

No losses were applied in the Murray downstream system for this initial trial, due to the very wet conditions as the Murray was coming out of unregulated conditions, and allocations in the Murray were already at 100 percent.

While no impacts to licence holders were identified for the proposed watering action, and rather than allowing a 'trade for immediate use' (as was allowed in 2012), the bulk scale delivery mechanism of the BED trial (provided under the Murray Darling Basin Agreement) was used to recognise environmental inflows to the Murray River from the Murrumbidgee River. The BED trial allowed for the much-needed ecological (and social) outcomes from the watering action, as well as showing NSW's willingness to fulfill its commitment to PPMs. The BED trial had been successfully applied in the Murray-Lower Darling system as the preferred method, being both administratively and operationally more efficient, effective and appropriate than the retail trade mechanism, and this was the first time it was used in the Murrumbidgee River.

# Murrumbidgee “Wetlands Reconnection event” (2017/18)

This event (E&HG event reference MBG 17/18-02) was a “stand alone” release of water from storages in the Murrumbidgee River during the winter of 2017 to provide beneficial flows for low-lying floodplain areas along the Murrumbidgee River. It was managed by (the then) OEH and referred to as the “Wetlands Reconnection event”. These releases from storage were made during a period where there were no significant prior river flows, and only modest downstream tributary inflows were occurring.

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## Event summary

- The environmental order was for a stand-alone release of approximately 236 GL, referred to as the “Wetland reconnection” event, with flow targets at Wagga Wagga, d/s Gogeldrie Weir and d/s Maude Weir as follows:
  - increasing flows were targeted at Wagga Wagga over four days to reach a peak of 22 GL/day, held at that peak for five days, then receded at a rate of 15% per day at Wagga Wagga until flows reduced to the level of consumptive demands
  - additional releases from Tombullen storage were also made on receding river flows to maintain a water level of 4.2 m at Darlington Point
- the event commenced 26 July 2017 and continued until 8 August 2017 at Wagga Wagga.
  - peak flows at Wagga Wagga achieved (22 GL/day)
  - second target at Darlington Point was exceeded (4.7 m achieved)
- additional flow of HEW to the River Murray was managed under a BED trial.

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## Operational implementation

Organisation of the event was led by OEH and commenced in March/April as an autumn event. However, there were some late changes to increase the volume available, and the duration of the peak flow at Wagga Wagga. This arose from allocation increases that improved CEWH water availability. The main irrigation corporations were just coming back online from a winter shutdown and were in the process of filling their channels and/or early orders and weather was the main driver for filling. A dry winter and autumn placed some winter crops in a position of distress, so filling and supply quickly became a factor for demand by irrigation corporations.

The details for this event are:

- CARM “scenario” modelling was used to estimate the required release at Burrinjuck Dam (given the capacity constraints at Blowering Dam) and to forecast river heights at different

sections of the river for advising customers/public. This takes three to four hours to run, and was undertaken during event design and at key points during the event

- CARM “storage operations” modelling (operates to Wagga Wagga only) was used to verify the flow pattern at Wagga Wagga for adopted release pattern from the dams. This takes about 15-30 minutes to run, and was undertaken during event design as a cross check
- the “Hourly Model” spreadsheet (previously used for flood operations) was used to cross check “CARM storage operations” results
- CAIRO was used to estimate the use during storage release periods and report the progress of the event. It was also used during and after the event for the purpose of calculating consumptive use and/or system losses.

The peak flow of 22 GL/day was negotiated with riparian landholders around Collingullie by WaterNSW. The environmental water releases were initially targeted to reach a river level of 3.7 m (or 20,000 ML/d) at Wagga Wagga. A flow height of 3.7 m at Collingullie is known to be of minimal inconvenience to river stakeholders. There were many discussions among irrigation corporations, landholders and environmental water managers around Collingullie before the constraint was increased to 4.0 m or 22,000 ML/day.

The WaterNSW work approval provides constraints within which WaterNSW must operate. The work approval also requires WaterNSW to consider factors such as inundation of private land or interference with access, and the effects of inundation on the floodplain and associated wetlands. As Collingullie landholders identified potential impact from high flows, WaterNSW together with OEH discussed targets with landholders to arrive at the initial 3.7 m target. When irrigation demand increased, the potential to increase the target was discussed with key stakeholders and agreed on. The engagement with key stakeholders was the key reason the event passed without significant negativity from the Collingullie community.

Releases from the dams were made based on the target flows at Wagga Wagga, and then at Darlington Point. Overall, the delivery of water against these target requirements was generally considered to have been successful.

The orders for this event were notionally placed at Balranald to avoid the releases from storage being considered as supplementary flows under the water sharing plan (i.e. flows in excess of identified requirements under the plan). This approach was effectively a “work-around” of the rules in the water sharing plan at that point in time. Provisions are required in water sharing plans to ensure that flows from directed releases can be protected along the length of the river, as required under PPMs (and not just above a nominated order point, as per current water sharing plans).

A rainfall event coincided with when flows were planned to recede from the peak at Wagga Wagga. Forecast advice from the Bureau of Meteorology and (as a result) CARM modelling over-estimated the rainfall and tributary inflows when making releases from storage, leading to a faster recession than planned (Figure 7, Figure 8). Although this had only a small effect on meeting the flow targets, additional releases were made from Tombullen, Hay, Maude, and Redbank Weirs after the event ended at Wagga Wagga (allowing for travel time), to manage the recession. These additional releases were not included in the environmental water order. It is understood that these releases were not authorized by the environmental water holders prior to the releases, and highlights the following operational issues:

- the uncertainty in forecasting both rainfall and tributary inflows
- who should bear risk arising from management actions to avoid any unplanned outcomes of environmental watering actions.

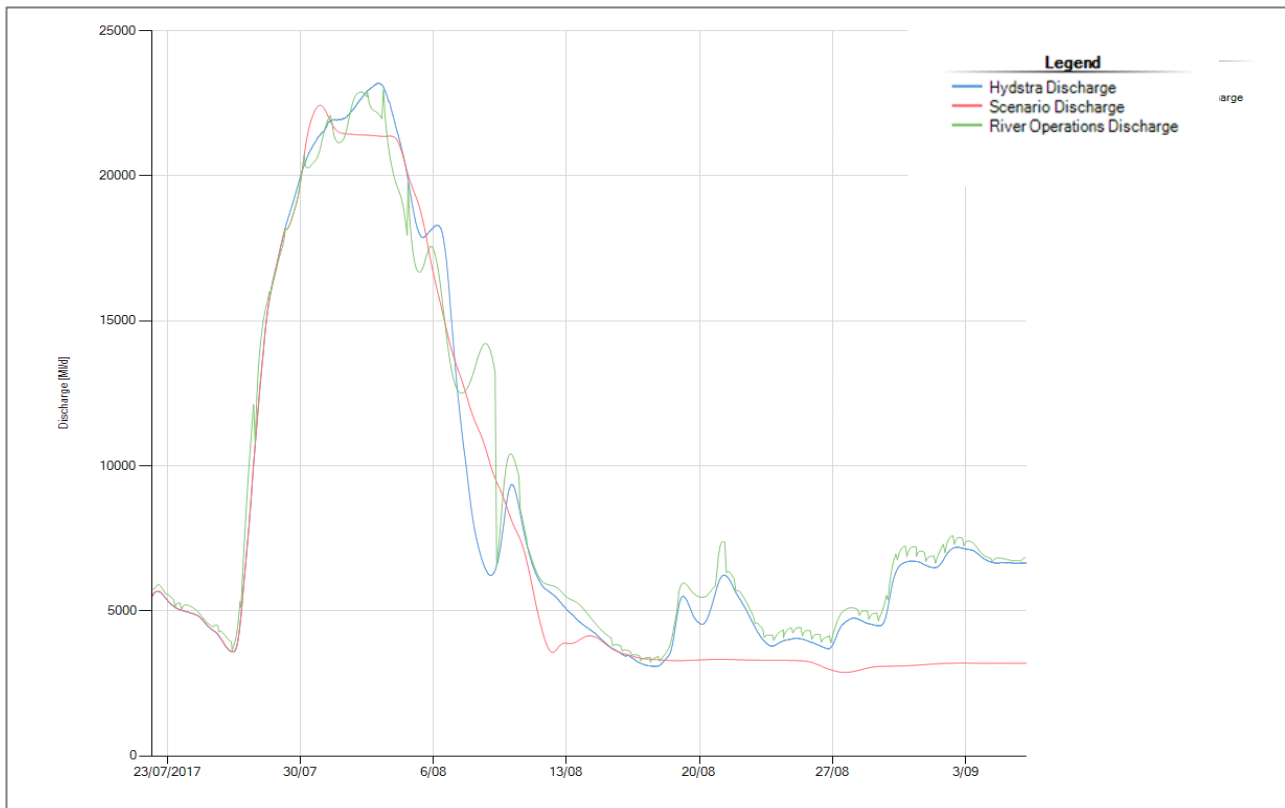


Figure 7. CARM “Scenario” simulation performed on 30/7/17

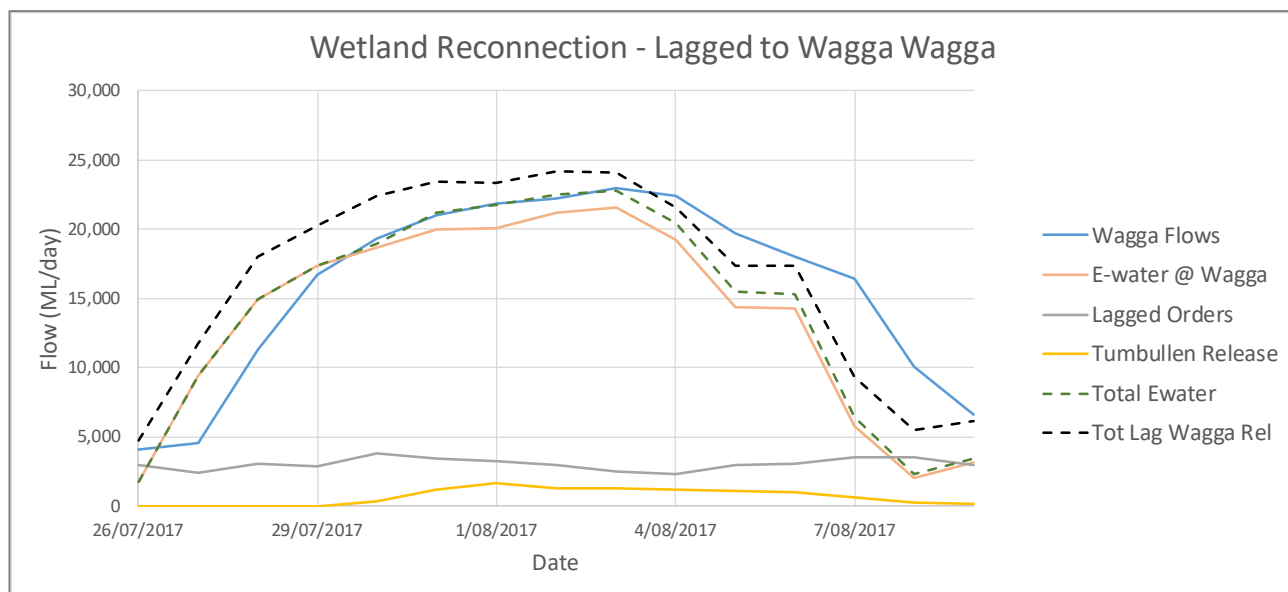


Figure 8. Environmental water accounting for the Wetlands Reconnection Event at Wagga Wagga

**Notes:**

1. **Wagga Wagga flows:** flow observed at Wagga Wagga.
2. **Environmental water @ Wagga Wagga:** flow at Wagga Wagga which is attributed to environmental delivery, taken as total releases from upper storages plus tributary inflows minus lagged orders.
3. **Lagged orders:** all orders downstream of Wagga Wagga, noting that the Expected Unaccounted Differences (EUDs) downstream of Wagga Wagga were assessed to be negligible.
4. **Tombullen Release:** releases made from Tombullen to support targets at Darlington Point, lagged to Wagga Wagga.
5. **Total e-water:** total e-water used, lagged to Wagga Wagga.
6. **Total Lag Wagga Wagga Rel:** Total releases made from upper storages and contributions from tributaries used to support environmental water delivery at Wagga Wagga and meet other demands.

## Accounting

Account debits (environmental water use) were taken to be the incremental increase in flow required at the target flow location compared to the flow that would have been required to meet consumptive demands. This was calculated as the:

- total release from dams (“Burrinjuck/Blowering releases lagged to Wagga” in Table 3), plus
- estimated tributary contribution above Wagga Wagga (“Total tributary inflows lagged to Wagga” in Table 3, as calculated in Table 4), minus
- consumptive flow requirement at Wagga Wagga (“Lagged other system orders/diversions” in Table 3, as calculated in Table 5).

The measures to provide protection from operational (forecasting) uncertainty used in the previous 2016 event were also applied for this event. The calculation of debits was limited at all times by using the lesser of:

- the target flow +10% minus required operational flow, or
- the observed flow minus required operational flow.

This approach to calculating debits using the total release from the dams plus total tributary inflows (rather than simply using the observed flow at Wagga Wagga) effectively includes the

losses between the dams and Wagga Wagga in the total debits, and resulted in an additional 12 GL of debits. This loss was not stable, but rather showed bank storage behaviour (i.e. the event was under losing conditions in the beginning of the event and then reverted to gaining conditions at the end of the event).

The losses were attributed to the environmental water order on the basis that the ordered flows were outside of the normal operating range and therefore the delivery of environmental order could very likely affect other water users. In support of this, WaterNSW indicated that the average unaccounted differences between the dams and Wagga Wagga in July 2017 (up to the commencement of the environmental watering event) were 59 ML/day, but during the event when dam releases (in conjunction with downstream tributary inflows) these were at or above 20,000 ML/day. The unaccounted differences were approximately 12 GL (resulting from 28 GL of “losses” during the rising limb, and 16 GL of “gains” during the falling limb), meaning the environmental water delivery accounted for virtually all the unaccounted difference (i.e. losses) experienced between the dams and Wagga Wagga. While this approach to the calculation of debits effectively includes all river transmission losses, as a result of the conditions during this release, the net result is that this is a reasonable representation of the incremental losses experienced as a result of the environmental releases. However, such conditions could not always be relied upon to be the case for future events.

Debit calculations were undertaken in a spreadsheet separate to CAIRO, to improve the calculation of the consumptive flow requirement at Wagga Wagga (i.e. what the demands would have been without the environmental water order; Table 3).

Whenever the flow targets were at Wagga Wagga, the initial debits advice (during the event) were calculated using consumptive flow requirement from CAIRO each day based on the forecast downstream water use, the Yanco Creek offtake requirement, and the end of system flow targets. The pre-event actual unaccounted differences (an estimate of transmission losses) were assessed as being negligible over this period (WaterNSW reported that the July 2017 daily average was actually a small gain of 28 ML/day between Wagga Wagga and Balranald), and were ignored for the purposes of calculating the other system orders. Debits advice was provided to the environmental water holders during the event via email and during Technical Advisory Group teleconferences.

The “final” consumptive flow requirement from CAIRO (Table 5) was calculated several weeks later, and was based on the observed diversions by the irrigation corporations and for the Yanco Creek offtake. This volume was the volume that was debited from environmental water accounts:

- Total debit 236 GL, comprising CEWO 164 GL, EWA 72 GL. (approximately 70:30 split):
  - approximately 214 GL for delivery at Wagga Wagga and from Tombullen to support target flow at Darlington Point
  - approximately 2 GL for releases from Hay during original event
  - approximately 20 GL of foregone tributary flows to manage recession.



Table 3. Wetland reconnection event - calculation of debits to environmental water accounts (ML)

Date	Burrinjuck releases lagged to Wagga	Blowering releases lagged to Wagga	Total tributary inflows lagged to Wagga	Total regulated releases lagged to Wagga	Observed Wagga Flows for Reference	Lagged other system orders/diversions	E-water use from Dams / tribs	Tombullen release	Cumulative use from Dams/ tribs	Account debit (EWA/GS)	
										EWA	GS
26/07/2017	960	2468	1346	4774	4102	2988	1786	0	1786	1786	
27/07/2017	4458	5195	2135	11788	4549	2382	9406	0	11192	9406	
28/07/2017	8477	8360	1173	18010	11272	3054	14956	0	26148	14956	
29/07/2017	10606	8650	1009	20265	16753	2872	17393	0	43541	17393	
30/07/2017	12631	8650	1177	22458	19290	3823	18635	345	62521	18980	
31/07/2017	13427	8650	1387	23464	21035	3449	20015	1169	83705	896	20288
1/08/2017	13336	8650	1329	23315	21843	3265	20050	1700	105455		21750
2/08/2017	13784	8880	1503	24167	22250	2968	21199	1305	127959		22504
3/08/2017	13753	8270	2067	24090	22989	2520	21570	1247	150776		22817
4/08/2017	11257	8360	1948	21565	22383	2300	19265	1194	171235		20459
5/08/2017	7113	8500	1767	17380	19679	2989	14391	1103	186729		15494
6/08/2017	5892	8500	2942	17334	18052	3024	14310	979	202018		15289
7/08/2017	1705	4870	2744	9319	16451	3499	5820	600	208438		6420
8/08/2017	640	1175	3695	5510	10124	3495	2015	300	210753		2315
9/08/2017	1260	610	4271	6141	6659	2944	3197	200	214150		3397

Notes:

1. Tombullen releases are subject to confirmation / revision by hydrographers
2. Coleambally channel losses are to be agreed between Coly and E&HG for finalisation of credits to CICL accounts; The total volume would then be debited to E&HG accounts.

Table 4. Calculation of tributary inflows lagged to Wagga Wagga (ML)

Date ending 5:00AM	Goo'andra lagged to Wagga	AUD 2 Brungle lagged to Wagga	Jugiong lagged to Wagga	Muttama lagged to Wagga	Adj'billy lagged to Wagga	Adelong lagged to Wagga	Tarcutta lagged to Wagga	Kyemba lagged to Wagga	Total
26/07/2017	282	679	74	19	94	46	147	5	1346
27/07/2017	286	1479	73	18	91	45	139	4	2135
28/07/2017	272	547	65	18	86	44	137	4	1173
29/07/2017	282	376	68	17	82	44	136	4	1009
30/07/2017	269	532	57	18	96	62	138	5	1177
31/07/2017	394	575	66	17	136	52	142	5	1387
1/08/2017	352	572	70	17	113	47	153	5	1329
2/08/2017	298	709	69	19	149	88	166	5	1503
3/08/2017	547	795	95	23	331	86	184	6	2067
4/08/2017	533	606	121	26	211	60	385	6	1948
5/08/2017	383	617	135	33	213	74	306	6	1767
6/08/2017	384	1073	170	111	804	163	230	7	2942
7/08/2017	1313	-147	267	83	700	180	339	9	2744
8/08/2017	1506	441	394	110	518	117	598	11	3695
9/08/2017	992	1537	282	75	565	229	582	9	4271

Table 5. Calculation of other system orders/diversions lagged to Wagga Wagga (ML)

Date ending 5:00AM	CAIRO lagged River pumers and EoS	Main diversions @ Bbed	Sturt diversions	Coleambally / Tombullen diversions	Yanco diversions
26/07/2017	1298	387	327	726	250
27/07/2017	1295	382	329	126	250
28/07/2017	1274	703	200	627	250
29/07/2017	1334	425	300	563	250
30/07/2017	1411	1039	375	748	250
31/07/2017	1293	1226	430	250	250
1/08/2017	1408	1202	376	29	250
2/08/2017	1408	970	324	16	250
3/08/2017	1413	632	225	0	250
4/08/2017	1348	373	329	0	250
5/08/2017	1452	487	300	500	250
6/08/2017	1395	566	350	463	250
7/08/2017	1376	524	430	919	250
8/08/2017	1291	504	450	1000	250
9/08/2017	1346	648	500	200	250

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## Yanco

The volume of water diverted into Yanco Creek was due to a natural split. The daily volume over and above the pre-event base demand was considered as environmental water that is already accounted at Wagga Wagga. Therefore, no additional accounting was done at Yanco Offtake, and no additional monitoring was done to track the environmental water flows. Excess flows at Darlot were not recognised in Murray system.

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## Protection of environmental flows (below target locations)

There was no operational process in place to restrict access to HEW downstream of the delivery point (Wagga Wagga) by consumptive water users, noting that PPMs were not in place prior to July 2019. WaterNSW undertook post-event accounting by recalculating the debits at Wagga Wagga within approximately two weeks of the event.

This revised the initial estimates for the “consumptive flow requirements downstream of Wagga Wagga” to reflect actual use for the irrigation corporations and Yanco offtake flows. For the river pumpers, unreconciled orders were still used. However, WaterNSW indicated that telemetry would now allow accounting to be updated with actual use for most river pumpers.

These measures were considered acceptable as the timing was very early in the water year, and the irrigation demand was sufficiently low to allow the environmental outcomes being sought.

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## End-of-system flow accounting

WaterNSW assumed that Balranald flow targets plus downstream orders would have been maintained had the environmental releases not occurred, as the conditions were generally dry and the re-regulatory storages along the river were well-balanced entering into the period of the releases. Accordingly, all flows in excess of the target flow at Balranald (plus the small downstream orders between Balranald and the Murray Junction) were considered to be the result of the environmental releases.

Under PPMs, HEW is protected along, and between, connected rivers. The ratio of debiting of the releases between HEW and EWA was approximately 70:30, and the same proportion was applied to the additional flows at Balranald to identify the volume of HEW for communication to the MDBA (and for recognition in the River Murray).

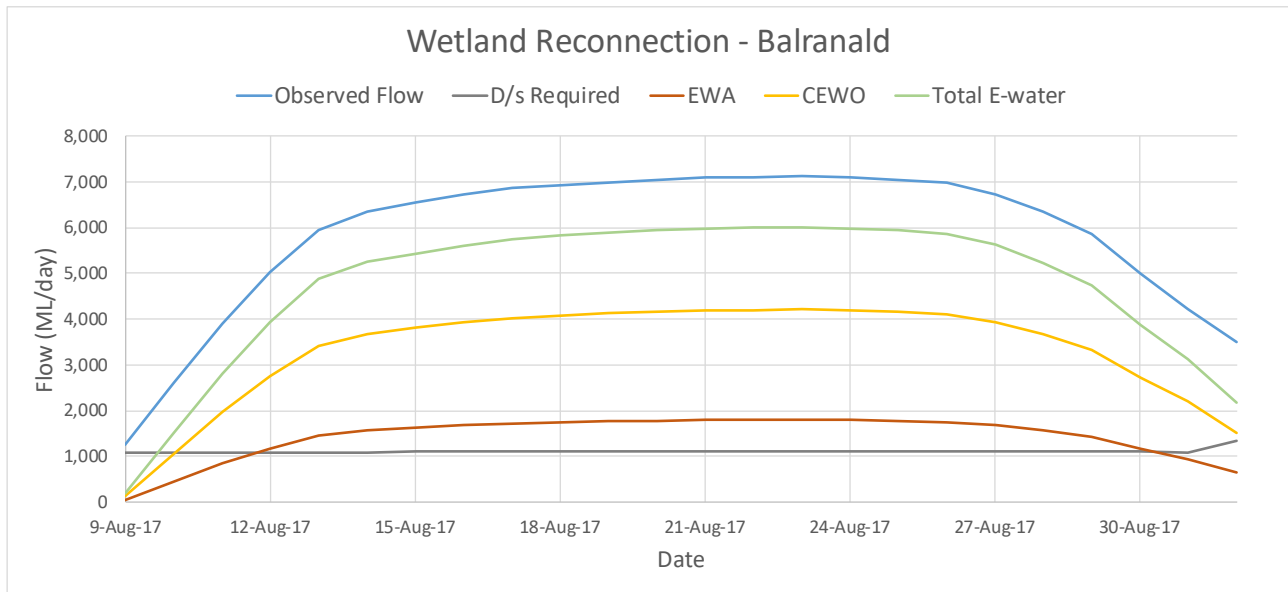


Figure 9. Environmental water accounting for the Wetlands Reconnection Event at Balranald (9/8/17 – 1/9/17)

**Notes:**

1. **Observed flow:** flow observed at Balranald.
2. **D/s required:** orders and EOS requirements below Balranald.
3. **EWA:** volume of water attributed to Environmental Water Allowance.
4. **CEWO:** volume of water attributed to account held water (Commonwealth), recognised in the Murray to South Australia border with a loss rate of 14%.
5. **Total Environmental water:** total environmental water component (EWA + CEWO).

## Bulk Entitlement Delivery trial

NSW authorised the MDBA (via letter on 29 June 2017 (BN17/4668)) to allow use of the BED process in 2017/18 to deliver releases from Hume Reservoir, Lake Victoria, Menindee Lakes and inflows from the Murrumbidgee or other NSW State tributaries (i.e. Lower Darling when in NSW-only access). WaterNSW gave effect to the trial by providing the MDBA with water orders as necessary, and in the case of NSW tributaries including the Murrumbidgee, a loss factor was provided by NSW DPI Water (now DPE Water) to apply for delivery to the South Australia border.

The loss factor for the 2017/18 Murrumbidgee BED Trial was determined using a conservative approach and considered transmission losses from 1989 to 2016. Losses for the winter months (June, July and August) were calculated using data provided by the MDBA. Data which was representative of losses between Wakool Junction and South Australia was requested by DPE Water, and as a response the MDBA provided loss time series from 1989 to 2016 for the reaches Wakool Junction to Wentworth and Wentworth to Rufus River.

The 99th percentile loss conditions were considered appropriate to be applied to the 2017/18 trials on a ‘no regrets’ basis to effectively prevent impacts on water users and accept risk levels similar to those in DPE Water’s resource assessment processes. As a result, a loss rate of 14 per cent was obtained and used for the trials, with an understanding that going forward refinements to this loss rate may be considered. Details on historical loss behaviour are provided in Attachment B and a letter to CEWO, describing the loss rate, is provided in Attachment C. MDBA feedback on this BED

trial is provided at Attachment D, including a summary of actual losses experienced during the BED trial. The detailed daily accounting at Balranald is provided in Attachment E.

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## Assessment of risks to other water users

WaterNSW made the assumption that the “without environmental releases” scenario would have resulted in flows remaining at target for Balranald, and there would have been little change in the volume of water stored in re-regulatory storages along the way.

The relatively dry conditions, and the relatively stable irrigation demands observed over this period resulted in this assumption being reasonable. However, under other circumstances (such as a longer period of environmental releases, more variable weather, periods of supplementary access, or undertaking events later in the water year when irrigation demands were higher), it may not be as simple to estimate what the flows at Balranald would have been under the “no environmental release” scenario.

A channel capacity constraint of 1,400 ML/day in Yanco Creek at the Offtake is nominated in the work approval (clause 18). An exemption for flows above 1,400 ML/day at Yanco Offtake is required. The stakeholder notification for this event stated *the current DPI Water approval specifies environmental flow levels up to 2,600 ML/day at the Yanco Creek Offtake (YCO), however with the proposed low target level at Wagga Wagga, the predicted peak YCO flow is unlikely to exceed 1,600 ML/day*. These exemptions are essential given the channel capacity constraints are legal obligations for operations under the water sharing plan and work approval and any subsequent water inundation on private lands. E&HG engaged with landholders deemed at risk in the planning process.

# Recommendations

Documenting lessons learnt and identifying where processes can be improved is a key aspect of adaptive management, one of the underpinning principles of PPMs. The review of the two watering events described in this report can be used to guide and inform future environmental water deliveries and in particular the development and implementation of PPMs in NSW as follows:

- ‘with’ and ‘without’ spreadsheets can be used for accounting purposes to determine what flows would have been in the system without an environmental water order (that is, the difference between the actual release and a hypothetical release scenario which meets all other water requirements, including consumptive demands, end-of-system requirements and planned environmental water releases)
- where possible and practical to do so, to assist with accounting transparency, observed data should be used for (post-event) account debiting
- post-event review of events can be undertaken to determine any impacts resulting from a watering action. For example, the likely “trade-off” for using piggybacking during the native fish event (2016/17) was that regulated water available resources were boosted while ‘historical’ access to supplementary water may have been reduced. The use of the ‘with’ and ‘without’ spreadsheets could also be used to determine ‘historical’ access of supplementary water to determine (any) impacts as a result of the action
- similarly, assumptions used during the planning and implementation of a PPM event should be back-tested where possible to determine their appropriateness and suitability, or otherwise, for future use, including refinement as needed. For example, during the Native Fish Event, WaterNSW was intending to restrict consumptive water users to travel time-ahead (forecast orders +/- operational flexibility. As the potential variability of actual take from the forecast was considered low, and the magnitude of take was small compared to the size of the flow event, no restrictions were used. A comparison of forecast and actual pumped water use could be completed to determine whether this assumption is reasonable for events of this type and size
- accounting arrangements and operational processes used to protect environmental water downstream of the nominated delivery point should be clarified and articulated, including consideration of different scenarios such as:
  - if large volumes of consumptive orders are being delivered at the same time as environmental water
  - longer period of environmental releases, more variable weather and periods of supplementary access
- accounting arrangements used should continue to be trialled and reviewed following events, including after an event during which the flow is significantly below the target flow or below operational requirements (i.e. shortfall conditions)
- further work is required to determine how environmental watering actions influence actual unaccounted differences



- accounting arrangements for deliveries into the Yanco/Billabong/Forest Creek system should be considered together with possible return flow arrangements
- the volumes of HEW passing Balranald for recognition in the Murray and delivery to South Australia should be provided for reporting purposes, regardless of conditions in the Murray
- documentation of event planning and implementation should be undertaken, including key decisions made, risk assessments and mitigation measures, key points of contact, issues raised by Customer Advisory Groups and Technical Advisory Groups, other consultation undertaken and contingency arrangements
- consideration of potential operational issues that may arise during an event, and how timely decisions can be made during an event should also be articulated and documented during the event planning, including potential uncertainties in forecasting rainfall and tributary inflows.

# Attachment A: Murrumbidgee “Native Fish Event” accounting (2016/2017)

Table A:1. Stage 1 – Wagga Wagga (ML/day)

Wagga Wagga	Target	Flow	D/s Required	E-water debit
29-Oct-16	20,000	20,181	8,911	11,270
30-Oct-16	20,000	18,799	8,422	10,377
31-Oct-16	20,000	18,123	8,483	9,640
1-Nov-16	20,000	17,871	6,935	10,936
2-Nov-16	20,000	17,777	6,744	11,033
3-Nov-16	20,000	19,002	7,171	11,831
4-Nov-16	20,000	19,088	7,264	11,824
5-Nov-16	20,000	18,888	5,998	12,890
6-Nov-16	20,000	18,703	7,115	11,588
7-Nov-16	20,000	18,664	7,000	11,664
8-Nov-16	20,000	18,635	6,619	12,016
Total EWA debit (ML)				<b>125,070</b>

Table A:2. Stage 2 – Gogeldrie Weir (ML/da)

DS Gogeldrie	Target	Flow	D/s Required	E-water debit
13-Nov-16	8,000	11,739	50	8,800
14-Nov-16	8,000	11,124	50	8,800
15-Nov-16	8,000	10,432	790	8,800
16-Nov-16	8,000	9,685	436	8,800
17-Nov-16	8,000	9,428	1,085	8,343
18-Nov-16	8,000	9,384	2,153	7,231
19-Nov-16	8,000	8,006	1,802	6,204
Total GS licence (40AL415740) debit.				<b>56,978</b>

Table A:3. Stage 3 – Maude Weir (ML/day)

DS Maude	Target	Flow	D/s Required	E-water debit	By	CEW	TLM	EWA	Total
27-Nov-16	7,000	6,875	130	6,745	CEW	6,745			6,745
28-Nov-16	7,000	7,157	130	7,027	CEW	7,027			7,027
29-Nov-16	7,000	7,074	130	6,944	CEW	6,944			6,944
30-Nov-16	7,000	7,375	130	7,245	CEW	7,245			7,245
1-Dec-16	7,000	7,329	130	7,199	CEW	7,199			7,199
2-Dec-16	7,000	7,134	130	7,004	CEW	7,004			7,004
3-Dec-16	7,000	7,084	130	6,954	CEW	6,954			6,954
4-Dec-16	7,000	7,125	130	6,995	CEW	6,995			6,995
5-Dec-16	7,000	7,123	226	6,897	CEW	6,897			6,897
6-Dec-16	6,500	6,703	130	6,573	CEW	6,573			6,573
7-Dec-16	6,500	6,555	130	6,425	CEW	6,425			6,425
8-Dec-16	6,000	5,906	130	5,776	CEW	5,776			5,776
9-Dec-16	5,500	5,641	130	5,511	TLM	3,216	2,295		5,511
10-Dec-16	5,500	5,564	130	5,434	TLM		5,434		5,434
11-Dec-16	5,300	5,422	130	5,292	TLM		5,292		5,292
12-Dec-16	5,300	5,326	130	5,196	TLM		5,196		5,196
13-Dec-16	5,300	5,291	130	5,161	TLM		5,161		5,161
14-Dec-16	5,000	5,166	130	5,036	TLM		5,036		5,036
15-Dec-16	5,000	5,048	130	4,918	TLM		4,918		4,918
16-Dec-16	5,000	5,058	130	4,928	TLM		4,928		4,928
17-Dec-16	5,000	5,033	130	4,903	TLM		4,903		4,903
18-Dec-16	5,000	5,061	130	4,931	TLM		4,931		4,931
19-Dec-16	5,000	5,040	192	4,848	TLM		4,848		4,848
20-Dec-16	5,000	5,030	220	4,810	TLM		4,810		4,810
21-Dec-16	4,000	5,001	262	4,400	TLM		4,400		4,400
22-Dec-16	4,000	5,301	140	4,400	TLM		4,400		4,400
23-Dec-16	4,000	5,753	540	4,400	TLM		4,400		4,400
24-Dec-16	4,000	6,270	388	4,400	TLM		4,400		4,400
25-Dec-16	3,500	6,766	338	3,850	TLM		3,850		3,850
26-Dec-16	3,500	6,882	530	3,850	TLM		3,850		3,850
27-Dec-16	3,500	6,681	892	3,850	TLM	1,902	1,948		3,850

DS Maude	Target	Flow	D/s Required	E-water debit	By	CEW	TLM	EWA	Total
28-Dec-16	3,000	5,527	1103	3,300	CEW	3,300			3,300
29-Dec-16	3,000	4,917	872	3,300	CEW	3,300			3,300
30-Dec-16	2,500	3,767	624	2,750	CEW	498		2,252	2,750
31-Dec-16	2,500	2,346	187	2,159	EWA			2,159	2,159
1-Jan-17	2,000	2,037	130	1,907	EWA			1,907	1,907
2-Jan-17	1,500	1,568	130	1,438	EWA			1,438	1,438
3-Jan-17	1,200	1,253	130	1,123	EWA			1,123	1,123
4-Jan-17	600	737	193	544	EWA			544	544
5-Jan-17	400	585	217	368	EWA			368	368
<b>Total</b>						<b>94,000</b>	<b>85,000</b>	<b>9,791</b>	<b>188,791</b>

Table A:4. Total environmental water debits for the 2016/17 'native fish' event

Licence	Volume	Holder
40AL415740	94 GL	CEW
40AL405811	85 GL	TLM
40MA412243	9.7 GL	EWA

# Attachment B: Historical losses from Wakool Junction to South Australia (1989/2016)

Loss rates in the lower Murray system show large variability and are generally negatively correlated with flow rates down the system and positively correlated with the warmer months.

Table B.1 shows monthly loss rate percentages over 1989-2016 between Wakool Junction and South Australia for key percentiles, along with loss rates for winter (June, July and August). The 99th percentile loss rates range from 6 percent in June to 37 percent in January. The 99th percentile loss rate for winter, which was applied to the 2017/18 Murrumbidgee BED Trial, is 14%. The 99<sup>th</sup> percentile loss rate is a risk level similar to that accepted in Dol Water’s resource assessment processes.

Within the winter months, August generally has higher losses than June or July, with the August 99th percentile loss rate being 18 percent. September historically shows similar loss rate behaviour to August, with a 99th percentile loss rate of 19 percent. August and September, the period over which the BED trial occurred, has 99th percentile loss rates which are higher than those applied on the trial.

Table B.1. Loss rate percentiles (1989-2016) between Wakool Junction and South Australia

Percentile	Winter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
100 <sup>th</sup>	20%	38%	31%	29%	20%	15%	6%	9%	20%	20%	34%	35%	36%
99 <sup>th</sup>	14%	37%	31%	28%	20%	13%	6%	9%	18%	19%	33%	34%	32%
95 <sup>th</sup>	9%	33%	30%	24%	19%	9%	5%	8%	12%	16%	27%	29%	23%
90 <sup>th</sup>	7%	32%	28%	24%	18%	9%	4%	7%	9%	15%	19%	21%	22%
50 <sup>th</sup>	3%	17%	18%	17%	12%	6%	2%	3%	4%	4%	6%	9%	13%

# Attachment C: Murrumbidgee BED trial (July 2017) loss factor description to CEWO

Extract from emailed provided to CEWO by (the then) DPI Water.

The start date for the Murrumbidgee Wetlands Reconnection Flow was confirmed this morning as 24 July 2017.

As you know NSW wishes to trial its PPM implementation on this event and have flows entering the Murray recognised through to the South Australia Border using our approved Bulk Entitlement Delivery (BED) framework.

We have used historical data from MDBA (River Murray Operations) to evaluate monthly losses in the Murray between about the Wakool junction to the South Australia Border from 1989 to 2016. This period covers a range of climatic and flow conditions. (Sheet attached).

Further, we have looked across the whole year but also separated out months June to August which typically exhibit lower loss rates (and coincide with this planned action in 2017).

While there is potential for further, more sophisticated, analysis going forward, as a first trial NSW is proposing to apply the 99 percentile loss factor for June to August (cell S21), **being 14%**.

This means that we will instruct MDBA to recognise (target) 86% of the eligible held environmental water passing Balranald (excludes planned environmental flows) for delivery to the South Australia Border.

This loss rate is considered sufficiently conservative that it will almost certainly protect third parties, is commensurate with the prevailing dry conditions and outlook, is consistent with our resource assessment processes which use the 99 percentile standard, yet guarantees a large proportion of the eligible flow entering the Murray will be delivered to the South Australia Border.

DPI Water will work closely with WaterNSW to identify and separate the flows passing Balranald in coming weeks and will keep you (and MDBA) informed accordingly.

Although we will back-calculate the actual losses from this action to inform future decisions, there will be no adjustments - it's on a no-regrets basis. It is intended that this one-off trial identify any short-comings in PPM implementation and thereby lead to improved operational delivery and accounting of environmental watering actions.

# Attachment D: MDBA feedback on the 2017/2018 event (22<sup>nd</sup> December 2017)

From 9 August to 1 September 2017, about 80 GL environmental water was delivered to the River Murray from the Murrumbidgee River at Balranald. After applying the agreed 14% loss, ~68 GL was then delivered to South Australia by MDBA River operations assuming a travel time of 9 days.

Attached is an Excel spreadsheet showing the estimated loss calculation for the reach from Wakool Junction to the South Australia border for each month from July to October 2017. These data use the reach losses from the MDBA accounts model. For the month of August, the loss in this reach was 2% while in September, it was 8%.

From an MDBA River Operations perspective, the trial worked smoothly. For any future environmental water deliveries from the Murrumbidgee, it would be appreciated if WaterNSW could provide daily environmental flow volumes as at Balranald on a weekly basis. With timely, accurate data from NSW, MDBA can then deliver this water to South Australia with the appropriate travel time.

As previously agreed with GMW and WaterNSW, it is best to use operational data when determining the receipt and delivery of environmental flows to avoid the need for retrospective accounting.

It is worth noting that from June to December 2017, approximately 388 GL has been delivered from the Goulburn system (Broken Creek, Goulburn River and Campaspe River) to downstream sites (Gunbower, Hattah, Lake Wallawalla and South Australia) using a system of recredits and trades. No loss has been applied to these deliveries.

2017 Murrumbidgee BED loss estimates.xlsx							
	A	B	C	D	E	F	G
		Year	Month	rwjww (.337 + .338)	rwwsab (.337 + .338)	RIVER MURRAY - D/S EUSTON WEIR	% loss
1							
2		Aug-16	2016	8		923.5	
3		Sep-16	2016	9		1024.9	
4		Oct-16	2016	10		1659.8	
5		Nov-16	2016	11		2886.6	
6		Dec-16	2016	12		1107.4	
7		Jan-17	2017	1		281.1	
8		Feb-17	2017	2		174.8	
9		Mar-17	2017	3		165.3	
10		Apr-17	2017	4		184.5	
11		May-17	2017	5		228.2	
12		Jun-17	2017	6	2.7	162.3	4.1
13		Jul-17	2017	7	4	294.7	4.9
14		Aug-17	2017	8	1.6	345.8	1.7
15		Sep-17	2017	9	10.8	352.7	8.0
16		Oct-17	2017	10	11.2	276.1	9.3
17							



# Attachment E: Inundation modelling for the 2017 wetland reconnection event

Figure E.1. Inundation modelling for the 2017/18 wetland reconnection event – storages to Berembed Weir

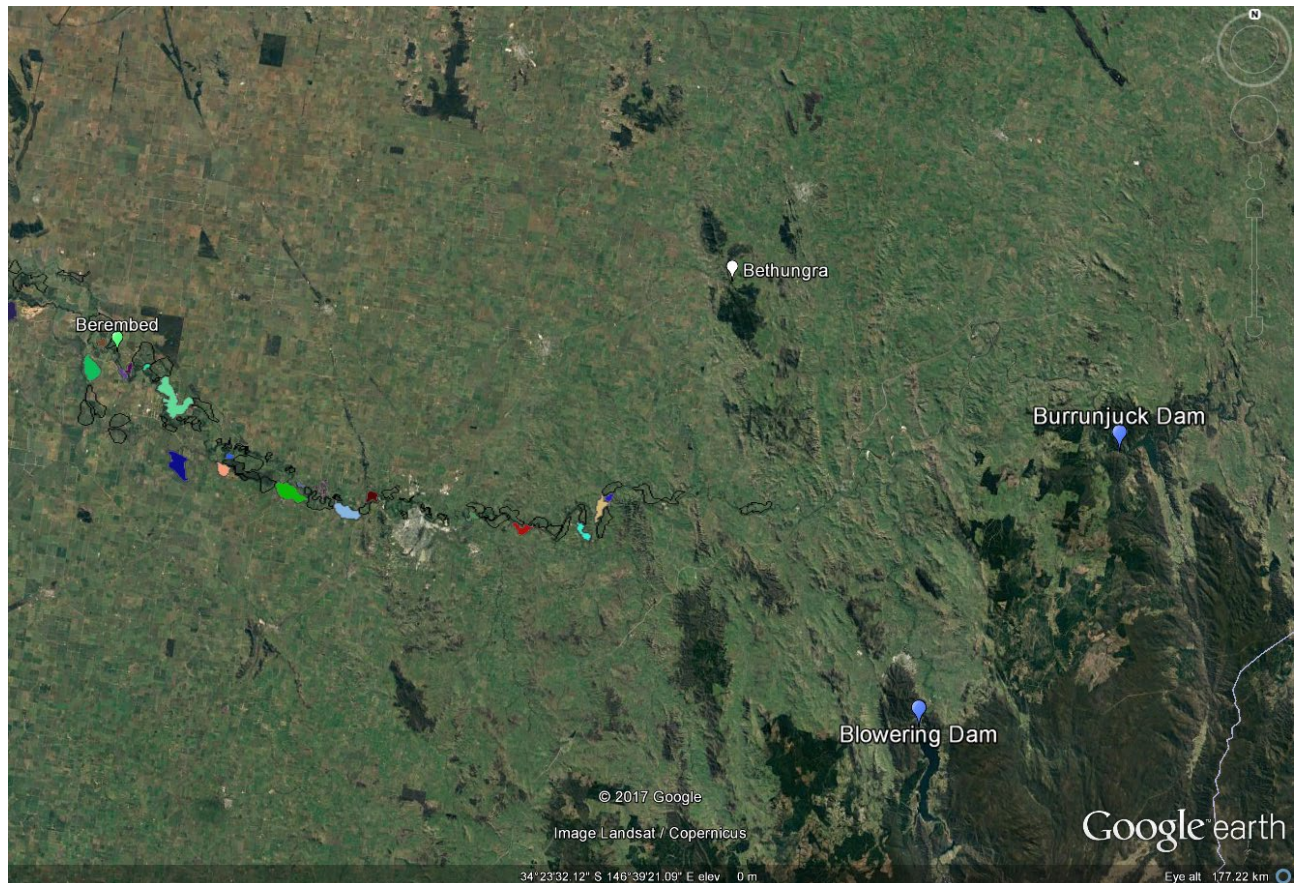




Figure E:2. Inundation modelling for the 2017/18 wetland reconnection event – Berembed Weir to Tombullen

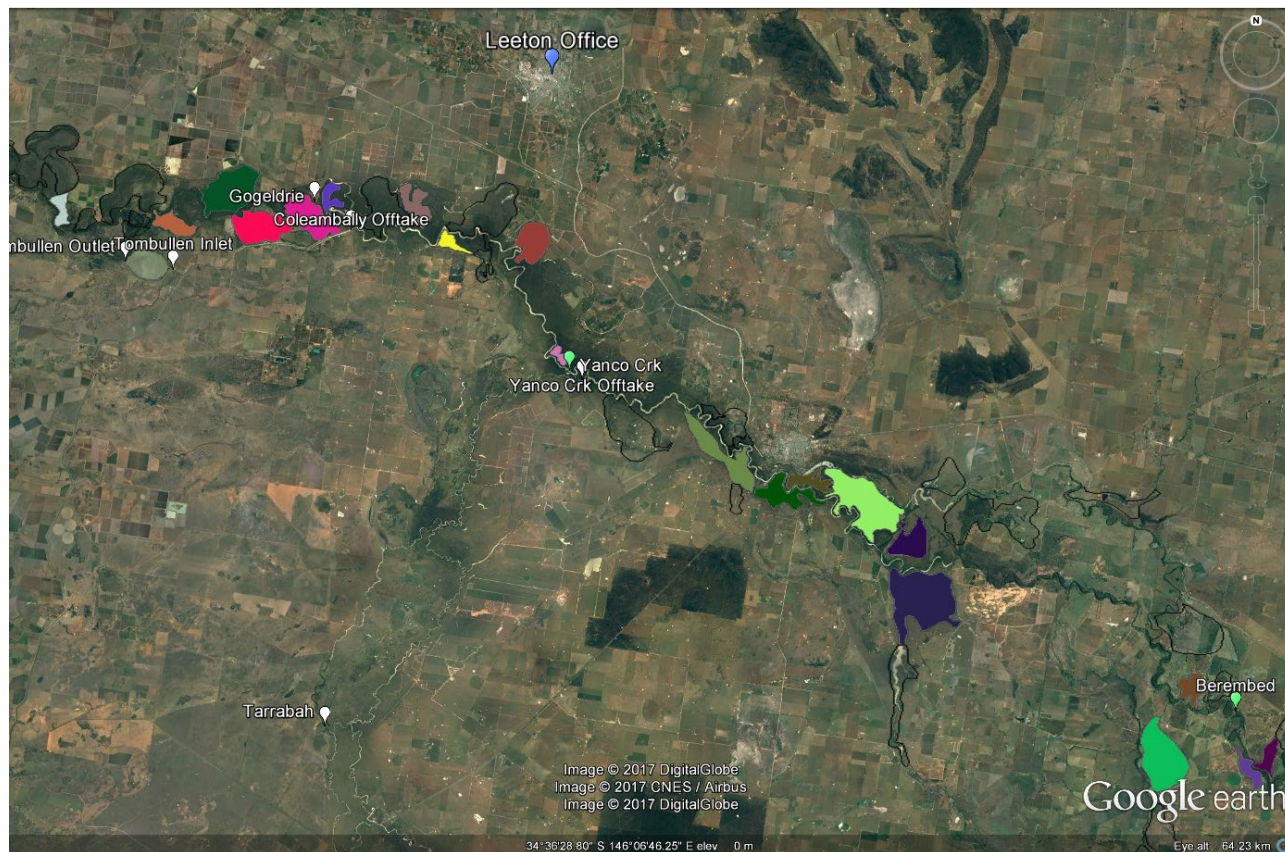
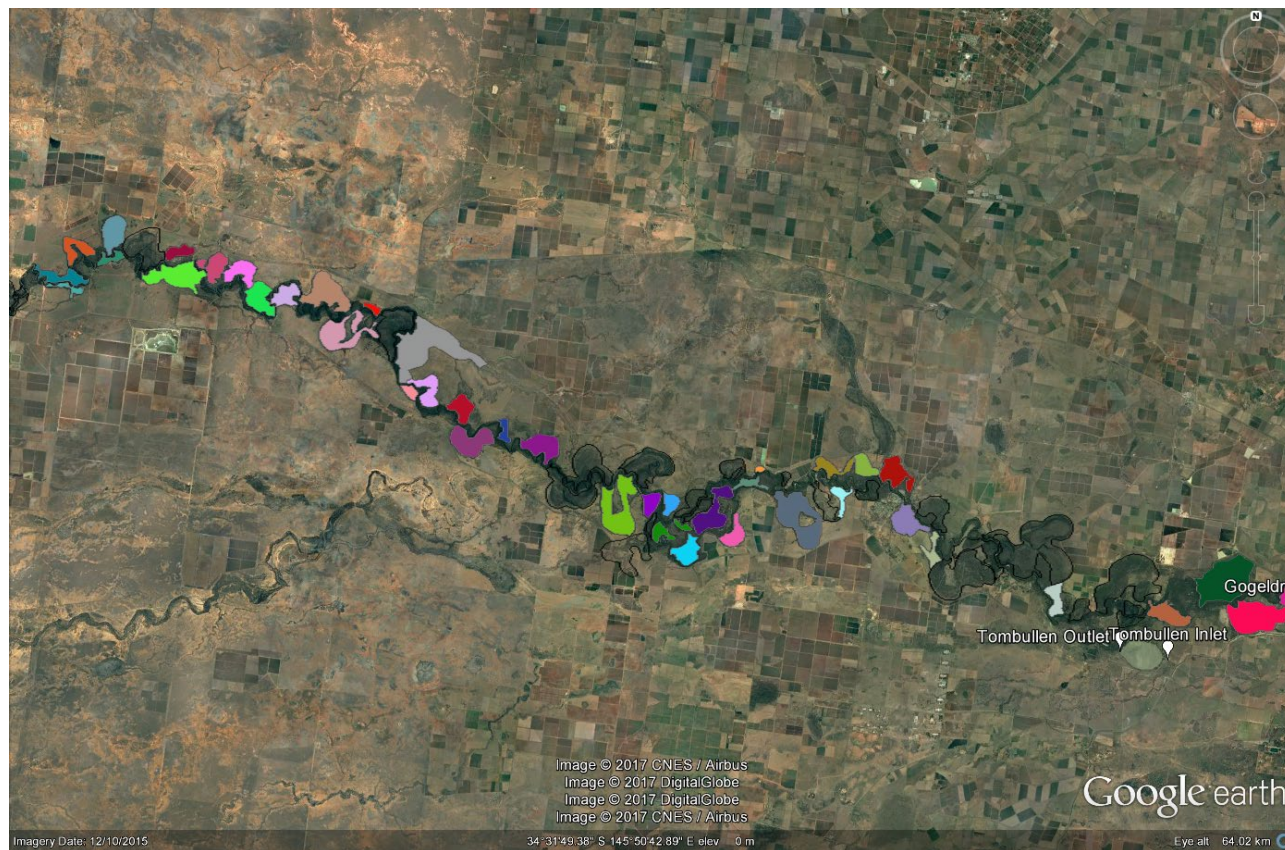


Figure E:3. Inundation modelling for the 2017/18 wetland reconnection event – Tombullen to Carrathool



# Attachment F: Wetlands reconnection accounting (July-August 2017)

Table F.1: Average actual unaccounted differences in July 2017

<b>US Wagga Wagga</b>	Burrinjuck to Gundagai		88
	Gundagai to Wagga Wagga		-147
<b>DS of Wagga Wagga</b>	Wagga Wagga	Berembed	227
	Berembed	Narrandera	0
	Narrandera	Gogeldrie	-201
	Gogeldrie	DP	116
	DP	Carrathool	-111
	Carrathool	Hay	333
	Hay	Maude	-296
	Maude	Redbank	90
	Redbank	Balranald	-130

Table F.2: Summary of usage (ML)

Location of use	Usage (ML)
Wagga Wagga Usage	214,150
Additional Hay Release	2,155
Tributary Usage to Recession	19,900
<b>Total</b>	<b>236,205</b>

Table F.3: Balranald account management (EWA/CEWH split)

Sub-account	EWA (ML)	CEWH (ML)	Total event (ML)
Orders	71,922	164,283	236,205
Ratio	0.3	0.7	



Table F:4. Summary of usage (ML)

24 hours ending at 5:00AM at DS Balranald	Observed Flow (ML/day)	D/s Required Flow (ML/day)	EWA (ML)	CEWH (ML)	Total E-Water (ML)
9-Aug-17	1,271	1,087	55	129	184
10-Aug-17	2,613	1,087	458	1,068	1,526
11-Aug-17	3,893	1,087	842	1,964	2,806
12-Aug-17	5,014	1,087	1,178	2,749	3,927
13-Aug-17	5,961	1,087	1,462	3,412	4,874
14-Aug-17	6,348	1,087	1,578	3,683	5,261
15-Aug-17	6,544	1,107	1,631	3,806	5,437
16-Aug-17	6,719	1,107	1,684	3,928	5,612
17-Aug-17	6,860	1,107	1,726	4,027	5,753
18-Aug-17	6,929	1,107	1,747	4,075	5,822
19-Aug-17	6,998	1,107	1,767	4,124	5,891
20-Aug-17	7,055	1,107	1,784	4,164	5,948
21-Aug-17	7,086	1,107	1,794	4,185	5,979
22-Aug-17	7,106	1,107	1,800	4,199	5,999
23-Aug-17	7,122	1,107	1,805	4,211	6,015
24-Aug-17	7,095	1,112	1,795	4,188	5,983
25-Aug-17	7,051	1,112	1,782	4,157	5,939
26-Aug-17	6,974	1,112	1,759	4,103	5,862
27-Aug-17	6,737	1,112	1,688	3,938	5,625
28-Aug-17	6,349	1,107	1,573	3,669	5,242
29-Aug-17	5,859	1,107	1,426	3,326	4,752
30-Aug-17	4,997	1,107	1,167	2,723	3,890
31-Aug-17	4,224	1,087	941	2,196	3,137
1-Sep-17	3,512	1,330	655	1,527	2,182
<b>Total</b>	<b>140,317</b>	<b>26,671</b>	<b>34,094</b>	<b>79,552</b>	<b>113,646</b>