Review of the Interim Unregulated Flow Management Plan for the North West

17 November 2021

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Alluvium recognises and acknowledges the unique relationship and deep connection to Country shared by Aboriginal and Torres Strait Islander people, as First Peoples and Traditional Owners of Australia. We pay our respects to their Cultures, Country and Elders past and present.

Artwork by Vicki Golding. This piece was commissioned by Alluvium and has told our story of water across Country, from catchment to coast, with people from all cultures learning, understanding, sharing stories, walking to and talking at the meeting places as one nation.

This report has been prepared by Alluvium Consulting Australia Pty Ltd for NSW Department of Planning, Industry & Environment.

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Executive summary

The Interim Unregulated Flow Management Plan for the North West (North West Plan) was released in 1992 to revise the management of unregulated flows to support improvement in the environmental condition of the Barwon-Darling River. The North West Plan outlined flow targets for the Barwon-Darling River to meet riparian rights, suppress algal growth, and support fish migration in the Barwon-Darling River. It indicated that to meet those targets, restrictions to 'off-allocation' access (now called supplementary access) in the Border Rivers, Gwydir, Namoi, or Macquarie valleys may be necessary.

DPIE Water requested a review of the appropriateness of the targets in the Plan, a historic assessment of when the Plan targets were met, and the role that restrictions on supplementary use (in the northern tributaries) and B- and C-class licences (in the Barwon-Darling) could have had. Additional work was undertaken to examine the potential impact of supplementary and B- and C-class restrictions on flow targets at Lake Wetherell and Lake Pamamaroo at Menindee. The analysis was conducted based on gauged data accessed from the WaterNSW online portal and use data from 2004-2020 provided by DPIE Water.

The riparian flow targets in the North West Plan specify flow rates for seven towns along the Barwon-Darling for maintaining riparian flows through the system. The review found that while the current flow targets for the northern section between Mungindi and Brewarrina are likely adequate, it was recommended that flow targets for Bourke, Louth, and Wilcannia be increased to support a minimum baseflow for maintaining basic landholder rights (BLR) access:

- Bourke – 500 ML/d (up from 390 ML/d)
- Louth – 450 ML/d (up from 280 ML/d)
- Wilcannia – 350 ML/d (up from 150 ML/d).

It is recommended that the algal suppression flow target be increased to 3000 ML/d for seven days unless flows have remained above the following throughout the spring/summer period:

- Walgett – 250 ML/d
- Brewarrina – 510 ML/d
- Bourke – 450 ML/d
- Wilcannia – 350 ML/d.

To achieve the desired native fish outcomes flow targets, including flows that promote migration, spawning, dispersal and condition will enhance the effectiveness of fish migration targets. Therefore, the Review recommended changes to the current flow targets at Bourke and Brewarrina as follows:

- 15,000 ML/d for 15 days at Bourke between July and September (dispersal and condition)
- 15,000 ML/d for 15 days at Bourke between October and April (spawning)
- 14,000 ML/d for 15 days at Brewarrina between October and April (migration).

An assessment of historic flows using gauge data taken from the WaterNSW Real-time Data website was conducted to determine the Plan's performance by reviewing the daily flow rates against the targets of the North West Plan. The modelling approach for the historical events used a Mass Balance spreadsheet model as well as the current Barwon-Darling Source model to estimate the potential volumes of returned flow from the tributary valleys (due to supplementary access restriction in those valleys) moving through the Barwon-Darling. The Mass Balance spreadsheet returned the supplementary volumes, applying losses, lag, and attenuation of the flow at each gauge as it moved through the valley.

The assessment of historic events showed that the targets were able to be met on some occasions, with tendencies towards either wet years or dry years. During the La Niña periods (i.e. between 2010-13 and 2016-17) long periods of flows over the targets occurred, as well as large volumes of supplementary flow access, and high inflows to the Barwon-Darling from tributary valleys. Similarly, drier years occurred when the flows could not be met for long periods. During the dry years, it was the lower flow riparian targets that were met, rather than the higher algal suppression or fish migration targets.

The Mass Balance analyses revealed that returning the supplementary use volumes primarily contributed to achieving the lower riparian flow targets; had a limited effect on the algal suppression target and had no impact on either fish migration target. The primary influence on the riparian targets was through additional days at the start and end of periods that met the target historically. The rising and falling limbs of the hydrograph were raised, passing the target earlier and dropping below the target later. Some events occurred outside of this trend, where returning supplementary use had the potential to meet targets when they were not met historically. The algal suppression target showed similarities in the changes, where additional days over the target were in the rising or falling limbs of flows, though the extensions were less pronounced and less frequent. There was only one occasion when the algal suppression targets were met in a period that they weren't met historically (i.e. creating a new period over the target).

The analyses of returning B- and C-class flows (i.e. restricting access to B- and C-class flows) revealed a similar benefit to the flows mainly on the extension of existing periods rather than creation of a unique event. The number of days that the North West Plan targets were met with B- and C-class restricted access were not as high as in the supplementary flow assessment, with the influence more akin to returning supplementary access from one or two valleys. Once supplementary access restriction was added to the B- and C-class restrictions, the influence was magnified. For the riparian targets, the unique events that occurred lasted longer, and the periods where targets were met historically started the earliest when all volumes were returned.

The Source model was updated to accommodate the return (i.e. restriction of access) of supplementary and B- and C-class extractions. The model was then run approximately 500 times with varying levels of return across the four tributary valleys as well as different combinations of returning the different Barwon-Darling B- and C-class extractions both in isolation and in conjunction with supplementary returns. The number of days that flow targets within the Plan, as well as contributions to storage targets at Lake Wetherell and Lake Pamamaroo, exceeded the thresholds were summed across all indicator gauges for each scenario. The number of days were then expressed as a percentage increase compared to the base case.

Returning unregulated flows had some impact on the riparian targets, with limited to no impact on the fish passage or algal suppression flow targets. For the contributions to storage targets at Lake Wetherell and Lake Pamamaroo, the benefit tended to increase linearly as more water was returned between 0% and 49% (of supplementary and B- and C-class), whereas at around 50% return there was a significant increase in days above the target for water returned.

Results were also expressed in terms of events, where an event was defined by the returned hydrograph being higher than the base case hydrograph by at least 1 ML/d. In the majority of events, both the base case and returned scenarios were above the targets. While there were some events where returning water changed an event from not achieving a target to achieving it, these were relatively few. This suggests that supplementary and B- and C-class water is, mostly available when the targets are likely to be exceeded already.

The relative contribution to these benefits from each of the valleys and B- and C-class were then determined using linear regression. It was found that the Gwydir and B-class typically contributed the most across all targets, the Namoi and Macquarie had a more significant influence downstream, while the Border Rivers contributed least. Returning C-class use had limited benefit, potentially because C-class is only activated when the riparian targets are already met.

The Source results matched those from the Mass Balance model, providing confidence in the results. Both models implied a contribution from all the valleys is required to meet the North West Plan. As expected, the more flows returned through the addition of more valleys and B- and C-class volumes, results in more periods that the targets are met, occurring more often and for longer.

The revised targets recommended as part of this project were also tested with the Source model, and it was found that the results in terms of benefits of returning flow were largely in line with the original targets. Overall, the results were similar to the original targets, with limited impact on fish and algal targets and a small improvement in the number of days that riparian flow targets are met (approximately 10% increase when 100% of the water is returned). Returning 100% of supplementary volumes and limiting B- and C-class access increased the number of events that met riparian targets by one at most gauges.

The Mass Balance and Source modelling has several potential limitations:

- the modelling only analysed the relatively short historical period that supplementary water declaration data was available (04/05 to 19/20). This may not be reflective of long-term hydrological conditions (either historical or future)
- the models returned a fixed proportion of the available water in each scenario. This does not vary within the scenario, and therefore targeted returns may provide the same benefit with a smaller amount of water returned
- although the Source model was calibrated to represent average behaviour, it cannot perfectly replicate individual events and may be inaccurate in terms of absolute numbers
- the Mass Balance model had some calculations to account for attenuation through the Barwon-Darling, however this is largely uncalibrated and may be over-estimating the increase due to water returns
- the Source model inherently captures the recent droughts and embargos within the model period. It therefore may not fully replicate long-term trends across the period modelled under the Basin Plan.

Given these limitations, it is suggested that the results are treated as indicative of the magnitude of benefits from returning water rather than a finer scale and absolute interpretation.

The relative contributions of the individual tributary valleys and the B-class licences in meeting the flow targets indicated that all these factors should be included in future forecast modelling of supplementary events. The scenarios showed a much higher tendency to reach the targets when supplementary use was returned in multiple valleys, and the most when all use was returned, so forecasting relating to access to supplementary events should include all these inputs.

1 Introduction

The Interim Unregulated Flow Management Plan for the North-West of NSW ('North West Plan') was released in February 1992 in response to the massive algal bloom in the Barwon-Darling River in late 1991. The primary objective of the North West Plan was to better manage unregulated flows to provide riparian access, water quality and fish passage outcomes for the Barwon-Darling River without significantly affecting water users. The North West Plan provided:

- target flows at key locations along the Barwon-Darling
- priorities for river health and riparian flows
- a framework for sharing unregulated flows between irrigators
- better management of water take
- improved monitoring and research programs.

The North West Plan provides targets for riparian flows to ensure river reaches remain connected, algal suppression flows, fish migration flows, and in the Barwon-Darling River. It stipulates that to meet those targets, restrictions to 'off-allocation' access (now called supplementary access) in the Border Rivers, Gwydir, Namoi, or Macquarie valleys may be necessary. These operational targets informed subsequent Valley Management Plans and are included in provisions in the major tributary water sharing plans (WSPs; NSW Border Rivers Regulated River Water Sources, Gwydir Regulated River Water Source, and Namoi Regulated River Water Source; Figure 1).

Figure 1. *Northern catchment of the Murray Darling Basin and Barwon-Darling River*

The North West Plan includes a list of management objectives to articulate the desired outcomes of unregulated flow management. These are to:

- ensure the overall sustainability and the health of the State's rivers and associated plants and animals
- protect important ecosystems
- achieve river health and water quality targets
- encourage the efficient and economically most productive use of water
- maintain regional integrity of irrigation
- minimise community disruption and conflict
- share water in an equitable way that is acceptable to the community
- involve the community in policy development and review.

Since the development of the North West Plan in 1992, water reform in the Murray-Darling Basin has driven considerable progress in our understanding of the flow requirements of the Basin's riverine ecosystems, including those of the Barwon-Darling. After the North West Plan was developed, a key development was the passage of the NSW *Water Management Act 2000*, which includes water management principles, priorities, and provisions for WSPs. This review re-examines the operational flow targets outlined in the North West Plan against our current understanding of the flows required to meet the North West Plan's objectives. This will ensure implementation of the North West Plan supports best practice management of unregulated flows in the Barwon-Darling system.

1.1 Scope of this review

This review analysed historic flows in the Barwon-Darling River, to determine if and when the flow targets were met, and for periods when they weren't, whether restricting access to supplementary flows in the tributaries and reducing B- and C-class diversions in the Barwon-Darling River would have contributed to meeting the targets in the plan.

As part of this process, the review addresses the current flow targets for effectiveness in meeting riparian objectives, the suppression or prevention of algal outbreaks, and the provision of fish passage objectives at Bourke and Brewarrina Weirs and uses modelling and other analyses to demonstrate their suitability or otherwise.

A gap analysis was then conducted to show the volumes of flow that occurred over the Barwon-Darling targets, and how access to flows could be shared equitably between the valleys. This involved assessing previous events for potential improvements in procedures that could assist in meeting the flow targets with a reduced reliance on forecasting, as well as finding any potential correlations between upstream flows and periods that meet the flow targets of the North West Plan.

Further to the review of the targets in the North West Plan, the review also sought to explore the influence that restricting supplementary and B- and C-class access can have in satisfying storage targets at Lake Wetherell and Lake Pamamaroo at Menindee.

2 Operational flow targets of the North West Plan

The North West Plan outlines a set of operational targets to help achieve immediate gains in the health of the river systems without causing severely adverse consequences to water users (Department of Water Resources, 1992). The operational flow targets apply to seven locations along the Barwon-Darling River to ensure riparian health, as well as extra targets to ensure algal suppression at Wilcannia and support fish migration at Bourke and Brewarrina. It is noted that the structure blocking fish passage at Brewarrina has been removed (since 1992), but the target has still been considered. The fish passage targets require flows at Bourke and/or Brewarrina, so including the Brewarrina target was considered an acceptable addition. These targets are linked to access to supplementary flows in the tributary valleys and B- and C-Class licences within the Barwon-Darling (Figure 2).

The flow targets held within the North West Plan are (Department of Water Resources, 1992):

- Riparian:
  - 850 ML/d at Mungindi
  - 760 ML/d at Collarenebri
  - 700 ML/d at Walgett
  - 550 ML/d at Brewarrina
  - 390 ML/d at Bourke
  - 280 ML/d at Louth
  - 150 ML/d at Wilcannia
  - if tributary inflows exist, then the target flows upstream of the inflows can be reduced.

- Algal suppression:
  - 2,000 ML/d at Wilcannia for a 5-day period between October and April, inclusive
  - required to have been met at least once in the previous three months
  - If the target is not met, then it may be necessary to restrict access in the tributaries and the operation of B- and C-class licence

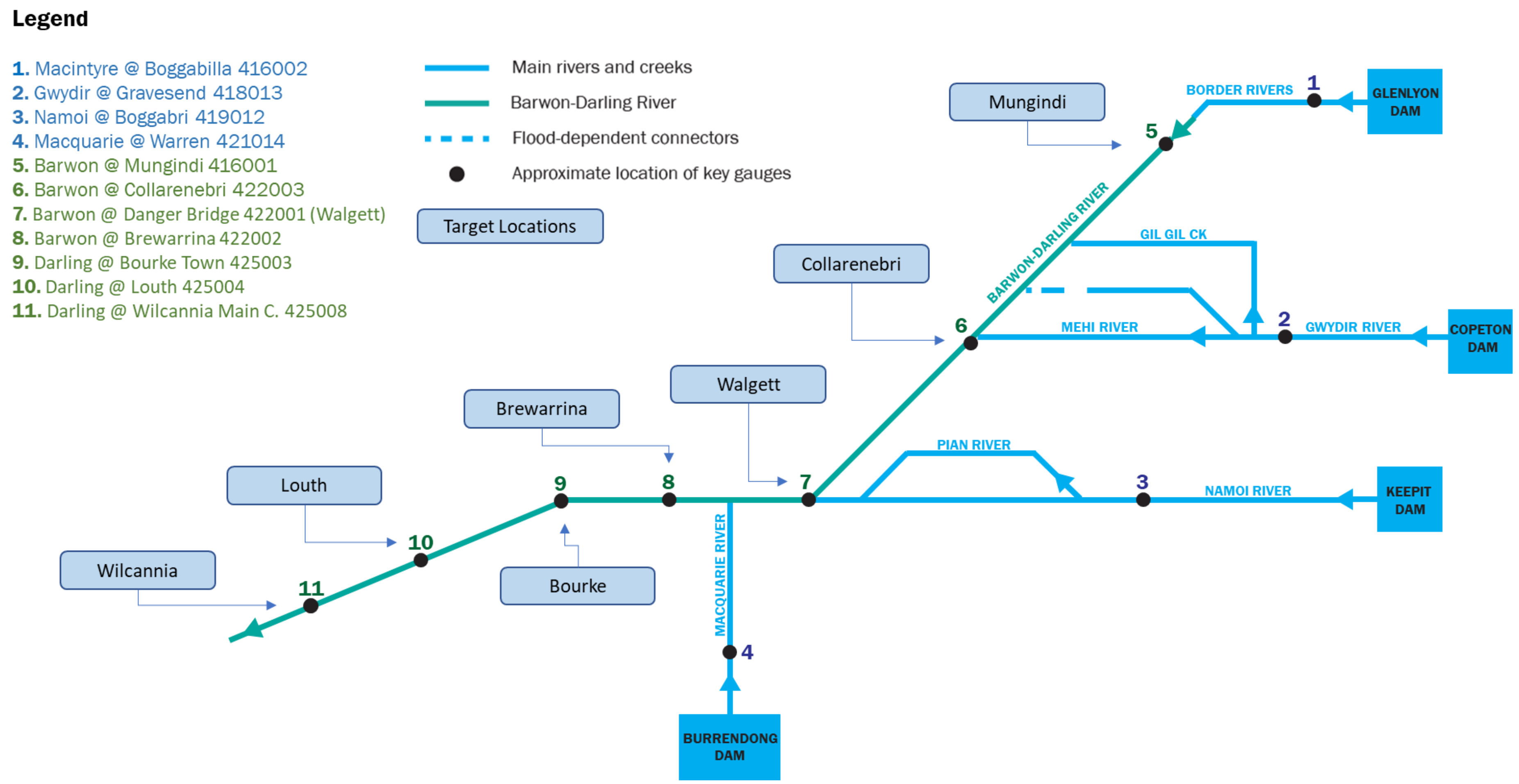
- Fish migration:
  - 14,000 ML/d at Brewarrina AND/OR
  - 10,000 ML/d at Bourke
  - must be met for five days between September and February, unless two such flows have already occurred in this period
  - If the target is not met, then it may be necessary to restrict access in the tributaries and the operation of B- and C-class licence.

Note that as per the brief provided by DPIE Water, the targets at Mungindi and Collarenebri were only partially assessed. This is appropriate given that these gauges are located upstream of the majority of return flow inputs.

This review analysed observed data from previous supplementary events to:

1. determine if and when the Barwon-Darling flow targets were met
2. determine in cases where the targets were not met, if supplementary access had been restricted in the tributaries, whether the target would have been likely to be met with an indication of likelihood
3. determine in cases where targets were not met, estimate if B- and C-class access restrictions in the Barwon-Darling would have contributed to meeting the targets and the likelihood of doing so
4. categorise all historic supplementary events as targets:
   a. achieved without intervention
   b. that would not have been achieved with intervention
   c. likely to have been achieved with intervention (in hindsight)
   d. unlikely to have been achieved with intervention (in hindsight).

Figure 2. *Section of the Barwon-Darling covered by the North West Plan*



3 Review of flow targets and recommended changes

The North West Plan provides flow targets to ensure riparian flows, suppression of potential algal blooms, and support fish migration in the Barwon-Darling River. This review re-examines those flow targets in relation to a contemporary understanding of the ecohydrology of the Barwon-Darling system. Further detail is provided at Attachment 2.

Riparian flows

The riparian flow targets in the North West Plan specify flow rates for seven towns along the Barwon-Darling for maintaining riparian flows through the system. The towns are Mungindi, Collarenebri, Walgett, Brewarrina, Bourke, Louth, and Wilcannia.

The riparian flow targets in the North West Plan were calculated to protect flows needed to meet BLR requirements along the Barwon-Darling.[1] To achieve provision of BLR, riparian flow targets should be calculated to support access to water of quality fit to meet the purposes of BLR as specified in the WMA 2000 (where possible), including domestic consumption. The provision of riparian flows therefore equates to maintaining fit-for-purpose water quality for BLR for the purposes of this review.

Flow rates in the Barwon-Darling Long-Term Water Plan (LTWP) suggest that the riparian flow targets from Mungindi to Brewarrina are likely adequate for maintaining water quality, however, those from Bourke to Wilcannia are unlikely to maintain adequate flows. Hence it is recommended that the current flow targets for Bourke, Louth, and Wilcannia are increased to support a minimum baseflow for maintaining BLR access, requiring the following flow targets:

- 500 ML/d at Bourke (was 390 ML/d)
- 450 ML/d at Louth (was 280 ML/d)
- 350 ML/d at Wilcannia (was 150 ML/d).

Algal suppression

The North West Plan includes a single five-day 2,000 ML/d flow event during spring/summer to suppress algal blooms. Current literature suggests a larger event of 3,000 ML/d for seven days is required to clear established blooms. However, maintaining a low flow threshold through spring/summer is the most effective way to prevent stratification and algal blooms in pools.

It is recommended that the algal suppression flow target be increased to 3,000 ML/d for seven days unless flows have remained above the following throughout the spring/summer period:

- 250 ML/d at Walgett
- 510 ML/d at Brewarrina
- 450 ML/d at Bourke
- 350 ML/d at Wilcannia.

Fish migration

The fish migration flow target in the North West Plan stipulates at least 14,000 ML/d at Brewarrina and/or 10,000 ML/d at Bourke for five days during September to February inclusive, unless two such flows have already occurred within this period. The North West Plan specifies that these flow targets will be suspended following the construction of fishways. The Brewarrina fishway was completed in 2013, however, it is recommended that the Brewarrina Weir flow target of 14,000 ML/d be retained to support fish passage and incidental ecological benefits of this flow.

It is also recommended that the flow duration be extended to 15 days, in line with environmental water requirements in the Barwon-Darling LTWP.

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[1] Note that an earlier legal framework applied when the North West Plan was developed, but it is understood that the intent aligned with protection of BLR.

Supporting fish migration is only one component of best practice fish population management. To achieve all the desired native fish outcomes from migration flow targets, consideration of the flows that promote dispersal, condition, and spawning is also required. Environmental water requirements for spawning, dispersal and condition at Bourke and Brewarrina are therefore also recommended. These are:

- 15,000 ML/d for 15 days at Bourke between July and September (dispersal and condition)
- 15,000 ML/d for 15 days at Bourke between October and April (spawning)
- 14,000 ML/d for 15 days at Brewarrina between October and April (migration).

4 Constraints to North West Plan implementation and interaction with other plans

4.1 Constraints to North West Plan implementation

Constraints to North West Plan implementation were identified through interviews with WaterNSW and DPIE Water.

The main constraints to implementation of the North West Plan are documented in Table 1. Please note that providing recommendations on how to address these constraints was outside the scope of the project.

Table 1. Constraints to North West Plan Implementation identified through agency interviews

Item	Description of constraint on Plan implementation	Which agency identified by	Commentary
1	Stakeholder concerns	WaterNSW	Also identified as 'social and political' limitations
2	Limitations within the Water Sharing Plan	WaterNSW	-
3	Limited timeframe and resources: Resources available to assess data in the limited time available as flow events develop	WaterNSW / DPIE Water	Quick decisions (on whether to deny or allow supplementary and B- and C-Class access) are required. This, combined with the lack of resources, makes it difficult to give proper consideration of the potential contributions of one tributary valley versus multiple valleys (see item 4) WaterNSW advised that running even a single valley assessment is so time-consuming that in smaller supplementary events the models are not run; rather, the lower flow rates are assumed.
4	Current approach to recommending / approving supplementary flow extraction considers only each tributary valley separately	WaterNSW / DPIE Water	The current approach to Water NSW forecasting and recommending supplementary flow extraction to DPIE Water considers only each tributary valley individually. This places the onus on DPIE Water to determine: - if there are any multi-valley impacts on flow, and - if there is any inequity in valleys providing flows as part of North West Plan targets or - if lower flows in multiple valleys have the potential to reach the targets downstream in the Barwon-Darling.
5	Issues linked to internal elements of the approval process	WaterNSW	These have already been identified by DPIE Water and WaterNSW and discussions have begun to improve the process

Item	Description of constraint on Plan implementation	Which agency identified by	Commentary
6	Lack of clear policy, procedures or forecasting guidance	WaterNSW / DPIE Water	Given the restricted timeframe (item 3) for making a judgement on supplementary flow access, the process is constrained by the lack of clear policy or forecasting guidance, including overarching principles of supplementary flow management, As the decision maker on providing or restricting access, DPIE Water have limited guidance on the equity between valleys and clear criteria for declarations of access or restriction.
7	Lack of tools or resources	WaterNSW / DPIE Water	Given the restricted timeframe (item 3) for making a judgement on supplementary flow access, the process is constrained by and a lack of tools or resources that allow rapid analysis of the available information.

While the systems and opportunities exist for the implementation of the North West Plan, the constraints to implementation have meant that it has either not been possible, or WaterNSW have recommended to DPIE Water that restricting supplementary flows would have no material impact on the North West Plan flow targets. The descriptions provided of the existing River Operations and Forecasting model used by WaterNSW (CAIRO/CARM/CARMLite) is that it has the capability to implement the North West Plan, but it is not actively or currently being used to do so.

4.2 Interaction with other plans

Since the development of the North West Plan in 1992, there have been significant changes in water legislation, policy and plans relevant to the Barwon-Darling and tributaries. Attachment 1 provides an overview of the significant of the *Water Management Act 2000* (WM Act) and its water management principles.

Following commencement of the WM Act, Water Sharing Plans (WSPs) have been developed and have now commenced for all water sources, including the Barwon-Darling Unregulated and the regulated and unregulated components of the tributary rivers. WSPs (among other things) establish environmental water rules and establish shares in the available water resource, as well as access rules and allocation rules for those shares. The Barwon-Darling WSP establishes flow classes and thresholds for access to those flow classes. This includes (since 2021) active management rules and resumption of flow rules that protection environmental water and share access equitably, based on declarations on the WaterNSW water insights portal. In addition, the North West Flow Plan targets are incorporated into the WSP provisions or via notes (see Attachment 1, Table 1.1).

Floodplain Harvesting is not referenced by the existing North West Plan. DPIE Water is currently working to bring Floodplain Harvesting within the water licensing framework under the WM Act and WSPs.

The Commonwealth *Water Act 2007* and *Basin Plan 2012* now set overall objectives, a sustainable diversion limit and environmental watering provisions (among other things). These are in general implemented via Water Resource Plans, which include the WSPs. The *Basin Plan* also required development of Long-term Watering Plans (LTWPs) for each WRP area, which establish environmental objectives and environmental watering requirements to achieve those objectives.

Key flow thresholds relevant to the north West Plan and subsequent plans are provided in Table 2.

4.3 Scope of this review and analysis in relationship to other plans

The North West Plan should also be considered in combination with other rules and policies, which can potentially operate concurrently, and subsequently influence the Plan's intended outcomes. These include the active management of held environmental water (HEW) and the resumption of flows (ROF) rules (NSW DPIE, November 2020). Given the Plan was developed in 1992, the rules developed since that time can potentially reduce the number of times the Plan targets are triggered and met because target flows may already have been satisfied or have been contributed to by the impact of the other policies or rules.

Table 2 details the interactions with the relevant water sharing plans and ROF rule, noting that:

1. in reality, B- and C-class licences will not affect target flows upstream of Mungindi, so these can only be met from supplementary flows
2. algal suppression is from October to April, and fish migration is from September to February unless otherwise stated
3. for the ROF rule there is interaction with different flow classes. For example:
    a. Bourke will not reach 390 ML/d because the minimum flow for the ROF rule is 450 ML/d. However, if flows are less than 390 ML/d then supplementary flows could provide additional flow
    b. Walgett may not reach the ROF trigger of 326 ML/d if adequate supplementary flow is available because the North West Plan target is 700 ML/d.

It should be noted that interaction with other plans was beyond scope of the brief for this review, with some exceptions.

- Water sharing plan rules were in scope to the extent of the North West Plan target references, Supplementary Access Licence access declarations in the tributaries and the Barwon-Darling B- and C-class flow access rules. These were analysed as part of the brief.
- Active management and resumption of flow rules were included in the Source modelling analysis as part of the scenarios.
- Long-term Watering Plan environmental objectives and environmental watering requirements were considered in the Review of the existing targets and informed the recommended revised targets.

Table 2. North West Plan interaction with other plans.

Target	Location	Existing plan targets (ML/d)	Recommended revised plan targets (ML/d)	B-class (WSP rules; ML/d)	C-class (WSP rules; ML/d)	Resumption of flows	
						Min flow Trigger (ML/d)	Relaxation trigger (ML/d)
Riparian flows	Mungindi	850	850	230*	230*	NA	NA
	Collarenebri	760	760	500*	2,900	NA	NA
	Walgett	700	700	900	900	326*	706*
	Brewarrina	550	550	840	6,800	468*	1008*
	Bourke	390	500🐟	1,250	11,000	450*	972*
	Louth	280	450🐟	1,130	1,130	NA	-
	Wilcannia	150	350🐟	850	12,000	200*	400*
Algal suppression	Wilcannia	2,000 (5 days)	3,000🐟 (7 days)	850*	12,000	NA	NA
Fish migration	Brewarrina	14,000 (5 days)	14,000🐟 (15 days Oct/April)	840*	6,800*	NA	NA
	Brewarrina	NA	9,000🐟 days July/Sept)	840 💧	6,800 💧	NA	NA
	Bourke	10,000 (5 days)	15,000🐟 (15 days July Sept)	1,250*	11,000*	NA	NA
	Bourke	NA	15,000🐟 (15 days Oct/April)	1,250 💧	11,000 💧	NA	NA

* Affects the North West Plan

💧 Recommended revised targets only

🐟 Target recommended to be revised

Recommended revised targets are based on Barwon-Darling Long-term Watering Plan (amongst other sources). B-class and C-class are from the Barwon-Darling Unregulated Water Sharing Plan (WSP). Resumption of Flow rules are also part of the Barwon-Darling Unregulated WSP.

5 Historic assessment

An initial analysis was conducted on flows at gauges linked to the flow targets listed in the North West Plan; applying each flow target and determining the frequency that the current and recommended revised targets were met. This initial analysis also considered whether all targets are met at the same time, 'near miss' events, and the relationship of the North West Plan to other plans.

5.1 Riparian

The riparian flow target assessment was conducted by assessing the flows at each of the seven locations and determining when the flows exceeded the values set in the North West Plan. The gauges used in the analysis are provided at Table 3. In the analysis , the targets were assessed as a percentage of days the target was exceeded between 2004-2020 before determining the events that met the riparian targets collectively. For the collective assessment, the targets were considered to have been met when all the targets are met at the same time. The percentage of days exceeding the flow targets is shown in Table 3 and graphed in Attachment 7.

Table 3. *Target flow locations and percentage exceedance*

Location	Gauge	North West Plan targets		Recommended revised targets	
		Target (ML/d)	Days targets were exceeded (%)	Target (ML/d)	Days targets were exceeded (%)
Mungindi	416001	850	15.6	850	15.6
Collarenebri	422003	760	22.2	760	22.2
Walgett	422001	700	26.0	700	26.0
Brewarrina	422002	550	34.8	550	34.8
Bourke	425003	390	38.3	500	33.8
Louth	425004	280	49.1	450	41.3
Wilcannia	425008	150	49.5	350	41.0
All targets	NA	NA	9.3	NA	9.3

When assessed as a collective, the North West Plan targets were all met in 27 flow events. The events ranged from a single day (occurred four times), up to 181 days (ending February 2011). The average period that the targets were met was 20.1 days, or 27.8 when the event exceeded a day. The total number of days that all of the targets were exceed was 9.1%.

5.2 Algal suppression

The algal suppression target in the North West Plan requires a flow of at least 2,000 ML/d for five days at Wilcannia between October and April, unless flows have exceeded this target in the last three months. This target is linked to restricting access to supplementary flows in the tributaries, as well as B- and C-class licences on the Barwon-Darling. For this target, it was assumed that an event required a period of low flow before the next is counted (i.e. if the target is exceeded for ten consecutive days, this is considered to be one ten-day event, not two five-day events).

Data from the gauge at Wilcannia (425008) between July 2004 and June 2020 showed that the target of five days of flows was met on ten occasions, ranging between six and 212 days with an average of 81.7 days for each event. It was noted that on any occasion that the flow target was exceeded, the event lasted over five days.

The North West Plan stipulates that the flow targets are required to have been met between October and April unless a flow has occurred in the preceding three months. This part of the rule allows three month durations following a period of flows above the target that the rule can be considered to have been met.

When assessed against the existing targets in the plan, there was an average of 190 days between events, with a maximum of 946 days (2.6 years ending in March 2020). When assessed against the recommended revised targets, there was an average of 240 days between events with a maximum of 949 days (2.6 years ending in March 2020)

5.3 Fish migration

The target for fish migration requires a flow of at least 14,000 ML/d at Brewarrina and/or 10,000 ML/d at Bourke. Each of these targets is required to be met for a period of at least five days between September and February. As with the algal targets, it was assumed that an event required a period of low flow before the next is counted (i.e. if the target is exceeded for ten consecutive days, this is considered to be one ten-day event, not two five-day events).

Data from the gauges at Brewarrina (422002) and Bourke (425003) showed the frequency with which the targets for fish migration were met. During the review period, nine events met the flow targets at either location at a range from five days to 151 days, and averaging 48.25 days. For each of these events the flow targets were met at Bourke for the whole period. The results from Brewarrina show that the flows were met during the same period but for a shorter duration. The number of events at Brewarrina was still nine, but the longest event was only 86 days with an average of 31 days.

The targets in the North West Plan for fish migration require the flows to last for at least five days between September and February unless two such flows have already occurred within this period.

When assessed against the existing targets in the plan, there was an average of 393 days between events at Brewarrina with a maximum gap of 1265 days (3.5 years ending Sept 2016), and an average of 263 days at Bourke with a maximum of 1094 days (3 years ending Sept 2016). When assessed against the recommended revised target at Bourke, there was an average of 386 days between events, with a maximum of 1174 days (3.2 years ending September 2016).

5.4 All targets

The analysis highlighted the frequency with which the flows were able to reach the targets listed in the North West Plan. The data showed that the targets were met during 26 events between July 2004 and June 2020, the longest of which lasted 181 days. Seven of the events lasted just one day, while an additional 14 events lasted between seven and 19 days (Table 4).

The majority of events occurred within a narrow period of time, with 11 of the periods occurring in the two years between August 2010 and August 2012. This accounted for 344 of the 536 days or 65% (a visual illustration of the periods that the flow targets were met is provided in Attachment 5). This coincided with the 2010-11 and 2011-12 La Nina events that were two of the most significant La Nina events in recorded history. These events resulted in the Murray-Darling Basin experiencing its wettest calendar year on record (Bureau of Meteorology, 2012).

Table 4. *Historic periods with all existing North West Plan targets met*

Start	End	Duration (days)
05/01/2005	05/01/2005	1
15/07/2005	15/07/2005	1
22/12/2007	27/12/2007	6
30/12/2007	30/02/2007	1
02/01/2008	04/01/2008	3
05/02/2008	23/02/2008	19
28/02/2008	03/03/2008	5
24/02/2009	24/02/2009	1
28/02/2009	06/03/2009	7
07/06/2009	16/06/2009	10
19/01/2010	21/01/2010	3
07/03/2010	25/03/2010	19
15/08/2010	11/02/2011	181
17/02/2011	25/02/2011	9
29/03/2011	04/04/2011	7
12/09/2011	26/09/2011	15
11/10/2011	23/10/2011	13
26/10/2011	27/10/2011	2
29/10/2011	04/11/2011	7
06/11/2011	14/11/2011	9
26/11/2011	06/01/2012	42
21/01/2012	11/03/2012	51
24/07/2012	01/08/2018	9
26/07/2016	28/07/2016	3
14/09/2016	28/11/2016	76
20/04/2017	20/05/2017	31
06/03/2020	18/03/2020	13

5.5 'Near miss' events and existing North West Flow Plan targets

'Near miss' events are historic flow events that occurred within a relevant event parameter but didn't meet the specific criteria held in the North West Plan. This might be through flows reaching a percentage threshold under the flow target or achieving the flow target but not for the five-day duration required by the Plan.

Analysis of the number of days that sit within the 'near miss' bands revealed there were periods when the targets were missed but potentially could have been lifted above the target with the return of flows (Table 5).

Table 5. *Occurrence of 'near miss' days with reference to existing North West Flow Plan targets*

Location	Target (ML/d)	Number of days in percentage band			
		100% +	90%-99%	80%-89%	70%-79%
Riparian					
Mungindi	850	910	86	91	144
Collarenebri	760	1295	113	114	133
Walgett	700	1517	121	153	169
Brewarrina	550	2034	149	158	166
Bourke	390	2238	87	65	90
Louth	280	2872	101	113	120
Wilcannia	150	2895	46	45	69
Fish Migration					
Brewarrina	14,000	321	33	43	64
Bourke	10,000	542	23	37	72
Algal Suppression					
Wilcannia	2,000	1279	38	61	63

As Table 5 shows, a relatively high number of days sit in the 'near miss' bands. However, investigation of when these days occurred showed that the vast majority were in the rising and falling limbs of other events. That is, where the flows rose from below the target flow to above, or returning below, rather than isolated events (as shown in Attachment 5).

The only potential exception to this opportunity was that a number of the gauges would rise above the target, then fall briefly before returning back above it. This is an opportunity for most of the flow targets, where returning flows to the 'near miss' band may potentially join two events into one. However, this approach may not work for the fish migration target, which requires the flows to be cleared for five days on two occasions within the window. This is an issue relating to the wording of the North West Plan and may be resolved by a clarification of the rules.

The change in probability of exceeding the flow target at each of the locations when supplementary and B- and C-class access is limited is shown in Attachment 7.

Near miss events can also occur when the targets are met but not for the period required. This only applies to the algal suppression and fish migration targets, where the flow targets are required to be exceeded for at least five days. For algal suppression, the lowest number of days the targets were met was five, with only two events lasting under ten days. There were 13 events during the analysis period that met the algal suppression, at an average of 98 days. The target for fish migration at Brewarrina also had no near miss events, with the shortest lasting nine days. The target at Bourke had four near miss events, where the targets were met for a period less than five days, with events of two, two, three and four days. The Bourke gauge had 20 events over five days, at an average of 50.7 days. The Brewarrina target was met in ten events, at an average of 32.1 days. The nine-day event at Brewarrina was the only event at Brewarrina, with the other nine events there coinciding with an event at Bourke.

6 Model methodology

The modelling approach adopted for the historical flow events combined a Mass Balance based model with the Source model. These models can estimate the impacts of the potential volumes of any returned diversions moving through the Barwon-Darling. The approach allowed for analysis of diversions from supplementary events that occurred in the tributary valleys, as well as diversions from metered B- and C-class irrigators on the Barwon-Darling.

This approach was selected because the:

- Mass Balance relies essentially on the historical gauge data of the Barwon-Darling and can determine when targets are met (i.e. the absolute values). The Mass Balance model can also include an estimate of attenuation of the increased flow due to the returned water.
- Source model is able to better determine the impacts of returning flow (i.e. the relative values). It is also better at running multiple scenarios to estimate the impact of these scenarios.

The Source and Mass Balance models have complementary strengths and weaknesses. In general, it is recommended that results from both are analysed when making decisions.

The relative strength of the Mass Balance model is that it is essentially using the historical gauge data, which is more accurate than the modelled Source data. Therefore, examination of individual historical events is likely to be more accurate. However, the way it adds and attenuates the supplementary B- and C-class diversions is simplistic and may not accurately calculate the addition to the hydrograph that occurs when water is returned.

The Source model has more complex and calibrated loss and routing calculations. Therefore, it is more likely to represent the additional flows more accurately. However, given that Source is a river system model (using the historical gauge data of the Barwon-Darling inflows, average losses, and average routing) it will be less accurate in determining the absolute values.

In summary, the Mass Balance model will be more accurate in terms of the absolute numbers (i.e. days above thresholds, number of events etc.) but the Source model is likely to be more accurate regarding the relative differences between scenarios (i.e., the increase due to returning water).

Both the Mass Balance and Source models have a number of potential limitations. These are:

- The modelling only looks at the relatively short historical period that supplementary water was available and subject to formal declaration (2004/05 to 2019/20), and this may not be reflective of long-term hydrological conditions.
- Within each scenario, the models are returning a fixed long-term proportion of the available water. This does not vary within the scenario and therefore targeted returns may provide the same benefit with a smaller amount of water returned.
- The Source model, while calibrated to represent average behaviour will not perfectly replicate individual events and may be inaccurate in terms of absolute numbers.
- The Mass Balance model has some calculations to account for attenuation through the Barwon-Darling. However, the attenuation is largely uncalibrated and may be over-estimating the increase due to water returns.
- Models include the effects of pumping embargoes, particularly in post drought periods.

Given these limitations, it is suggested that the results are treated as indicative of the magnitude of benefits from returning water rather than a finer scale interpretation.

Further detail on the model methodology is located in Attachment 4.

6.1 Tributary flows

The tributaries that were investigated as part of the analysis were the Border Rivers, Gwydir River, Namoi River and Macquarie River Valleys. Supplementary flow use was assessed by grouping the use for each valley. When investigating supplementary access, the daily recorded use was averaged across seven days to allow for delays in flow movement within the valleys and in recording the supplementary access. Supplementary use was also scaled down by 20% to account for loss within the tributary system (see 'Loss model approaches'). This number was determined on advice from DPIE Water and Water NSW officers. It is a reasonable indication of the magnitude of expected reduction in effective supplementary returns.

The supplementary water in each valley was split based on the spatial location of their extraction into the different inflow points into the Barwon-Darling. For example, the Gwydir valley inflows were split into the Gil Gil Creek, Gwydir River and Mehi River inflows. Similarly, the Namoi (Namoi River and Pian Creek) and Macquarie (Macquarie River, Marra Creek) valley supplementary access was also split.

6.2 Supplementary water restriction

The models were developed to use data from the historical period 2003/04 to 2019/20. Therefore, discussion around model results has been phrased such that water is "returned" while discussion around future implementation has been phrased as "restricted".

Supplementary water was returned at the tributary 'end of the system' gauge (e.g. 416001 Macintyre River at Mungindi) by adding the supplementary use to the historical gauge flows. Given that the supplementary use would occur at various locations throughout the valley, which would have variable travel time to the end of the system, some adjustment of the use data was required.

Tests were undertaken where the supplementary use was applied directly, using a one-week and one-month moving average, to effectively "smear" the use across a longer time series. Initial results generally showed that this had little impact on the targets as the Barwon-Darling tended to attenuate these flows regardless of how they were applied. Given this, the weekly moving average was adopted as it was thought to mimic the system most accurately. This was decided in consultation with DPIE Water modellers.

6.3 B-class and C-class restriction

Daily recorded use data for the Barwon-Darling was not available, so the irrigation nodes were activated within the Barwon-Darling Source Model. These nodes are a direct copy from the Barwon-Darling IQQM and developed by DPIE Water and have not been re-calibrated. Each irrigation node incorporates:

- access conditions (i.e. entitlement and commence to pump thresholds)
- farm infrastructure (i.e. pump and on-farm storage [OFS] capacity, crop type, and maximum cropped area)
- farm management (i.e. OFS emptying strategy, planting decision for actual crop area).
- The pumping embargo periods declared since 2004 are also represented in the nodes.

Restricting B- and C-class access in the Barwon-Darling was also investigated. It is likely that if supplementary water in the tributary valleys were to be restricted in the future, then B- and C-class would also need to be restricted for equity reasons. That is, there would be a risk that tributary irrigators are prevented from accessing flows that is subsequently extracted by Barwon-Darling irrigators rather than contributing to meet the North West Plan targets.

B- and C-class restrictions were initially undertaken by limiting the pump capacity of individual irrigators however, it was found that this did not achieve a corresponding reduction in use. It appears that restricting pump capacity meant that irrigators would pump a similar volume of water, over a longer period of time. Therefore, restrictions were made by limiting the B- and C-class access. This also has limitations since within each event the level of available entitlement will vary depending on the length of the proceeding period below the commence-to-pump flow levels. The results show that over the long-term the restrictions generally followed the expected behaviour, but in individual farms and individual events it did not always adhere to the required percentage. This reflects previous comments that the Source model is likely to provide a good indication of long-term behaviour, however, it will potentially represent individual events incorrectly.

6.4 Model scenarios

The model was run approximately 500 times, returning varying volumes of supplementary water as well as a "base case" where no water was returned and a full return (i.e. 100% returned) scenario.

The random scenario runs allowed for the influence of individual valleys to be calculated as well as provide a scatter of results, which provides an estimate of the potential range of results.

6.5 Loss model approaches

Three options for losses for the supplementary flows were considered:

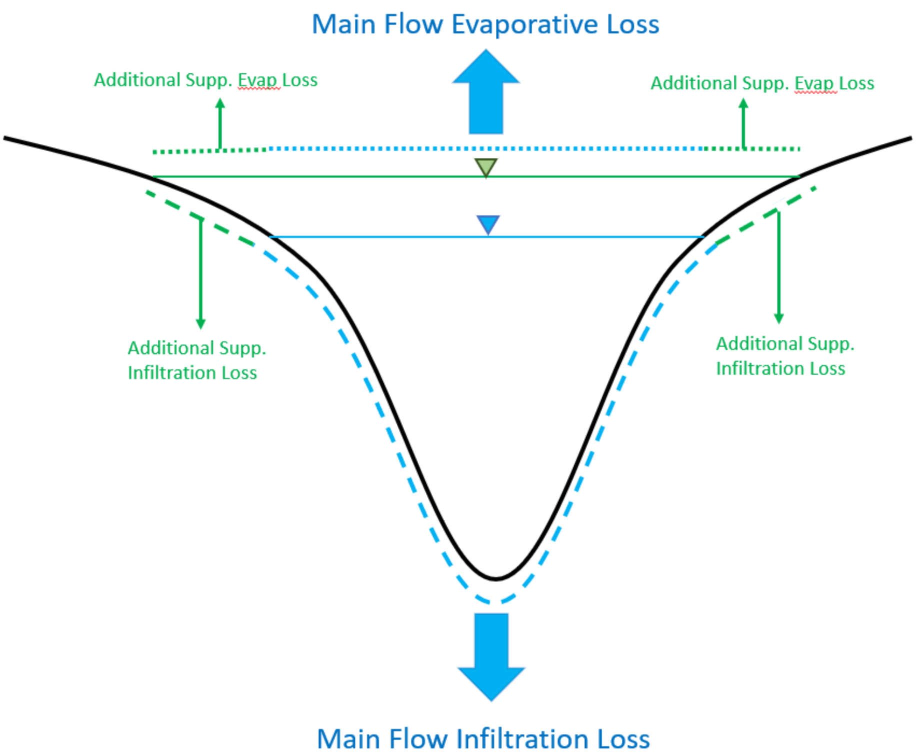
- estimate through gauge analysis
- Source model adjustment calculations
- sensitivity analysis based on minimal additional losses from supplementary flow access volumes.

The gauge analysis method compared gauged data through a comparison of flows, using indicator reaches (areas with little tributary inflow in periods of minimal rainfall) to create an expected loss per kilometre of river. Upstream volumes were used as the inflow volumes, with the outflows estimated as the downstream gauge volumes and losses incurred between gauges. This placed too high a loss on the supplementary flow, given the flows will coincide with existing channel flows. The comparison method assumes that the supplementary volumes lose volume through infiltration at the same rate as the existing flow volumes. As the rate of infiltration and similar losses are unlikely to change significantly with the return of supplementary flows, this method was not used.

A model approach was considered, where the Source model was used to adjust flow volumes in the valley, and a comparison of results was used to determine the increase in losses from the return of supplementary flow. This was discounted as the Source model uses a staged loss method, using predetermined thresholds to apply losses to the change in flow volume. This application was not considered useful in this scenario.

The third option assumes that when supplementary flow access is approved, a level of flow already exists in the channel that the access volumes sit on top of. Losses occur in the river flow from infiltration and evaporation, but as these losses are going to occur in the flow event regardless of supplementary access, most of the loss cannot be applied to the supplementary volume (Figure 3). Additional wetted area and surface area would incur further losses, but the difference in water level with and without supplementary access is likely to be minor, so the increase in areas subject to loss will also be minor.

Figure 3. *River section for losses in main flow and supplementary flow*



The additional loss applied to the supplementary flows was estimated by:

- examining the gauge time series for key events at key locations within the tributaries, adding back the supplementary extractions upstream to the hydrograph, and determining the relative change in gauge level and, therefore, the change in evaporative surface and wetted perimeter
- examining events of similar magnitude with and without supplementary access along key reaches to determine if there is a step change in losses
- comparing the flow range losses applied in the tributary river system models above and below supplementary commencement flows.

Note though, that these techniques are indicative only and used to inform the estimate of losses (i.e. provide an 'envelope' of potential returned supplementary volumes).

The modelling of returned supplementary use applied a 20% loss on all use volumes prior to returning it to the flows in the Barwon-Darling River. As a result, in the modelling a portion of all the supplementary events will flow out of the tributary valleys and into the Barwon-Darling.

To check that this return of supplementary flows occurs to the Barwon-Darling system, a comparison of the supplementary events in each of the tributary valleys and the gauged flows out of the valley (Table 6 with item descriptions in Table 7) was done. Note that daily supplementary use is assumed to occur over seven days, creating a seven-day event. The total flows show the combined outflows from all the rivers within the tributary valley. The results show that in all supplementary events flows were able to reach the end of the valley.

A visual check was conducted on the supplementary events linked to low flow periods to ensure that the period checked was the nearest flow period that is most likely to be the supplementary access event.

Table 6. *Review of valley flows in supplementary events confirming all events reach the end of the valleys*

Valley	Gauge Location	Number of supplementary events	Average Volume (ML)	Average total flow (ML/d)	Average minimum flow (ML/d)	Minimum flow (ML/d)
Border Rivers	Mungindi	37	6698	688	106	7.2
Gwydir River	Collarenebri	50	14,430	1,515	122	7.1
Namoi River	Walgett	33	12,222	1,906	120	2.4
Macquarie River	Brewarrina	11	8084	2,431	797	3.4

Table 7. *Supplementary event review heading description*

Item	Description
Valley	Tributary valley where the supplementary access was assessed
Number of supplementary events	The number of supplementary events recorded between July 2004 and June 2020
Average use volume (ML)	The average supplementary use recorded per event. This is for all the rivers and creeks with gauged flow out of the valley
Average total flow (ML/d)	The average daily flow of out of the valley in the period that supplementary use events were recorded. This is for all of the rivers and creeks with gauged flow out of the valley in ML per day
Average minimum flow (ML/d)	The average of the minimum flow for each supplementary use event
Minimum flow (ML/d)	Minimum flow recorded in the event period

6.6 Assumptions

The flow modelling via the Mass Balance and Source models and the subsequent analysis included several assumptions:

- the modelling of supplementary flows in the Source model and the additional volumes in the Mass Balance model applied constant loss values.
- the Mass Balance model used gauged data from the locations listed in Attachment 3. It was assumed that the data is accurate.

- the supplementary, B-class and C-class use data was provided by DPIE Water. It was assumed that the data is complete and accurate.
- static travel times in the system were applied when lagging flows in the Mass Balance model. It is recognised that travel times vary, however, a best-fit value based on analysis was used. This will be variable in the Source model, depending on channel conditions and the size of flows to which the supplementary water is returned.
- the models assume that restricting access to supplementary flows or B-class and C-class licences will result in complete compliance with the restriction. Therefore, the full volumes were returned (minus losses as discussed).

7 Model results

7.1 Impact of returning supplementary water on existing targets

The return of supplementary flow use to the gauged flow in the Mass Balance model resulted in an increase in the total days that the individual targets were met (Table 8).

Table 8. *Change in days existing targets were met with supplementary flows returned*

Location	Target (ML/d)	Historic (days targets met)	Supplementary added (days met)	Increase %
		Riparian		
Mungindi	850	910	989	9%
Collarenebri	760	1295	1453	12%
Walgett	700	1517	1697	12%
Brewarrina	550	2034	2207	9%
Bourke	390	2238	2406	8%
Louth	280	2872	2983	4%
Wilcannia	150	2895	3068	6%
		Fish Migration		
Brewarrina	14,000	321	338	5%
Bourke	10,000	542	558	3%
		Algal Suppression		
Wilcannia	2,000	1279	1386	8%

Table 9 shows the number of supplementary events that occurred in each valley and breaks down those events to show the number of times targets were met during that use period. Note that these results are based on the supplementary access in the individual valleys and do not represent the combined valleys as there will be some overlap in the supplementary flow use periods. Attachment 5 provides a visual display of the change in periods where targets were met and when the additional days occurred.

Table 9. *Comparison of the number of supplementary access events that met existing targets in North West Plan when Supplementary access was permitted versus limited*

Valley	No. of events	Supplementary return scenario	Number of events that meet the existing targets									
			Riparian targets							Algal	Fish	
			Mungindi	Collarenebri	Walgett	Brewarrina	Bourke	Louth	Wilcannia	Wilcannia	Brewarrina	Bourke
Border Rivers	37	No return	16 (43%)	21 (57%)	25 (68%)	28 (76%)	27 (73%)	31 (84%)	33 (89%)	16 (43%)	6 (16%)	10 (27%)
		Single valley	18 (49%)	23 (62%)	26 (70%)	28 (76%)	28 (76%)	31 (84%)	33 (89%)	16 (43%)	6 (16%)	10 (27%)
		All valleys	18 (49%)	24 (65%)	27 (73%)	29 (78%)	30 (81%)	32 (86%)	33 (89%)	18 (49%)	6 (16%)	10 (27%)
Gwydir River	50	No return	NA	33 (66%)	34 (68%)	34 (68%)	35 (70%)	38 (76%)	36 (72%)	17 (34%)	6 (12%)	10 (20%)
		Single valley	NA	36 (72%)	39 (78%)	38 (76%)	37 (74%)	40 (80%)	38 (76%)	18 (36%)	6 (12%)	10 (20%)
		All valleys	NA	39 (78%)	39 (78%)	40 (80%)	39 (78%)	40 (80%)	39 (78%)	20 (40%)	7 (14%)	12 (24%)
Namoi River	33	No return	NA	NA	28 (85%)	29 (88%)	27 (82%)	29 (88%)	23 (70%)	16 (48%)	6 (18%)	10 (30%)
		Single valley	NA	NA	30 (91%)	31 (94%)	30 (91%)	29 (88%)	24 (73%)	16 (48%)	6 (18%)	10 (30%)
		All valleys	NA	NA	32 (97%)	31 (94%)	31 (94%)	29 (88%)	24 (73%)	16 (48%)	6 (18%)	11 (33%)
Macquarie River	11	No return	NA	NA	NA	9 (82%)	9 (82%)	9 (82%)	7 (64%)	6 (55%)	3 (27%)	5 (45%)
		Single valley	NA	NA	NA	11 (100%)	11 (100%)	10 (91%)	7 (64%)	6 (55%)	3 (27%)	6 (55%)
		All valleys	NA	NA	NA	11 (100%)	11 (100%)	10 (91%)	7 (64%)	6 (55%)	3 (27%)	6 (55%)

The visual results indicate that additional days where existing North West Plan targets are met occur in two ways:

1. periods when the targets were not met are able to create a new period of flows above the North West Plan targets
2. existing periods that meet the North West Plan targets rise above target levels earlier and drop below the levels later, extending an existing period

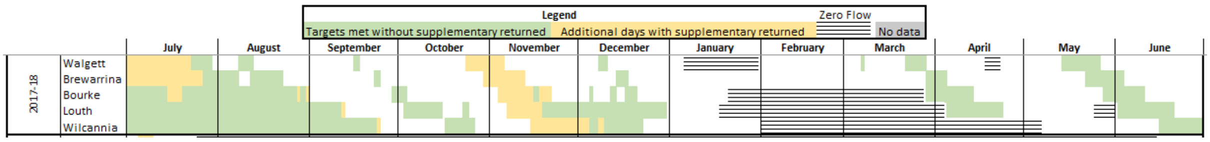
Review of the events showed that the second outcome (lengthening of existing periods), is the more common of the two in the data. There were however four instances after supplementary usage volumes were returned when a flow event reached the riparian targets in a period that hadn't been met historically. For the algal suppression target at Wilcannia one independent period was created, and two others added a slightly detached period to the beginning of an existing. Returning supplementary volumes did not create any new events for the higher fish targets at Brewarrina or at Bourke, only rarely enhancing an existing event.

Detail on the unique riparian and algal suppression events is shown in Attachment 7.

This indicates that restricting supplementary use is more likely to contribute to meeting the lower (riparian and algal suppression) flow targets because these events are smaller and therefore returned supplementary volumes represent a higher portion of the flow. The volumes that are being returned did not make a significant difference to the higher flows.

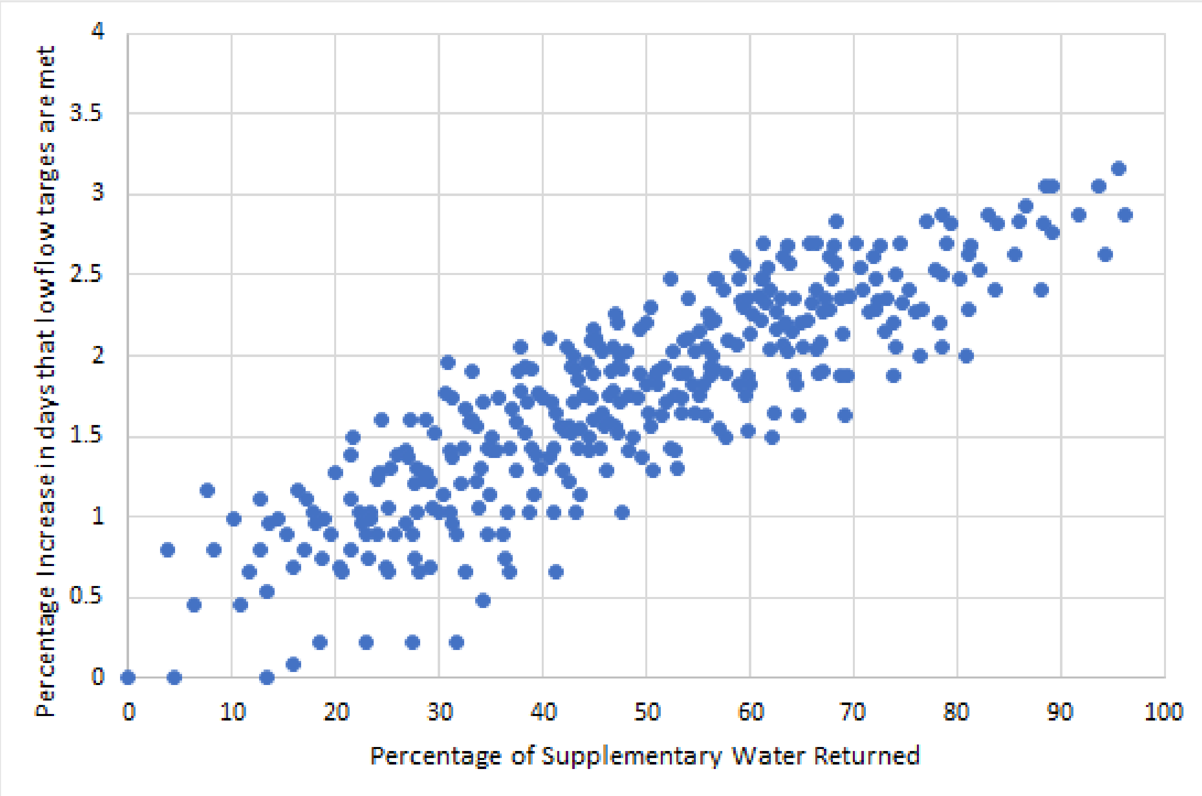
Only the largest flow events satisfied all the targets at the same time. Figure 4 (a snapshot taken from the larger representation in Attachment 5) shows the importance of a longer event to meet multiple targets at the same time. Peaks in flow that are above the riparian targets move through the river and will often drop below the target flow before the downstream flow is able to rise over the target for that gauge.

Figure 4. *2017-18 Water year Riparian targets*



In the Source model, the total number of additional days (for the gauges Walgett, Brewarrina, Bourke, Louth, and Wilcannia) that the riparian flow targets were met were calculated for all scenarios in both models. Figure 5 presents this as the increase compared to a no water return scenario. Both models show a relatively linear increase with the percentage of total supplementary water returned (from the sum of all valleys). The Mass Balance model predicts a greater return if the majority of water is returned, with a maximum increase in days of 5% compared to 3% for Source. This lower trend is not entirely unexpected in the Source model results, as irrigators upstream of Walgett have access to flows below the riparian targets. However, in low return scenarios, the models tend to match well in terms of percentage increase and degree of scatter.

Figure 5. *Percentage increase in days where existing riparian flow targets are met*



For the Source Model, preliminary results (where all supplementary and B- and C-class use was returned) showed that there was limited to no impact on the existing algal or fish passage targets. Therefore, further investigation of these targets was not pursued.

7.2 Analysis of recommended revised targets

The Review's recommended revised targets (see Chapter 3 and Attachment 2) were also analysed in the Source Model. The recommended revised targets were:

- Walgett and Brewarrina riparian flow targets remain
- Bourke riparian flow target increased to 500 ML/d
- Louth riparian flow target increased to 450 ML/d
- Wilcannia riparian flow target increased to 350 ML/d
- Algal suppression target increased to 3,000 ML/d for 7 days
- Fish Migration target at Brewarrina increased to 14,000 ML/d for 15 days
- Fish Migration target at Bourke increased to 15,000 ML/d for 15 days.

In general, the recommended revised targets are an increase compared to the existing targets. Therefore, the impact of supplementary water returns will move to a slightly higher part of the flow range and potentially produce different results to those analysed above. However, it is not a large change, and it is expected that the outcome will likely remain the same. To test this, the 0% return and 100% return (including B- and C-class) scenarios using both the Mass Balance and Source models was run and analysed against the recommended revised targets.

Overall, the results against the recommended revised targets were similar to the original targets, with limited impact on fish and algal targets (one or two event improvement with 100% returned across the 16-year period) and a small improvement in the number of days that riparian flow targets are met (approximately 10% increase when 100% of the water is returned).

On an event basis, returning 100% of supplementary volumes and limiting B- and C-class access increased the number of events where returning water met targets by one at most gauges and also increased the number of events where returning water was within just 20% of the targets by one.

The benefit is limited in terms of the number of events and is largely just increasing the length of time that events that are already meeting the targets remain above the required flow.

7.3 Classification of supplementary events for existing flow targets

Gauge Data

Periods of supplementary access were analysed individually to determine the effect each may have had on existing flow targets in the Barwon-Darling River. Each of the announcement periods was assessed to determine if restrictions could have contributed to meeting targets during that period. The periods were assessed for changes in targets over the period, with the lags considered, shifting the assessed period in accordance with the delays applied to the flows.

The allowance for lag in the tables below is an important factor to note, as it is the key differentiator to the results in Table 9. The results shown below consider the time water can take to move through the system to show the flows potentially affected by the supplementary announcements. Table 9 shows the portion of existing targets that are being met at the time of announcement.

These changes were used to classify the events as to whether they could have achieved the existing flow targets. Individual event classification has been included in Attachment 9, however a summary of the classifications is provided at Table 10 and Table 11.

Table 10. *Classification types*

Classification number	Classification description
1	All existing riparian targets met across all event days
2	Some days targets were met, no additional days when supplementary use volumes returned
3	Some days targets were met, some additional days when supplementary use volumes returned
4	No existing targets met in historic events, some met when supplementary use volumes returned
5	No targets met in any scenario

Table 11. *Summary of classifications*

Valley	Total events	Classification				
		1	2	3	4	5
Border Rivers	71	3	24	44	0	0
Gwydir	271	0	186	85	0	0
Namoi	80	0	42	38	0	0
Macquarie	31	0	27	4	0	0
Total	**453**	**3**	**279**	**171**	**0**	**0**

The classifications show that all the supplementary access events occurred at a period when at least one of the North West Plan targets was being met (given the 0 values in classifications 4 and 5 that relate to no targets met historically). However, the low numbers (in classification 1) that relate to all the targets being met show there is capacity for improvement in the management of the events. In 171 events across the valleys, there were additional days that could have been met if access restrictions were placed on supplementary flows.

Source model

The results of all gauges for both the Source models are presented in Table 12. The number of events where targets were met historically make up a large majority of all events in both models. At the same time, the Mass Balance model predicts a greater number of events where returning water meets the targets where it otherwise wouldn't (5 - 8% of events). The Source model only predicts a single event at each gauge where returning supplementary water would mean targets were met.

In both the Source and Mass Balance models there were few, if any events in the 3rd and 4th category where flows were within 20% of reaching the target but not exceeded (i.e. near misses).

Table 12. *Source model event analysis (supplementary water returned)*

Location	Total number of events	Number of events where targets met historically	Number of events where returning supplementary water meant targets met
Walgett	64	56	1
Brewarrina	56	50	1
Bourke	68	61	1
Louth	53	46	1
Wilcannia	62	54	1

Note that the event analysis is based on returning 100% of supplementary water in all valleys. Scenarios where only a proportion of supplementary water is returned would have a smaller number of events where targets were met by the returned volume.

The results suggest that the beneficial impact of returning supplementary volumes is most likely to increase the time above the thresholds in events where the riparian flow targets have already been met thereby extending either the rising or falling limb of the hydrograph. There also appears to be some potential to increase the number of events where targets are met, particularly from the Mass Balance results; however, the Source results suggest this is more limited.

7.4 Impact of returning B- and C-class access on existing targets

Similar to supplementary flow, operation of B- and C-class licences can be restricted under the North West Plan to achieve the riparian, fish migration and algal suppression targets. By returning the B- and C-class use volumes to the gauged flows as described, the increase in days that flows exceed the North West Plan targets was noted and is listed in Table 13. The Mungindi gauge was included as it is a target in the North West Plan, however, all of the B- and C-class water returned occurs downstream of this gauge.

Table 13. *Change in days existing North West Plan targets are met with B- and C-class returned*

Location	Target (ML/d)	Historic - days targets met	B- and C-class added - days targets met	Increase (%)
		Riparian		
Mungindi	850	910	910	0
Collarenebri	760	1295	1348	4
Walgett	700	1517	1599	5
Brewarrina	550	2034	2129	5
Bourke	390	2238	2349	5
Louth	280	2872	2950	3
Wilcannia	150	2895	2993	3
		Fish Migration		
Brewarrina	14,000	321	324	1
Bourke	10,000	542	565	4
		Algal Suppression		
Wilcannia	2,000	1279	1365	7

The addition of the B- and C-class volumes has a similar effect to the return of supplementary use volumes, in that it mainly increases the number of days that the targets from the North West Plan were met. The number of days increases by 3-5% for the riparian targets, 7% for the algal target at Wilcannia and 1% and 4% for the fish migration targets. It is noted that the algal suppression target at Wilcannia saw a period of extra days occur in February 2017. The majority of extra days for this target and all of the additional days for the fish migration targets occurred outside the timeframes required by the North West plan.

The additional days that the riparian targets were met occurred in a similar distribution to the supplementary use return days, with some additions to existing events and some unique days. However, as expected by the smaller number, the extensions were shorter, and the new periods were isolated to a single gauge for 1 or 2 days rather than longer periods over multiple gauges.

The influence of B- and C-class access on meeting the North West Plan targets was analysed in the Source model by completely preventing access (100% restricted by limiting the entitlement) and then comparing this with access permitted (according to their licence access conditions and entitlement availability). This approach provided a comparative model study as it is likely that the exact timing and volume of extractions for some modelled irrigators may vary significantly when compared to their historical data. Therefore, the number of "events" between the Source and Mass Balance model is likely to vary significantly.

It is still important to consider the results of the Source model, as it is known that the historical extraction data in the Barwon-Darling is potentially unreliable (especially on a daily scale), and calibration of demand models is usually done on a yearly timescale for this reason.

The results from the Source model were similar to the return of supplementary water. The B- and C-class percentage returned mainly contributes to an increase in the number of days that low flow targets rather than an increase in the number of events (**Error! Reference source not found.**, Table 14).

Note that the percentage increase is likely to be higher for some individual events and that the results reflect long-term averages. The small percentage increases are expected as B- and C-class pump limits are in general considerably higher than the riparian targets. Therefore the benefit to achieving riparian targets is generally on the falling limb of events that are already exceeding these targets.

Figure 6. *Additional number of days that existing North West Plan riparian flow targets were met*

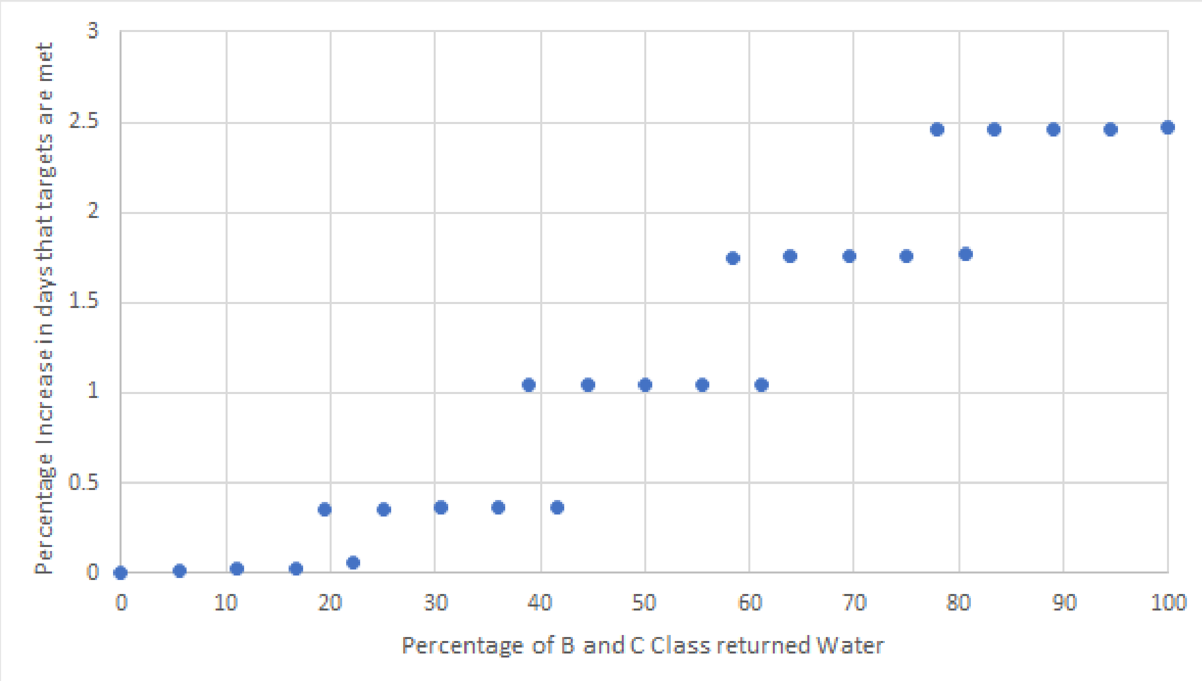


Table 14. *Source model event analysis (B- and C-class water returned) against existing North West Plan targets*

	Total number of events	Number of events where targets met historically	Number of events where returning water meant targets met
Walgett	66	59	0
Brewarrina	61	57	1
Bourke	75	73	0
Louth	53	50	0
Wilcannia	61	54	0

7.5 Combined influence on existing targets of supplementary and B- and C-class volumes

In the same way that supplementary use volumes and the B- and C-class volumes were returned, the two uses were combined in the analysis and returned to the rivers to determine their combined influence. Table 15 shows that with the higher volumes added to the gauged flow, the number of days where existing North West Plan targets are met increases. The additions show a significant increase from the historical flows.

Table 15. *Change in days that existing North West Plan targets are met with supplementary use, B- and C-class returned*

Location	Target (ML/d)	Historic days targets met	Supplementary added - days met	Combined addition - days met	Increase from historic (%)	Increase from supplementary added - days met (%)
			Riparian			
Mungindi	850	910	989	989	9%	0%
Collarenebri	760	1295	1453	1500	16%	3%
Walgett	700	1517	1697	1764	16%	4%
Brewarrina	550	2034	2207	2278	12%	3%
Bourke	390	2238	2406	2508	12%	4%
Louth	280	2872	2983	3063	7%	3%
Wilcannia	150	2895	3068	3154	9%	3%
			Fish Migration			
Brewarrina	14,000	321	338	341	6%	1%
Bourke	10,000	542	558	584	8%	5%
			Algal Suppression			
Wilcannia	2,000	1279	1386	1471	15%	6%

The distribution of periods of extra days was similar when supplementary days and B- and C-class days were returned, so when combined they have a greater effect. The lengthening of existing events (by adding days at the start and finish) becomes greater, and the new events last longer. Some dates hadn't reached the targets when either source was added on its own, showing that the extra volumes in the flow are able to overlap and raise levels above the targets.

7.6 Relationship to key gauges

The most meaningful flow events for reviewing the North West Plan were identified using correlation analyses between flows at key gauges and the existing North West Plan targets in the Barwon-Darling River. Periods of flow that historically had not met the targets but were likely to if supplementary volumes were returned were identified, using short-term peaks in flow.

During the analysis period of July 2004 to June 2020, localised peaks in flow that missed the targets in the gauged data but passed the target by less than 20% in the Mass Balance result were used as these were considered to be the times when the management of supplementary access would be most relevant in determining when access could be limited. This was done for the existing North West Plan riparian targets at Mungindi, Collarenebri, Walgett and Brewarrina, where the tributary valleys meet the Barwon-Darling River. This identified key flow events (four each for Mungindi and Collarenebri, seven each for Walgett and Brewarrina, one each for the Brewarrina fish target and the Wilcannia algal suppression target).

These events were used to identify the flows at key upstream gauges for the 30 days prior to the points identified. The upstream tributary gauges used were:

- Boggabilla (416002), used as the key upstream gauge of Mungindi

- Gravesend (418013), used as the key upstream gauge of Collarenebri
- Boggabri (419012), used as the key upstream gauge of Walgett
- Warren (421014), used as the key upstream gauge of Brewarrina.

The total volume of flow over the 30 days prior in the upstream tributary gauges for each of the identified Barwon-Darling flow events was used to determine if a relationship between the upstream tributary gauge and the Barwon-Darling gauge existed. The test included investigating the Barwon-Darling gauges to identify correlations in the system and as well as the lowest upstream volumes required to guarantee North West Plan targets. Table 16 shows that if the upstream flows are used to predict targets being met downstream, a very large volume of flow over the 30-day period is required to meet downstream targets.

For a flow period in upstream gauges that will correlate to existing North West Plan targets being met with reasonable confidence level, the upstream flow levels would need to be too high for it to be a practical tool for downstream predictions. A simplistic solution such as upstream flow triggers could not be found as a robust viable method for implementation of the North West Plan.

Table 16. *Lowest 30-day volumes that guaranteed existing North West Plan targets*

Gauge	Upstream source	Lowest 30-day flow total (ML)
Mungindi	Boggabilla	935,316
Collarenebri	Gravesend	224,289
	Mungindi	397,974
Walgett	Boggabri	202,768
	Collarenebri	374,747
Brewarrina	Warren	210,947
	Walgett	638,895

7.7 Volumes over the targets

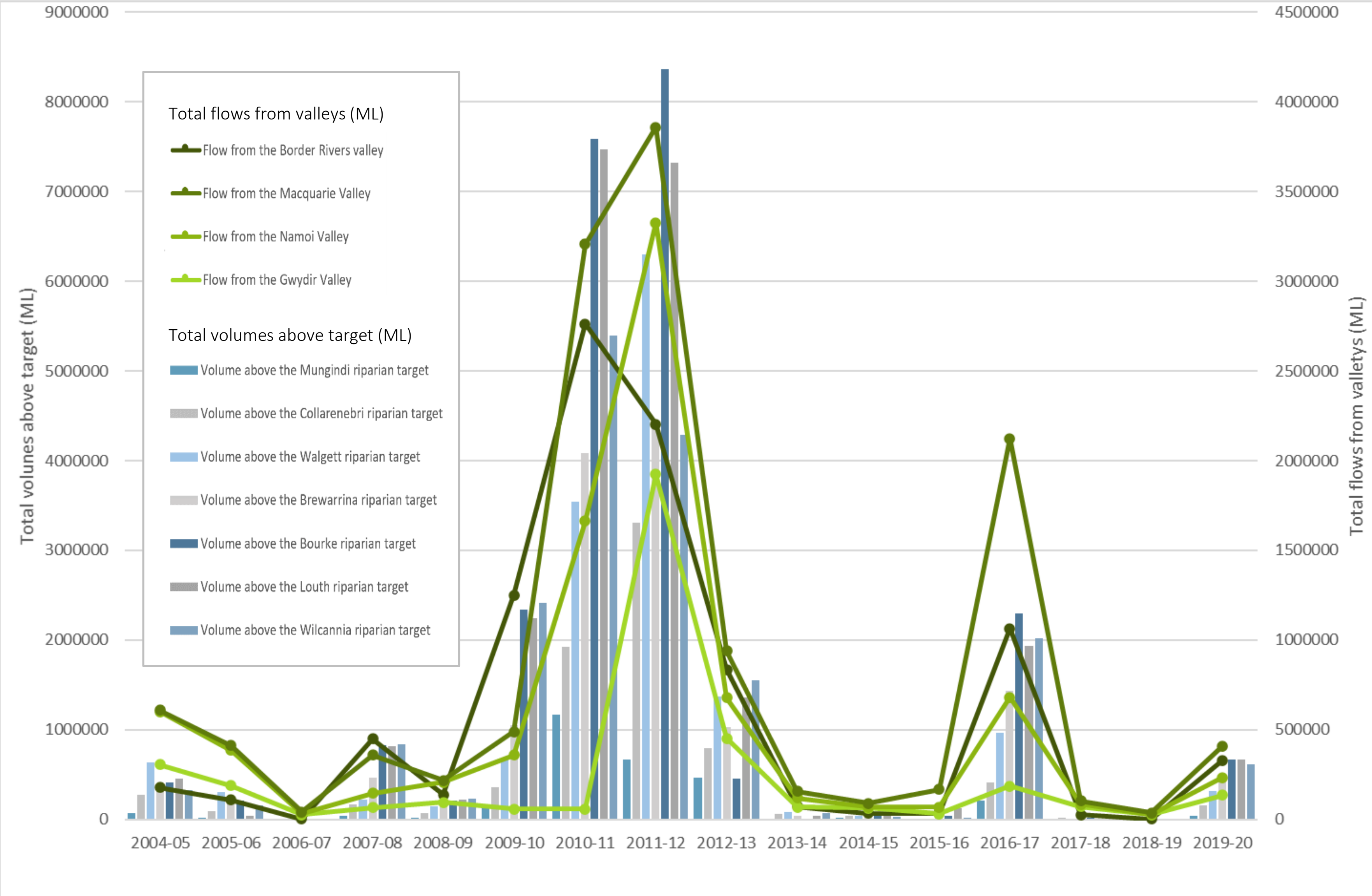
When an event was met, a target analysis was conducted to gain an indication of the volumes of flow that surpassed the existing targets of the North West Plan. This was done by taking any volume of flow each day over the flow target and adding them together for each water year. When the flows were under the target, the volume was taken as zero and not a negative volume. The volumes over the targets were graphed against the year flow from the tributary valleys to indicate how they compared (Figure 7**Error! Reference source not found.**). For each water year that a significant number of days of flow over the targets in the Barwon-Darling River occurred, volumes over the targets coincided with flows from at least one valley. The major flow periods over the targets occurred around the record La Nina periods around 2010 to 2012 and the 2016-17 water year, when there were large spikes in volume above the targets and flows from the valleys.

Figure 7**Error! Reference source not found.** demonstrates that the levels above the North West Plan target are g enerally proportionate to the flows from the valleys over the course of a water year. The volumes taken from above the target levels show a yearly volume that could theoretically have been extracted from the system and the targets still have been met (assuming perfect active management (see (NSW DPIE, November 2020))[2]).

Water years 2006-07, 2013-14, 2014-15, 2015-16, 2017-18 and 2018-19 were of extremely low volumes above the existing North West Plan target and periods of very low to no flow out of the tributary valleys.

[2] 'Active management' is a system for ensuring protection of environmental water and equitable access to available water by licence holders on the Barwon-Darling. See NSW DPIE (2020) Active Management Procedures Manual - Barwon-Darling (nsw.gov.au)

Figure 7. *Volumes in excess of the flow targets (bars) vs total flows out of the valleys (lines)*



8 Valley equity

8.1 Historic equity analysis

When assessing the relative contributions made by the tributary valleys, the influences were considered in three ways:

- the volume of supplementary flow use in each valley (Figure 8)
- the contribution of access to supplementary flow relative to the flows leaving the valley (Figure 9)
- the portion of additional days the targets are met when the supplementary volumes from each valley are returned (Table 17).

Figure 8 shows the cumulative supplementary use per valley for the assessment period (July 2004 to June 2020). At the end of the period the Border Rivers accounted for the most supplementary use, with the Gwydir Valley contributing the least. All of the valleys showed significant use in the wet 2011-12 discussed previously, with flood events occurring across the valleys. When the comparison was made as a percentage of the total flows from the valley (Figure 9), the Gwydir valley uses the largest percentage of its supplementary flows. The graphs in Figure 9 start in 2012 as the initial period of use returned large variations, but over time the results settled to a consistent percentage of flow.

Figure 8. *Cumulative supplementary use by valley*

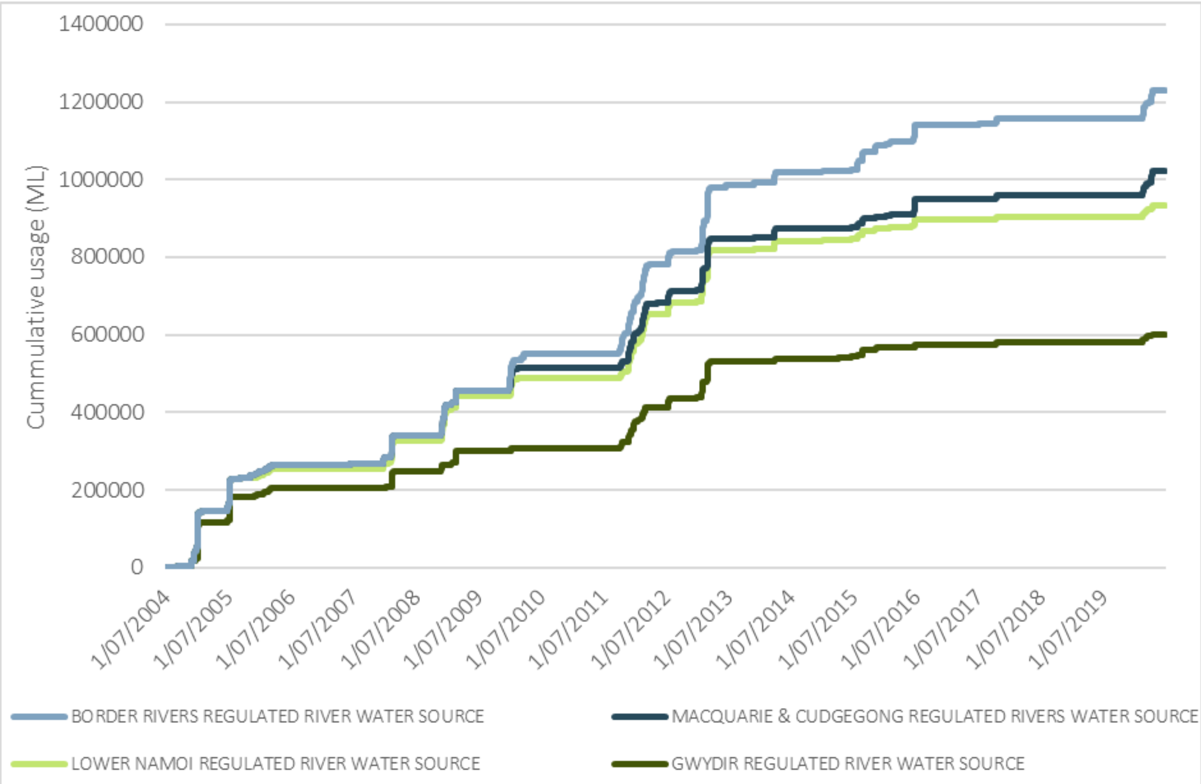
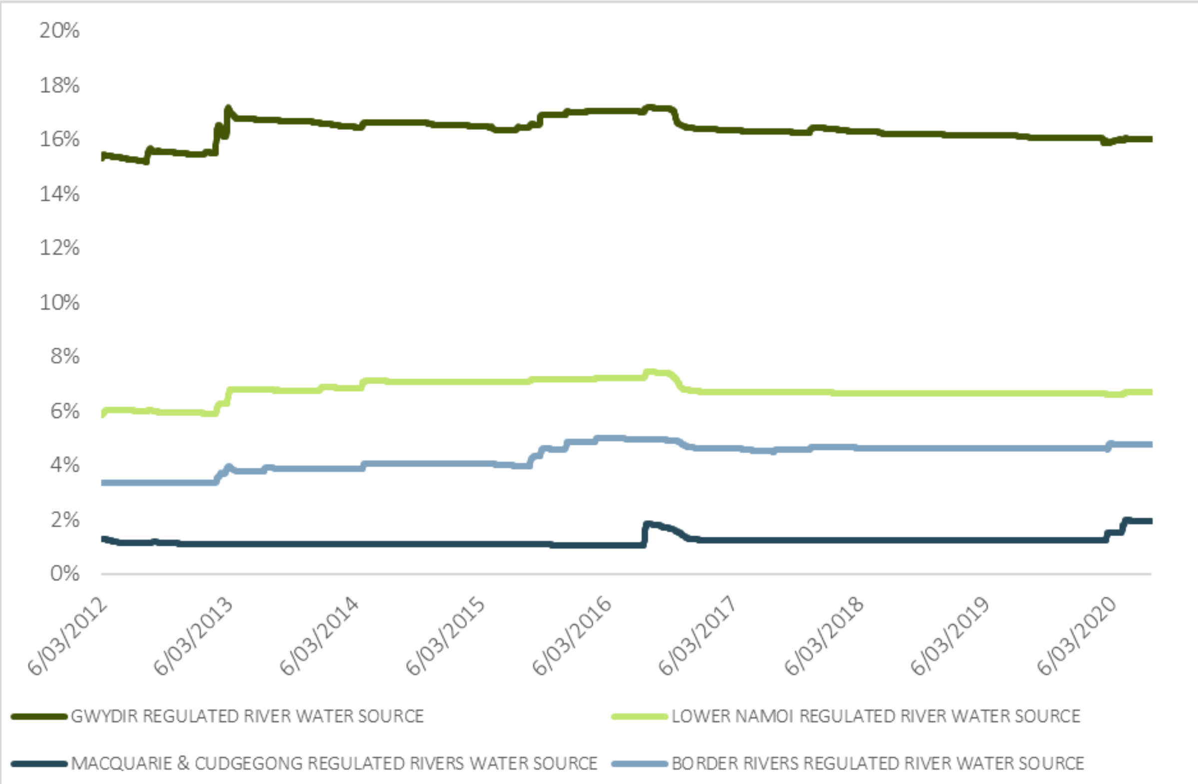


Figure 9. *Cumulative supplementary use as a percentage of total flow exiting the valley*



How those contributions relate to meeting existing North West Plan targets can be seen by adding in one valley at a time and then combinations of valleys to see how many days targets were met. Table 17 shows how returning individual valley contributions affected the number of additional days where targets were met. The changes are shown as a percentage of total additional days with all valleys returned. It shows higher portions of the days are met with more valleys added, particularly when the Border Rivers and the Gwydir Valley's use are returned.

Understanding the long-term trend from the relative combinations can allow for specific targets to be aimed for in each event. For example, the Namoi's influence on the Wilcannia algal suppression target may make it important if that target hasn't been met in recent months, or if the riparian targets were the only focus as the others had been met, then the Macquarie could supply flows.

Table 17. *Valley contribution to number of days existing North West Plan targets were met*

	Riparian Targets							Fish Migration		Algal
	Mungindi	Collarenebri	Walgett	Brewarrina	Bourke	Louth	Wilcannia	Brewarrina	Bourke	Wilcannia
No supplementary usage returned	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
All Valleys	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Border	100%	40%	36%	44%	38%	32%	40%	10%	10%	1%
Gwydir	0%	60%	44%	51%	54%	56%	48%	40%	40%	54%
Namoi	0%	0%	21%	24%	33%	22%	33%	20%	20%	9%
Macquarie	0%	0%	0%	8%	8%	8%	8%	20%	20%	0%
Macquarie + Border	100%	40%	36%	52%	46%	39%	47%	50%	50%	1%
Namoi + Border	100%	40%	57%	59%	69%	45%	63%	60%	60%	15%
Gwydir + Border	100%	100%	80%	84%	80%	83%	79%	60%	60%	66%
Gwydir + Namoi	0%	60%	65%	62%	72%	66%	63%	70%	70%	87%
Gwydir + Macquarie	0%	60%	44%	59%	62%	64%	56%	70%	70%	54%
Namoi + Macquarie	0%	0%	21%	32%	40%	30%	41%	50%	50%	16%
Border + Namoi + Gwydir	100%	100%	100%	92%	93%	92%	92%	90%	90%	91%
Border + Namoi + Macquarie	100%	40%	57%	68%	76%	53%	71%	70%	70%	24%
Namoi + Gwydir + Macquarie	0%	60%	65%	70%	79%	73%	71%	90%	90%	94%
Gwydir + Macquarie + Border	100%	100%	80%	92%	88%	91%	86%	80%	80%	66%

8.2 Influence of individual valleys in the Source model

The increase in the number of days existing North West Plan targets were met as a function of the total water returned (supplementary and B- and C-class combined) was calculated. A linear regression was undertaken for each of the target gauges, where all the valley return volumes are included as parameters, and the relative strength of each relationship has been calculated.

Equation 1 describes the linear regression, where the output is the increase in days that the target is met at one of the gauges. The intercept (a) is equal to zero because the values have been standardized (values subtracted from the mean and then divided by the standard deviation). The size of β for each of the tributary values and B- and C-class indicates the influenced of that input on the output.

Equation 1. *Linear regression of the increase in days that a target is met at a gauge*

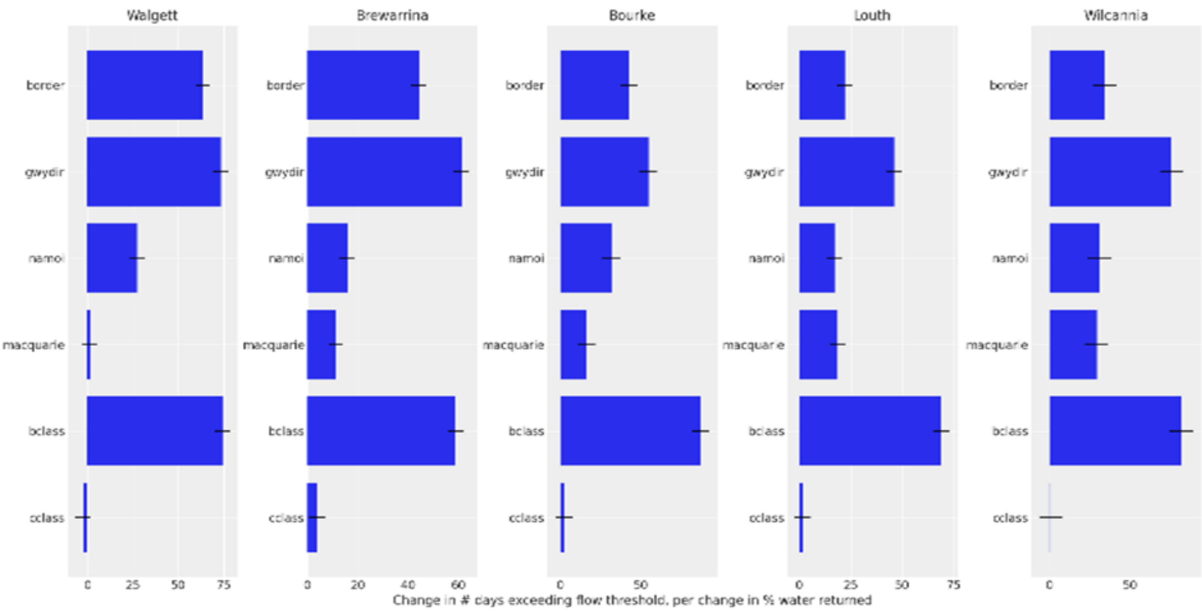
$$output = a + \beta_{bor} input_{bor} + \beta_{gwy} input_{gwy} + \beta_{nam} input_{nam} + \beta_{mac} input_{mac} + \beta_{b} input_{b} + \beta_{c} input_{c}$$

So, for example, if the β_c value is low, then varying the C-class diversions would make little difference to the overall result.

The following observations can be made from the data (Figure 10):

- inflows from the Border Rivers have a decreasing influence moving downstream, which matches expectations as the water is attenuated
- contributions from the Gwydir have a relatively strong influence across all gauges
- inflows from the Namoi have a smaller but relatively consistent influence
- the Macquarie also has a small but relatively consistent influence (clearly it has no influence on Walgett as it is upstream of the confluence)
- B-class returns have quite a strong influence across the system
- C-class returns have a small influence. This is likely due to the fact that the targets are largely already met when C-class access commences.

Figure 10. *Comparison of different valleys influence on increasing riparian flow target days met*



9 Conclusions and recommendations

The results demonstrated that limiting access to supplementary flows and B- and C-class access does contribute to meeting the existing North West Plan targets, though this impact may be limited.

A review of the historic implementation of the Plan revealed that strategic limitation of access could have increased the periods that the riparian targets were met, though influence on the algal suppression and fish migration targets would be minimal. This is not unexpected as the lower flows of the riparian targets are more likely to be influenced by returned volumes. The additional periods that the targets would be met were mainly located at the start and end of periods when targets were already met without restrictions. There may however be potential to create some standalone events when flows rise to near the target without actually reaching the target.

The results indicated that the influence of restricting access in a single valley is unlikely to have much of an impact on target flows, with multiple valleys, if not all, requiring restrictions. This shows that when considering providing supplementary flow access, modelling should be conducted to include all of the tributary valleys and the Barwon-Darling with the potential for restrictions to all. Given that the analysis showed that additional periods over the targets are at the start and end of larger events, this is likely to just be a delay in access in most cases but should be reinstated as the flows in the Barwon-Darling begin to decrease.

The difficulty in restricting access is in forecasting which events will contribute to meeting the target versus those which would never meet the Barwon-Darling targets anyway, or are so large the targets would be met even with supplementary and B- and C-class access permitted. Another difficulty is that the analysis and resulting decision-making must take place in a very short timeframe as flow events develop in response to rainfall events. The source modelling undertaken in this investigation also included historical restrictions that were implemented as a result of the drought. It should also be noted that the 16-year period included two significant droughts with the 2018/2019 period experiencing some of the lowest rainfalls on record in the catchment.

The Review of the existing North West Plan targets, drawing on contemporary practice, science and knowledge, recommended that some of the individual targets should be revised to ensure that the desired outcomes of the North West Plan are being achieved. This would involve raising the flow target at three of the gauge points (Bourke, Louth, and Wilcannia) and modifications to the fish migration and algal suppression targets.

The Mass Balance analysis showed that more days of meeting the existing North West Plan targets could have occurred historically, partially because the events that were under historically but able to create new events with supplementary volumes returned, were estimated to be over the target in the Source model.

There are two main reasons for the differences between the two model results:

1. the Source model appears to over-predict the time that targets are met; therefore, there is less opportunity for supplementary to assist in meeting the targets. This means that the Source results are likely to be conservative
2. the Mass Balance model appears to under-predict the attenuation that occurs with the added water. This means that the Mass Balance model results are likely to be optimistic.

Given the Source model is likely to be conservative, and the Mass Balance model is likely to be optimistic, the "real" outcome is likely to be within the range of results presented by the two models.

The relative contributions of the individual tributary valleys and the B- and C-class licences on meeting existing targets show that forecast modelling of supplementary events will be most accurate when including all these factors. The scenarios showed a much higher tendency to reach the existing targets when supplementary use was returned in multiple valleys and the most when all use was returned, so forecasting relating to access to supplementary events should include all these inputs.

In order for the North West Plan to be implemented effectively, this Review recommends a number of points should be considered:

- a clear procedures manual or guidance is required to either reduce scope for interpretation or establish clear principles to be considered when exercising interpretation

- decision support tools and adequate resourcing is required to support analysis and decision-making a very short timeframe as flow events develop in response to rainfall events
- there are other plans that influence access to flows that require consideration when providing access to supplementary and B- and C-class licences, such as the Resumption of Flows rule and the active management of HEW. The potential for overlap of different rules should be clarified, along with how they should operate in conjunction with each other.
- accounting for water licencing has changed substantially since the North West Plan was developed. Now, unused entitlements are permitted to be carried over from one water year to the next, as well as, transfer between irrigators is also permitted. The impact of these changes should be considered.
- the North West Plan targets need to be clarified. There is ambiguity in the wording, particularly during supplementary events where the targets are not going to be met, that requires clarification. This could be through rewording or a separate policy to show when the rules apply
- the administrative process for supplementary access approval should be simplified to reduce potential delays in decision-making.

Addressing the above considerations was beyond the scope of this Review.

The ideal scenario would be the creation of a decision tree and supporting tool that considers multiple valleys and their contributions to the flow targets and can allow unambiguous decision making to occur as quickly as possible. This would be based on clear and transparent principles, heads of consideration and criteria for decision making. Guidance would be provided regarding who decides to allow or restrict extraction and why. It would ensure an equitable sharing of flows into the Barwon-Darling while ensuring best value from supplementary flows. Best value would ensure that targets would be met if restrictions were in place, restrictions not placed in events that could have met flow targets, or targets being exceeded by more than the amounts provided through restrictions. It would be clear and based on a solid scientific foundation, ensuring that all stakeholders can understand the decision making and limit possibilities for uncertainty. Clarity around the decisions to allow or restrict extractions is hoped to limit the social and political constraints noted by WaterNSW.

The multivalley approach will allow an equitable approach to decisions linked to the North West Plan, ensuring the different valleys will share the 'burden' of providing flows in the Barwon-Darling. The potential for one or a few valleys to provide the majority of flow or to have a larger number of events is restricted.

It is recognised that even with an updated manual and forecasting methodology, some of the constraints will still exist so the ideal scenario may not be achievable. It is also understood that the methodology is likely to be requested to enable the inclusion of environmental flow to be considered and decisions made on releases; however, that is beyond the scope of this project.

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Attachment 1. Legislative Context

Since the development of the North West Plan in 1992, legislation that governs the management of water resources in NSW has come into effect, such as the *Water Management Act 2000* (NSW) and the *Water Act 2007* and *Basin Plan* (C'wth). These instruments have altered the legislative context that guides the content of management plans for NSW water resources. Of particular relevance to the targets in the North West Plan is the enhanced legislated focus on the sustainable management of water resources and the protection of water-dependent ecosystems.

In assessing the appropriateness of flow targets in the North West Plan against contemporary understanding of the ecohydrology of the Barwon-Darling, it is also necessary to consider their consistency with relevant aspects of current legislation.

The Water Management Act 2000 (WMA)

In common with most modern legislation, the *Water Management Act 2000* (WMA) sets out its Objects (section 3), that is, what the legislation is seeking to achieve. The Objects are an important reference point for clarifying the intent of all parts of the WMA.

In addition, the WMA provides Water Management Principles (section 5). Importantly, the WMA requires (s section 9 (1)):

"It is the duty of all persons exercising functions under this Act:

- *a) to take all reasonable steps to do so in accordance with, and so as to promote, the water management principles of this Act, and*
- *b) as between the principles for water sharing set out in section 5 (3), to give priority to those principles in the order in which they are set out in that subsection".*

General water management principles are provided (section 5(2)), which focus on (in summary):

- protection of water dependent ecosystems,
- protection of water quality,
- protection of Aboriginal and culturally significant items, features etc,
- maximise social and economic benefits and
- application of adaptive management.

The principles for water sharing (section 5(3) provide very specific direction to water sharing, requiring (in summary, paraphrased):

- first protect the water source and dependent ecosystems, and
- protect BLR (stock and domestic, native title, harvestable rights), and
- that these must not be prejudiced by sharing under any other right (e.g. water access licences).

Many other parts of the WMA (e.g. water planning, implementation and review requirements) refer back to the water management principles in section 5. It is also worth noting that the Natural Resources Commission, other recent reviews and the report of the Independent Commission Against Corruption have also noted the relevance and centrality of the Objects and Principles of the WMA (NRC 2019; ICAC 2020).

Water Act 2007 and Basin Plan

Similar to the WMA, the overall objectives of the Water Act 2007 (C'wth) include, in section 3(d):

> "to protect, restore and provide for the ecological values and ecosystem services of the Murray Darling Basin (taking into account, in particular, the impact that the taking of water has on the watercourses, lakes, wetlands, ground water and water dependent ecosystems that are part of the Basin water resources and on associated biodiversity)."

This overall objective is reflected in section 21 of the Act, which sets out the general basis upon which the Basin Plan is be prepared:

> “promote the sustainable use of the Basin water resources to protect and restore the ecosystems, natural habitats and species that are reliant on the Basin water resources and to conserve biodiversity.”

These objectives are reflected in the environmental objectives and outcomes for the Basin and set out in section 5.03 of the Basin Plan 2012 which include ‘protecting and restoring’ water-dependent ecosystems and ecosystem function. The Basin Plan states the overall outcome for the Murray-Darling Basin as a whole is a healthy and working Murray-Darling Basin that includes:

a) *communities with sufficient and reliable water supplies that are fit for a range of intended purposes, including domestic, recreational and cultural use; and*

b) *productive and resilient water-dependent industries, and communities with confidence in their long-term future; and*

c) *healthy and resilient ecosystems with rivers and creeks regularly connected to their floodplains and, ultimately, the ocean.*

Water Sharing Plans

The North West Plan targets have been recognised in the water sharing plans for the NSW Border Rivers, Gwydir and Namoi regulated river water sources. The targets appear as a note in the Barwon-Darling water sharing plan. The relevant clauses that reference the requirements of the North West Plan are shown below in Table 1.1.

Table 1.1. Water Sharing Plan clauses that reference the requirements of the North West Plan

Water Sharing Plan	Relevant Clause current / final draft
Water Sharing Plan for the Gwydir Regulated River Water Source 2016	Clause 47 (7) & (9)
Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016	Clause 48 (5) & (6)
Water Sharing Plan for the NSW Border Rivers Regulated River Water Source 2009	Clause 45 (12) & (13) / 46 (8) & (9)
Water Sharing Plan for the Barwon-Darling Unregulated Water Sources 2012	Clause 46 (4) notes.

The North West Plan noted that the Macquarie valley could make only modest contributions to the Barwon-Darling River through the Northern Marsh Channel and the Bogan River. As such, rules were not included in the water sharing plans for the Macquarie and Cudgegong regulated river.

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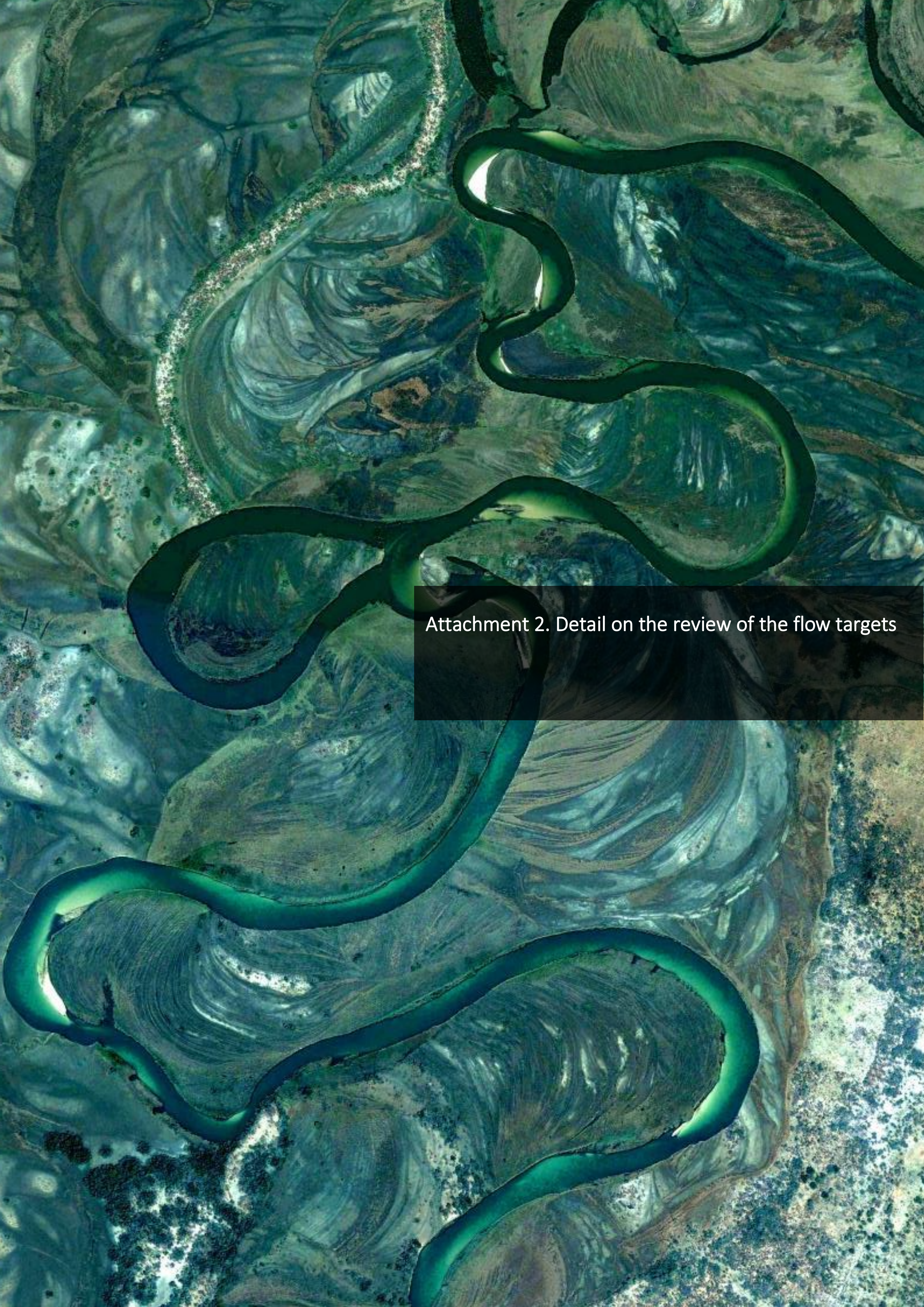
Attachment 2. Detail on the review of the flow targets



Detail on Review of the Flow Targets

This attachment provides further detail on the Review of the flow targets in the Interim Unregulated Flow Management Plan for the North West (the 'North West Plan'). The provisions of the existing North West Plan are summarised in the breakout boxes. These are reviewed against contemporary (2021) best practice and best available knowledge and science. The Review recommends some of the targets be revised based on improved knowledge.

Protection of the water source and dependent ecosystems

The Barwon-Darling connects the rivers, lakes and wetlands in the northern Murray-Darling Basin and provides a connection to the southern Basin through the lower Darling River. The Barwon-Darling provides refuge habitat during dry periods and travel pathways for aquatic biota between rivers, especially for fish that are known to move long distances such as golden perch. Habitat components in the Barwon-Darling include deep channels, flowing water, pools, wetlands, gravel beds, instream woody habitats, aquatic plants and floodplains. The river provides habitat for other aquatic species including turtles, mussels, river snails and shrimp.

Longitudinal connectivity is particularly important for native fish and other aquatic species. There are many billabongs and lagoons along the Barwon-Darling, as well as lakes and wetlands on the floodplains, which provide major bird foraging and breeding sites (NRC 2019).

The Barwon-Darling supports a broad range of flow dependent species, many of which are listed as Threatened under State and Commonwealth legislation (Table 2.1). The habitats and species of the Lower Darling River aquatic ecological community are also listed as an endangered ecological community. This includes all native fish and aquatic invertebrates within all-natural creeks, rivers, streams and associated lagoons, billabongs, lakes, flow diversions to anabranches, the anabranches, and the floodplains of the Darling River within the State of New South Wales, and including Menindee Lakes and the Barwon River. The basis for this listing is that the community is likely to become extinct in this state, unless the circumstances and factors affecting its survival and evolutionary development cease to operate (DPI 2007).

Table 2.1. Flow dependent species and ecosystems of conservation significance of the Barwon-Darling river system (from NRC 2019).

Group	Details
Fish	• Critically Endangered: Silver Perch (Cwth) • Endangered: Southern Purple Spotted Gudgeon (NSW) • Endangered population: Olive Perchlet (western population) (NSW); Freshwater catfish (MDB population) (NSW) • Vulnerable: Silver Perch (NSW); Murray Cod (Cwth) • Key populations: Golden Perch; Spangled Perch; Rendahl's Tandan; Hyrtl's Tandan; Darling River Hardyhead; Desert Rainbowfish; Murray-Darling Rainbowfish; Bony Herring
Birds	• **Critically endangered**: Curlew Sandpiper (Cwth) • **Endangered**: Curlew Sandpiper (NSW); Australasian Bittern (NSW; Cwth); Australian Painted Snipe (NSW; Commonwealth); Black-necked stork (NSW) • **Vulnerable**: Magpie Goose (NSW); Brolga (NSW); Black-tailed Godwit (NSW); Freckled Duck (NSW); Blue-billed Duck (NSW)
Other vertebrates	• **Vulnerable**: Sloane's Froglet (NSW)
Invertebrates	• **Critically endangered**: *Notopala sublineata* Darling River Snail (NSW) • **Key populations**: Freshwater mussels

Group	Details
Vegetation	• **Critically endangered**: *Myriophyllum implicatum* • **Vulnerable**: *Solanum karsense* Menindee nightshade (NSW; Commonwealth) • **Other key species**: River Red Gum *Eucalyptus camaldulensis*; Black Box *Eucalyptus largiflorens*; Coolibah *Eucalyptus coolabah*; Lignum *Muehlenbeckia florulenta*
Endangered Ecological Communities	• **Terrestrial**: Coolibah-Black Box Woodland; Marsh Club-rush sedgeland • **Aquatic**: Lowland Darling River

Protection of Basic Landholder Rights

Under the *Water Management Act 2000* (WMA), Basic Landholder Rights (BLR) (together with the water requirements of ecosystem maintenance) have priority over other extractive uses. The WMA outlines three types of BLR, which do not require a licence:

1. Domestic and stock rights - owners or occupiers of land over an aquifer or with river, estuary or lake frontage can take water without a licence for household use or to water stock
2. Native title rights - anyone holding native title with respect to water (as per the Commonwealth Native Title Act 1993) can take and use water for a range of personal, domestic and non-commercial purposes
3. Harvestable rights - allows landholders to collect a proportion of rainfall runoff on their property and store it in one or more farm dams of defined capacity.

The principles of the WMA relating to the protection of ecosystems and BLRs have come into effect since the development of the North West Plan in 1992. As directed by section 9 (1) of the WMA, it is the duty of all persons exercising functions under the Act to 'take all reasonable steps to do so in accordance with, and so as to promote, the water management principles of this Act'. In reviewing the appropriateness of flow targets of the North West plan, it is therefore necessary to consider them in terms of their consistency with the WMA principles listed in sections 5 (2) and (3). The role of the North West Flow Plan Targets in providing for basic rights is discussed in Section 3 of the main report.

Riparian flows

North West Plan:

Off-allocation pumping and B- and C-class licence operation will not be permitted unless the riparian flow targets are met.

The flow targets at each town along the Barwon-Darling will vary depending upon the inflows from tributaries downstream of Mungindi. If no such inflows exist, the targets would be:

Town	Target flow ML/d
Mungindi	850
Collarenebri	760
Walgett	700
Brewarrina	550
Bourke	390
Louth	280
Wilcannia	150

If tributary inflows exist the target flows upstream of that tributary will be reduced.

The riparian flow targets in the North West Plan were calculated to protect flows needed to meet BLR requirements along the Barwon-Darling. To achieve provision of BLR, riparian flow targets should be calculated to support access to water of quality fit to meet the purposes of BLR as specified in the WMA 2000 (where possible), including domestic consumption. The provision of riparian flows therefore equates to maintaining fit-for-purpose water quality for BLR for the purposes of this review.

Figure 2.1 shows the prevalence of cease-to-flow conditions at Bourke (425003) has increased over the last three decades. While it is likely that a combination of factors is driving this change (including a changing climate), it appears that the security of access to BLR is decreasing in the Barwon-Darling, particularly downstream of Bourke (Figure 2.2, Sheldon 2017).

Figure 2.1. *Observed flows at Bourke (425003) since 1944, together with the proportion of time that cease-to-flow conditions (<1ML/d), by decade (NSW DPIE 2020)*

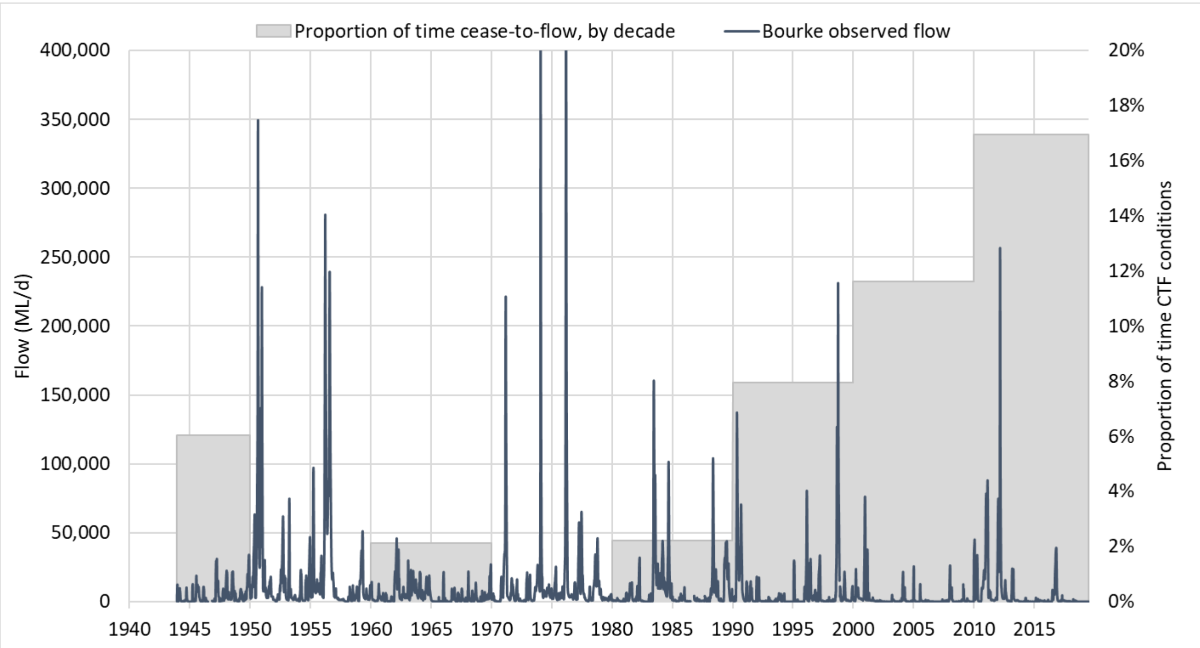
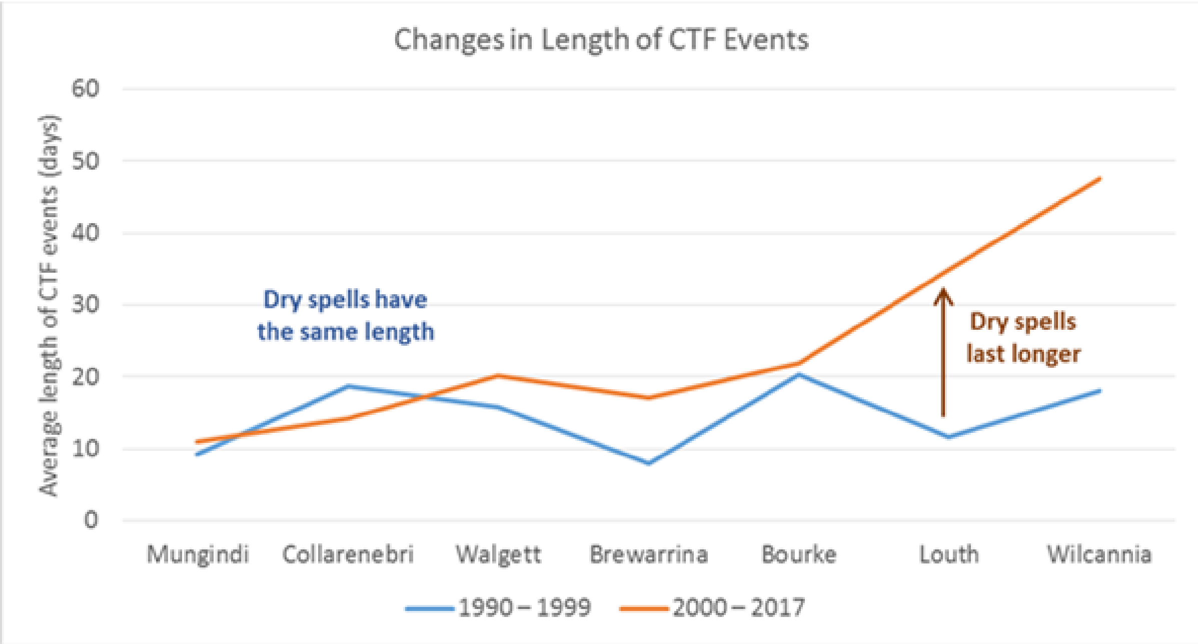


Figure 2.2. *Comparison of the average length of dry spells from Mungindi to Wilcannia (MDBA Unpublished data, from Sheldon 2017).*



Similarly, the NRC (2019) found that access under native title rights has been impacted by water availability and water quality issues during low flow and cease to flow periods. Despite the Barkandji's 2015 and 2017 native title determination granting specific rights to water (volume yet to be determined), it is apparent that the actual implementation of native title rights is constrained in the context of an already fully-allocated system and complex water governance processes (NRC 2019).

To support the objectives of the Barwon-Darling Water Sharing Plan to maintain fit-for-purpose water for BLR (e.g. section 12A (2)(c)), flows below the baseflow threshold should be limited in frequency of occurrence and duration where possible. Baseflow at a minimum and intermittent freshes are likely to assist in moderating water quality along reaches by preventing the establishment of thermal stratification, mitigating algal blooms and reducing conductivity.

The Barwon-Darling Long-term Water Plan (LTWP) identifies flow bands for flow components along the Barwon-Darling that can be used to identify flow requirements between Mungindi and Wilcannia. Table 2.2 presents the riparian flow targets in the North West Plan against flow bands from the Barwon-Darling LTWP. Current riparian flow targets between Mungindi and Brewarrina are likely to provide adequate flows to maintain water quality, supporting at least a baseflow, however from Bourke to Wilcannia it appears the flow targets are below the required threshold (Table 2.2).

Table 2.2. North West Plan flow targets for riparian flows and flow rates identified for components of the flow regime from the Barwon-Darling LTWP. *Green shading indicates flow bands that align with flow targets from the North West Plan. (All flows ML/day)*

Town	North West Plan flow target	Flow bands from the Barwon-Darling LTWP			
		Very low flow	Baseflow	Small fresh (pulse)	Large fresh (pulse)
Mungindi	850	45-160	160-540	540-3000	3000-7900
Collarenebri	760	80-280	280-650	650-4200	4200-16,000
Walgett	700	95-320	320-700	700-6500	6500-22,000
Brewarrina	550	100-500	500-1000	1000-9000	9000-26,000
Bourke	390	105-500	500-1550	1550-15,000	15,000-30,000

Louth	280	70-450	450-1500	1500-15,000	15,000-30,000
Wilcannia	150	30-350	350-1400	1400-14,000	14,000-25,000

Riparian flow targets for Bourke, Louth and Wilcannia that align with the baseflow flow band in the LTWP would be more appropriate for maintaining adequate connectivity and water quality in this lower part of the system. This would be, at a minimum, 500 ML/d at Bourke, 450 ML/d at Louth, and 350 ML/d at Wilcannia. These flow rates are also supported by analysis from the MDBA (2018) that there is a very high likelihood of system scale connectivity, through to Wilcannia, with flow event volumes of at least 20 GL at Bourke. This would generally be a magnitude of 500 ML/d for at least 14 days, with 20 days providing more certainty. This flow would also be sufficient to mix and freshen pools to improve water quality.

Review finding and recommendation

The riparian flow targets in the North West Plan specify flow rates for seven towns along the Barwon-Darling for maintaining riparian flows through the system.

Flow rates specified in the Barwon-Darling LTWP suggest that the riparian flow targets from Mungindi to Brewarrina are likely adequate for maintaining water quality, however those from Bourke to Wilcannia are unlikely to maintain adequate flows.

The Review found that the current flow targets for the northern section between Mungindi and Brewarrina are likely adequate. However, the Review recommends increasing the current flow targets for Bourke, Louth and Wilcannia to support a minimum baseflow for maintaining BLR access requires the following flow targets:

- Bourke – 500 ML/d
- Louth – 450 ML/d
- Wilcannia – 350 ML/d

Algal suppression flows

North West Plan:

Access to unregulated flows will be managed to achieve a flow of at least 2000 ML/d for 5 days at Wilcannia in the period October to April inclusive, unless a flow of at least this size has occurred within the preceding three months.

Normal pumping will be permitted unless it is assessed that pumping will reduce flows below this target. To achieve this target it may then be necessary to restrict off-allocation access in the tributaries and the operation of B- and C-class licences on the Barwon-Darling.

It may be necessary to restrict pumping on the tributaries prior to 3 months of below algal suppression flows at Wilcannia to allow for the time it takes for flow to travel from the tributaries to the lower Barwon-Darling.

Blue green algae may affect the raw water provided to towns in the North West Plan area through dual reticulated water systems for external use. It is important to note that public drinking water supplies are carefully monitored for the risk of algal blooms and the water treatment plants for Brewarrina and Bourke townships treat blue-green algae for reticulation to properties. Other towns such as Wilcannia switch their source to groundwater when there is a blue-green algae bloom. Concerns around blue-green algae contact are therefore most relevant for outdoor household use, stock purposes and recreational activities (NRC 2019). Exposure to blue-green algae has also been linked to fatalities of livestock, wildlife and pets. As a bloom subsides, dead and decaying algae can deplete oxygen concentration in the water, causing stress or death to aquatic animals.

In the Barwon-Darling, low stable water levels have been associated with saline inflows in some weir pools, which not only increases the conductivity of the refuge pool but also reduces turbidity which increases light penetration and increases the likelihood of algal blooms, including blue-green algal blooms (Sheldon 2017). The MDBA (2018) found these circumstances lead to the 1991 blue-green algal bloom during a period of low flow (~100 ML/d) and hot/still conditions.

Over the past ten years, harmful algal blooms have been an irregular occurrence in the Barwon-Darling. Although high nutrient concentrations have been recorded, other factors such as flow, turbidity and light availability have limited the extent of blooms (DPIE 2019).

The flow target for algal suppression in the North West Plan involves a spring/summer high flow disturbance to manage algal blooms. Sheldon (2017) and Mitrovic et al. (2006, 2011) suggest a minimum flow for preventing the occurrence of algal blooms, and Mitrovic et al. (2011) suggest individual larger events to manage existing blooms that have already become established. These approaches are described in more detail below.

The increased turbidity and water movement associated with in-channel flows can reduce the concentrations of nuisance algae (green and cyanobacteria) in the water column (Sheldon 2017). Mitrovic et al. (2006) identified critical velocities and discharges required to mix the water column within weir pools to prevent stratification and suppress blooms from forming at three sites along the Barwon-Darling at Brewarrina (510 ML/d), Bourke (450 ML/d) and Wilcannia (350 ML/d). These critical discharge rates correspond to a velocity of 0.04 m/s. It is estimated that it takes 12 days with flows below this threshold for weir pools to stratify (MDBA 2018). Subsequent investigations in the Lower Darling by Mitrovic et al. (2011) identified flows of 0.03 m/s as adequate to suppress development of algal blooms, and a larger flow of 3000 ML/d for 7 days to clear an existing bloom.

Sheldon (2017) provides flow rates as intermittent pulses for Walgett (250 ML/d) and Louth (1200 ML/d), and a flow of 500 ML/d at Bourke for 50 days, with a peak of 1,500 ML/d for 14 consecutive days to reset water quality and support breeding outcomes for native fish (Table 2.3).

Table 2.3. Minimum flow thresholds to suppress pool stratification and blue-green algae blooms by Mitrovic (2006) and Sheldon (2017)*.

Town	North West Plan algal suppression target (ML/d)	Flows identified by Mitrovic and Sheldon* (spring/summer)	
		Minimum flow (ML/d)	Duration (days)
Walgett	-	250*	Ongoing
Brewarrina	-	510	Ongoing
Bourke	-	450	Ongoing
	-	500 / 1500	50 / 14
Louth	-	1200*	Ongoing
Wilcannia	-	350	Ongoing
	2000	-	5

While maintaining a relatively low (variable) flow rate to suppress stratification and algal blooms in pools is likely to most effective at preventing blue green algal blooms, limited options for managing flows in this unregulated system make targets such as these difficult to achieve. It is therefore recommended that a single spring/summer flow target be retained, and be revised from 2000 ML/d for five days to 3000 ML/d for seven days, as identified by Mitrovic (2011). However, should the minimum threshold flows described by Mitrovic (2006, 2011) and Sheldon (2017) be maintained throughout the spring/summer period, the need for a flushing flow for algal suppression would be negated.

Review finding and recommendation

The North West Plan includes a single 5-day 2000 ML/d flow event during spring/summer for suppression of algal blooms. Current literature suggests a larger event of 3000 ML/d for seven days is required to clear established blooms, however maintaining a low flow threshold is the most effective way to prevent stratification and algal blooms in pools.

It is recommended that the algal suppression flow target be increased to **3000 ML/d for seven days**, unless flows have remained above the following throughout the spring/summer period:

- Walgett – 250 ML/d
- Brewarrina – 510 ML/d
- Bourke – 450 ML/d
- Wilcannia – 350 ML/d

Fish migration flows

North West Plan:

Access to unregulated flows will be managed to achieve a flow target of at least 14,000 ML/d at Brewarrina and/or 10,000 ML/d at Bourke for 5 days in the period September to February inclusive, unless two such flows have already occurred within this period.

To achieve this target it may then be necessary to restrict off-allocation access in the tributaries and the operation of B- and C-class licences on the Barwon-Darling.

If it is assessed that pumping will not reduce flows below this target or if restrictions on flows will not allow the target to be achieved, normal pumping will be permitted. Flow events of sufficient size to achieve the fish migration target usually have a substantial period of high flows following the flow peak during which significant pumping can take place.

The Department arranged for the construction of fishways at Bourke and Brewarrina weirs. It is anticipated that these will be completed by the end of September 1992.

Once operational, target flows for fish migration will be suspended.

If, during the course of the North West Plan Investigations, appropriate target flows for fish migration at other sites or other essential river health targets can be validated, these will be introduced after consultation.

The Basin-wide Environmental Watering Strategy (BWS) (MDBA 2019) identifies the Barwon-Darling (Menindee to Mungindi) as an asset for native fish for the following attributes:

- Key movement corridor
- High biodiversity
- Key site of hydrodynamic diversity
- Threatened species
- Dry period/drought refuge.

The BWS also identifies the Barwon-Darling as a candidate site for range extension of silver perch, and a location to establish additional population of southern purple-spotted gudgeon.

The fish community in the Barwon-Darling was described as in fair condition using fish community value derived from SRA/MER metrics using nativeness, expectedness & recruitment (NSW DPI 2016). The range of in-channel and floodplain habitats in the Barwon-Darling river system supports a diverse assemblage of 15 native fish species, including five threatened species (Table 2.4), as well as other important native aquatic plants and animals.

Table 2.4. Threatened fish species expected to be found in the Barwon-Darling system (MDBA 2018)

Species	Status	Legislation
Purple spotted gudgeon	Endangered	NSW Fisheries Management Act 1994
Freshwater catfish of the Murray–Darling Basin	Endangered	NSW Fisheries Management Act 1994
Western population of olive perchlet	Endangered	NSW Fisheries Management Act 1994
Silver perch	Vulnerable Critically endangered	NSW Fisheries Management Act 1994 Environment Protection and Biodiversity Conservation Act 1999
Murray cod	Vulnerable	Environment Protection and Biodiversity Conservation Act 1999

The operational targets for fish migration flows in the North West Plan are designed to drown out the Brewarrina and Bourke weirs for periods of five days during spring and summer to allow passage of native fish to spawn. While these are two of many fish migration barriers on the Barwon-Darling, flows that drown out these barriers will also support passage past other barriers in the system.

The North West Plan includes that once fishways are operational, the targets for fish migration will be suspended. Construction of the Brewarrina fishway has enabled some fish passage at lower flows, however this has not negated the need for the Brewarrina weir flow target, which provided for complete drown out of the weir and unobstructed fish passage, as well as a range of critical productivity and habitat access outcomes. Figure 2.3 shows the remaining major barriers to fish passage on the Barwon-Darling (note fish passage works have been completed at Walgett Weir, and are planned for Wilcannia Weir since this map was originally produced).

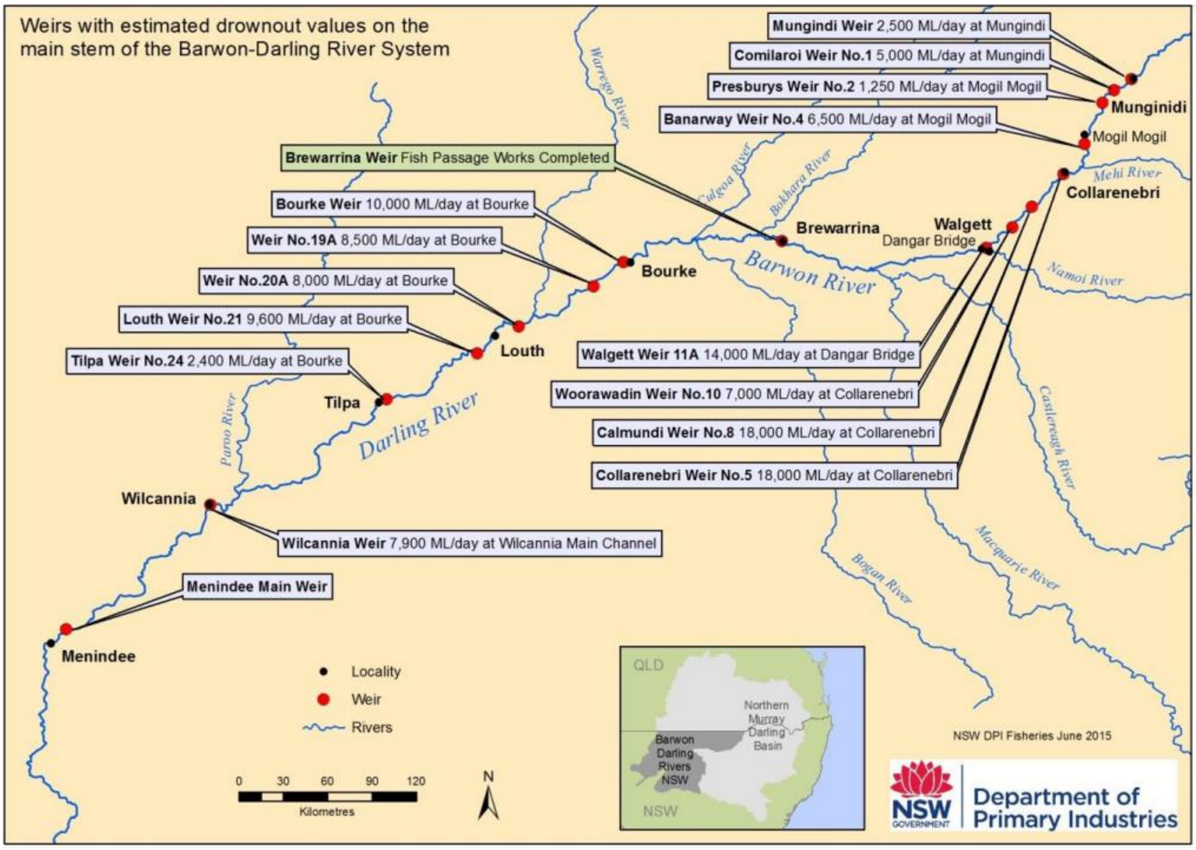


Figure 2.3. *Location of 14 major fish passage barriers on the main stem of the Barwon-Darling, highlighting estimated drown out flows (DPI 2015)*

Note: Woorawadin Weir at Collarenebri has been removed since the map was orignially produced, fish passage works have been completed at Walgett Weir and are planned for Wilcannia Weir.

Since the development of the North West Plan, considerable work has gone into determining the flow requirements of healthy and resilient native fish populations in addition to those supporting migration past barriers. While addressing barriers to migration is a priority for supporting native fish in the Barwon-Darling, maintaining viable fish populations also requires appropriately timed instream productivity pulses to build condition, and flows to support spawning.

The Barwon-Darling Long-term Water Plan draws on planning and policy documents including the Basin Plan, the Basin-wide environmental watering strategy, the Barwon-Darling Water Sharing Plan, as well as the best available science and expert opinion to articulate a range of objectives and their watering requirements for native fish. Adding the environmental watering requirements for spawning and dispersal and condition to the migration targets in the North West Plan would enhance the effectiveness of those targets in generating outcomes for native fish (Table 2.5).

Where the timing and duration of two flow targets are the same, adopting the greater of the two flow rates to cover both targets may be appropriate. For example, achieving the 'migration' target of 14,000 ML/d at Brewarrina will also meet the 'spawning' target of 9000 ML/d. These two targets may therefore be combined. Similarly, the 'spawning' target at Bourke will achieve the 'migration' target from the North West Plan, so only the spawning target needs to be retained.

Table 2.5. Fish migration flow targets from the North West Plan* and environmental watering requirements for spawning and dispersal and condition from the Barwon-Darling Long-term Water Plan#.

Location (gauge)	Flow rate (ML/d)	Duration	Timing	Objective
Brewarrina (422002)	14,000*	15 days	October - April	Migration
	9000#	15 days	July -September	Dispersal and condition
	9000#	15 days	October - April	Spawning
Bourke (425003)	10,000*	15 days	October - April	Migration
	15,000#	15 days	July - September	Dispersal and condition
	15,000#	15 days	October - April	Spawning

Of the two fish migration flow targets in the North West Plan, only the flow of 10,000 ML/d for five days at Bourke remains since the construction of the Brewarrina fishway. However, it is recommended that the Brewarrina Weir flow target of 14,000 ML/d be retained to support fish passage and incidental ecological benefits of this flow more effectively.

It is recommended that the flow duration be extended to 15 days, in line with environmental water requirements in the Barwon-Darling LTWP.

To achieve desired native fish outcomes from migration flow targets, including flows that promote migration including dispersal and condition, and spawning flows will enhance the effectiveness of fish migration targets. Environmental water requirements for spawning and dispersal and condition at Bourke and Brewarrina are therefore also recommended.

Recommended fish flows for the North West Plan are:

- 15,000 ML/d for 15 days at Bourke between July and September (dispersal and condition)
- 15,000 ML/d for 15 days at Bourke between October and April (spawning)
- 14,000 ML/d for 15 days at Brewarrina between October and April (migration)
- 9000 ML/d for 15 days at Brewarrina between July and September (dispersal and condition)

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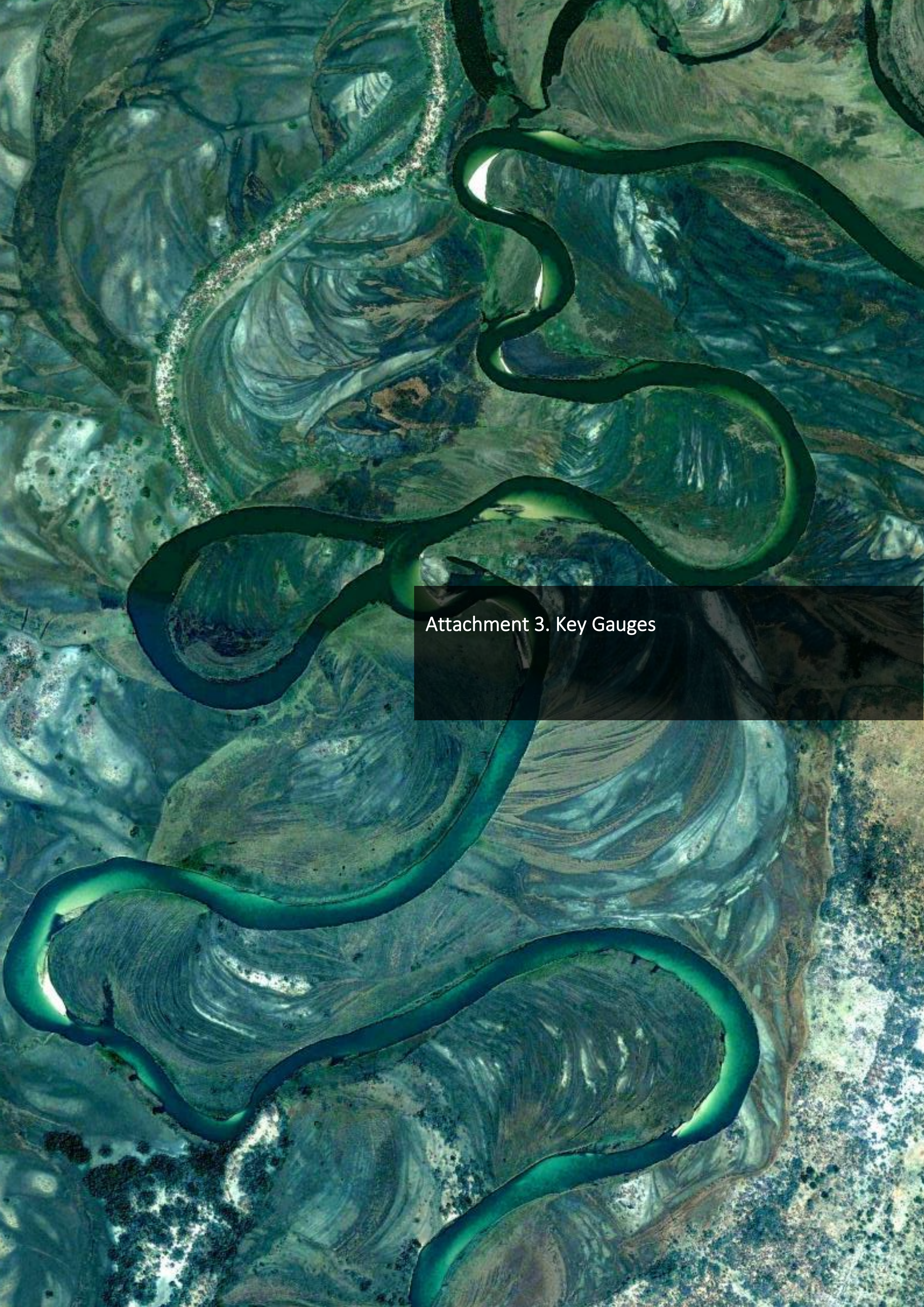
Attachment 3. Key Gauges



Gauges used in the analysis of the historic events are in Table 3.1 below.

Table 3.1. Key Gauges

Location	Gauge Number	Use
Barwon River at Mungindi	416001	North West Plan flow target location Outflow gauge for the Border Rivers tributaries
Barwon at Collarenebri	422003	North West Plan flow target location
Barwon at Dangar Bridge (Walgett)	422001	North West Plan flow target location
Barwon at Brewarrina	422002	North West Plan flow target location
Darling River at Bourke	425003	North West Plan flow target location
Darling at Louth	425004	North West Plan flow target location
Darling at Wilcannia Main Channel	425008	North West Plan flow target location
Gil Gil at Weemelah	416027	Outflow gauge for the Gwydir valley tributaries
Mehi at Collarenebri	418055	Outflow gauge for the Gwydir valley tributaries
Gingham at Gingham Bridge	418079	Outflow gauge for the Gwydir valley tributaries
Thalaba Ck at Belarre	418091	Outflow gauge for the Gwydir valley tributaries
Namoi at Goangra	419026	Outflow gauge for the Namoi valley tributaries
Pian Ck at Waminda	419049	Outflow gauge for the Namoi valley tributaries
Bogan at Gongolgon	421023	Outflow gauge for the Macquarie valley tributaries
Marra at Billybingbone	421107	Outflow gauge for the Macquarie valley tributaries
Macquarie at Carinda	421012	Outflow gauge for the Macquarie valley tributaries
Marthaguy at Carinda	421011	Outflow gauge for the Macquarie valley tributaries
Macintyre Boggabilla	416002	Upstream correlation gauge for North West Plan flow target location locations
Namoi at Boggabri	419012	Upstream correlation gauge for North West Plan flow target location locations
Macquarie at Warren	421014	Upstream correlation gauge for North West Plan flow target location locations
Gwydir at Gravesend	418013	Upstream correlation gauge for North West Plan flow target location locations

Attachment 4. Model methodology

Source model summary

Source is a node-link hydrological model that represents key hydrologic processes in a spatially correct manner and represent recent historical extraction behaviour. Tributary inflows are modelled at their respective end-of-system gauges and then routed through the Barwon-Darling system by the model. As the water moves down the river, extractions by irrigators are modelled as well as additional rainfall, tributary inflows, and losses such as evapotranspiration, infiltration and effluent and floodplain diversions.

The Barwon-Darling Source Model is being developed by DPIE Water to replace the existing IQQM model. While the model is still under development, it has some advantages over the IQQM model in that it:

- includes representation of the Barwon-Darling Weir pools, which form a critical component of the system, particularly during cease to flow and low flows
- includes a more detailed estimation of losses due to: dead storage, evaporative and channel infiltration
- is easier to run many multiple simulations and synthesise results.

To test the calibration and ability of the model to simulate naturally variability in the system, the model was run for five different event volumes at five different initial and environmental conditions (i.e. channel dryness). This resulted in a total of 25 events. Each event had a single inflow at Mungindi and the travel time to and total resultant volume at Wilcannia was measured (Table 4.1). Depending on the event size, initial and environmental conditions, there is significant variability in the model results in terms of travel time and volume of losses.

Table 4.1. *Model loss and travel time variability*

	Total Event Inflow Volume (ML/d)				
Mungindi to Wilcannia	530,000	265,000	106,000	53,000	26,500
Volumetric Loss	29 - 44%	31 - 51%	39 - 84%	61 - 100%	100%
Travel Time	16 - 18 Days	22 - 25 Days	32 - 45 Days	47 - 68 Days	N/A

Model schematisation

Improvements to the Source model include better representation of key loss processes, such as:

- drought refuge pools within the channel
- key environmental asset storage and loss
- floodplain storage and loss
- channel infiltration.

With the inclusion and parameterisation of these features, the standard "loss node" has been removed from the model. By describing these parameters within the model (rather than as a simple loss), it also allows the model to "dry out" the system between flows, which is a common occurrence in the Barwon-Darling.

Flow model calibration

The calibration was checked at the three key North West Plan gauges (Brewarrina, Bourke, and Wilcannia) for the flow ranges that are of interest to the Plan targets. The results are presented in Table 4.2 and show that in general the Source model performs reasonably well on average over the period analysed (2004/5 to 2019/20). Note that the model includes irrigators as per the demand model developed by DPIE Water.

However, it is important to note that it may over-predict and under-predict on individual events. Therefore, the Source model is most useful for looking at average behaviour and response and whether there is likely to be significant gain from restricting access. If the results indicate significant gains are likely then more detailed analysis may be required.

Table 4.2. *Model and gauge exceedance for target ranges*

Brewarrina			
Target	Flow (ML/d)	% Time Exceeded	
		Gauge	Model
Fish Passage	14,000	5%	4%
Riparian Flow	550	43%	38%
Bourke			
Target	Flow (ML/d)	% Time Exceeded	
		Gauge	Model
Fish Passage	10,000	9%	8%
Riparian Flow	390	48%	50%
Wilcannia			
Target	Flow (ML/d)	% Time Exceeded	
		Gauge	Model
Algae	2,000	23%	21%
Riparian Flow	150	53%	52%

Loss variability

Concerns were raised regarding the suitability of the Source model particularly regarding the calibration and ability of the model to simulate naturally variability in the system due to the stop-start and wet-dry nature of the Barwon-Darling. To address this, the model has been run for five different event volumes at five different initial and environmental conditions, leading to a total of 25 events. Each event had a single inflow at Mungindi and the travel time to and total resultant volume at Wilcannia was measured and presented earlier in Table 4.1. It can be seen that depending on the event size, initial and environmental conditions, there is significant variability in the model results in terms of travel time and losses.

Mass Balance summary

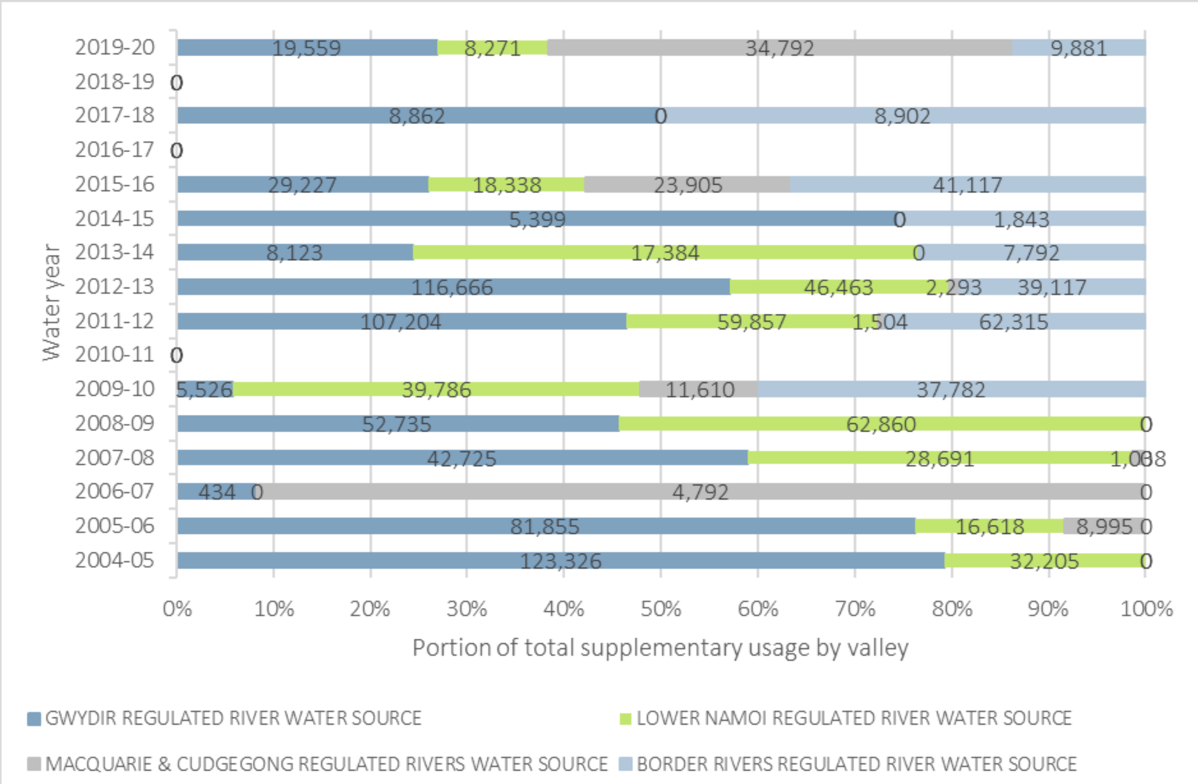
The Mass Balance used a spreadsheet approach to return the use volumes, applying losses, lag, and attenuation of the flow at each gauge as it moved down the Barwon-Darling River.

Data Availability

Analysis was conducted based on use data provided by DPIE Water from 2004 to 2020 (Figure 4.1). The data detailed daily recorded use across the tributaries and reaches of the Barwon-Darling where supplementary, B

Class and C Class use was able to be extracted. The historic flow data was taken from the WaterNSW Real-time data website (WaterNSW, 2021) at the locations shown in Figure 4.2.

Figure 4.1. *Supplementary use in each valley per water year*



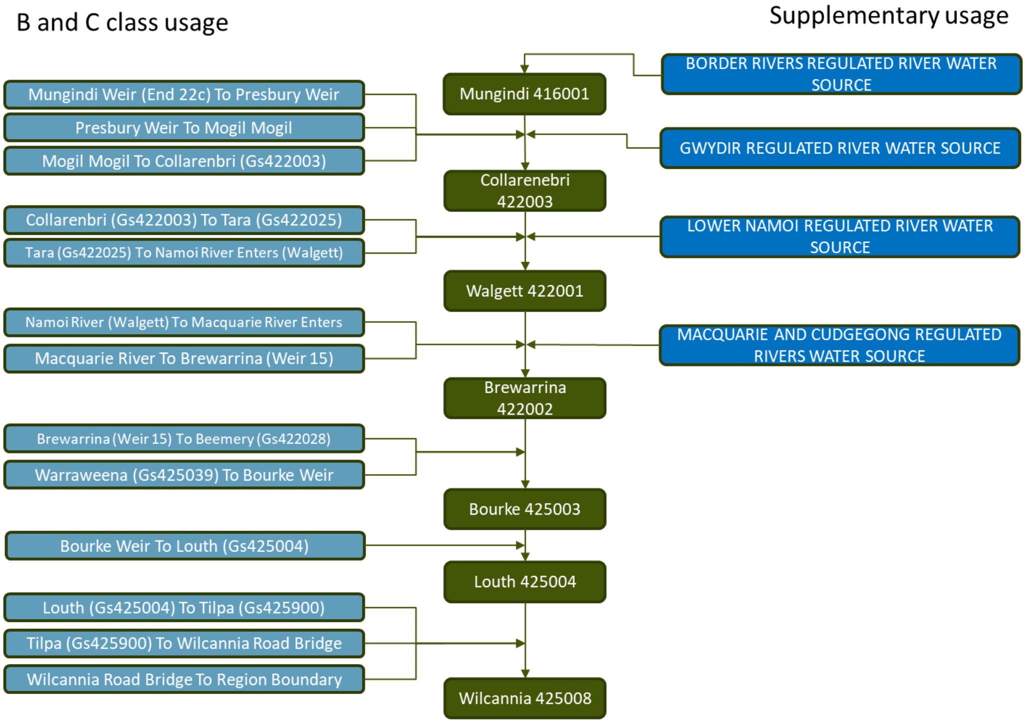
Analysis period

Supplementary flow access was analysed for the period starting July 2004 to June 2020. The chosen period provided consistent and high-quality data in supplementary access and gauge data across the valleys.

Use return method

To estimate the flows in the Barwon-Darling system that would have occurred without supplementary or B- and C-class extraction, the use volumes were returned at the gauges nearest to the confluence of the tributary with the Barwon-Darling River. The flows were also returned at each location downstream (Figure 4.1). The uses volumes recorded were adjusted to create a more realistic return by applying a lag period, losses, and attenuation of the flows.

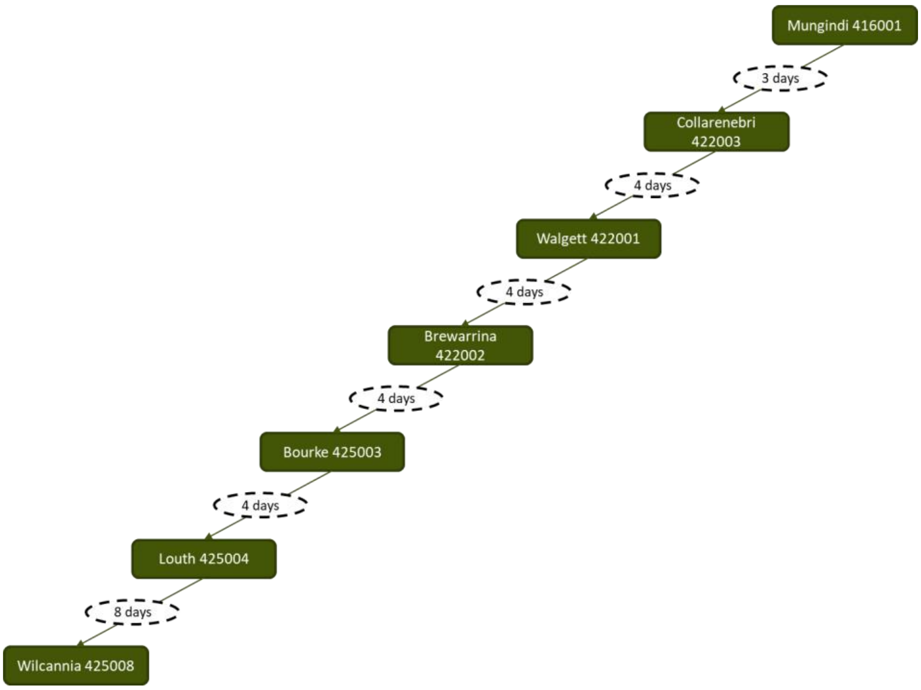
Figure 4.2. *Return locations*



Lag

The natural lag created by travel time through the Barwon-Darling River was included when returning the flows to the system. Returning the flows to the downstream locations included a cumulative delay, with the delay estimates taken from the time between gauge peaks. The travel time lag in the river is shown in Figure 4.3. The travel time was estimated using the average time between events, using the start, end, and peak of multiple events. The events were chosen with a focus on events when gauged events reached the flow targets in the North West Plan.

Figure 4.3. *Travel times between gauges*



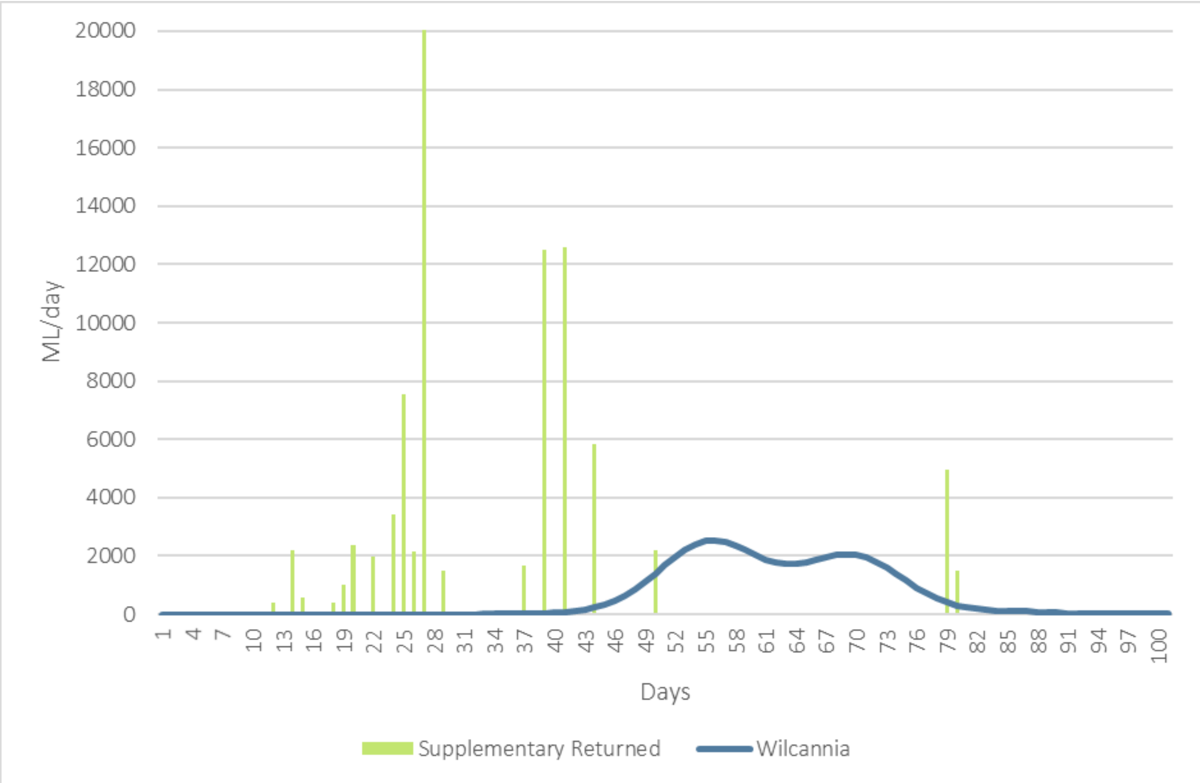
Attenuation

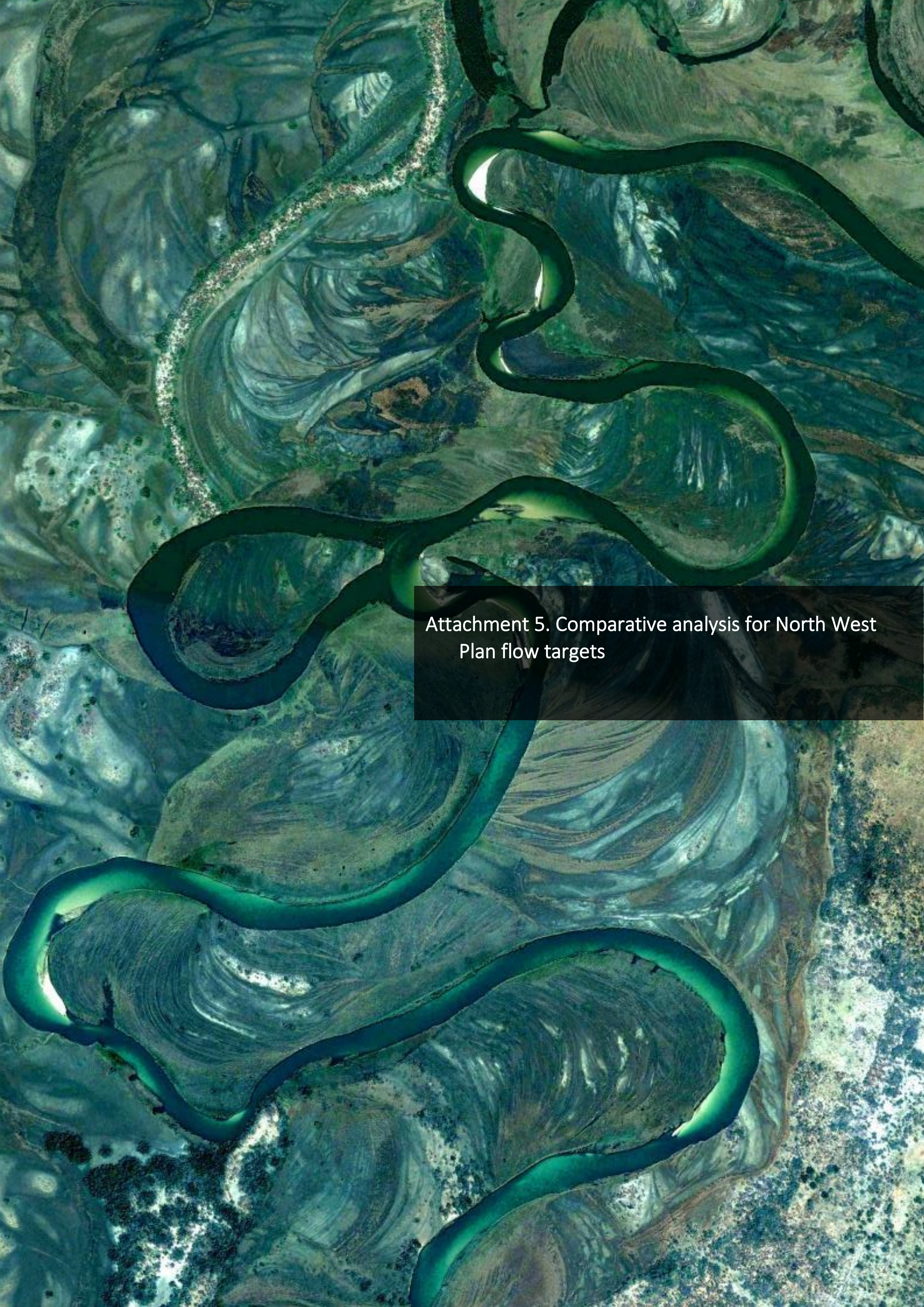
To simulate the return of supplementary and B- and C-class access use, an initial and ongoing attenuation was applied to the use volumes.

At each gauge, the daily volume of supplementary and B- and C-class use was returned to the gauged flow to determine an updated flow at the gauge location. The recorded use was returned to the gauge volumes by taking the daily returned volume of the upstream gauge and applying the lag as discussed above. This lagged volume was then combined with the use returned to that gauge (Figure 4.2) with the total volume spread over a seven-day period to allow for instream attenuation and for delays in flows and reporting in the tributaries.

The 'smoothed' return volumes combined with the gauged flows provided a predicted flow rate for analysis and became the return volume for use in the next assessment gauge downstream. An example of how the supplementary use volumes become an attenuated hydrograph by the time it reaches Wilcannia is shown in Figure 4.4. This hydrograph is then added to the gauged data to develop updated flows.

Figure 4.4. *Total supplementary return vs addition at Wilcannia*





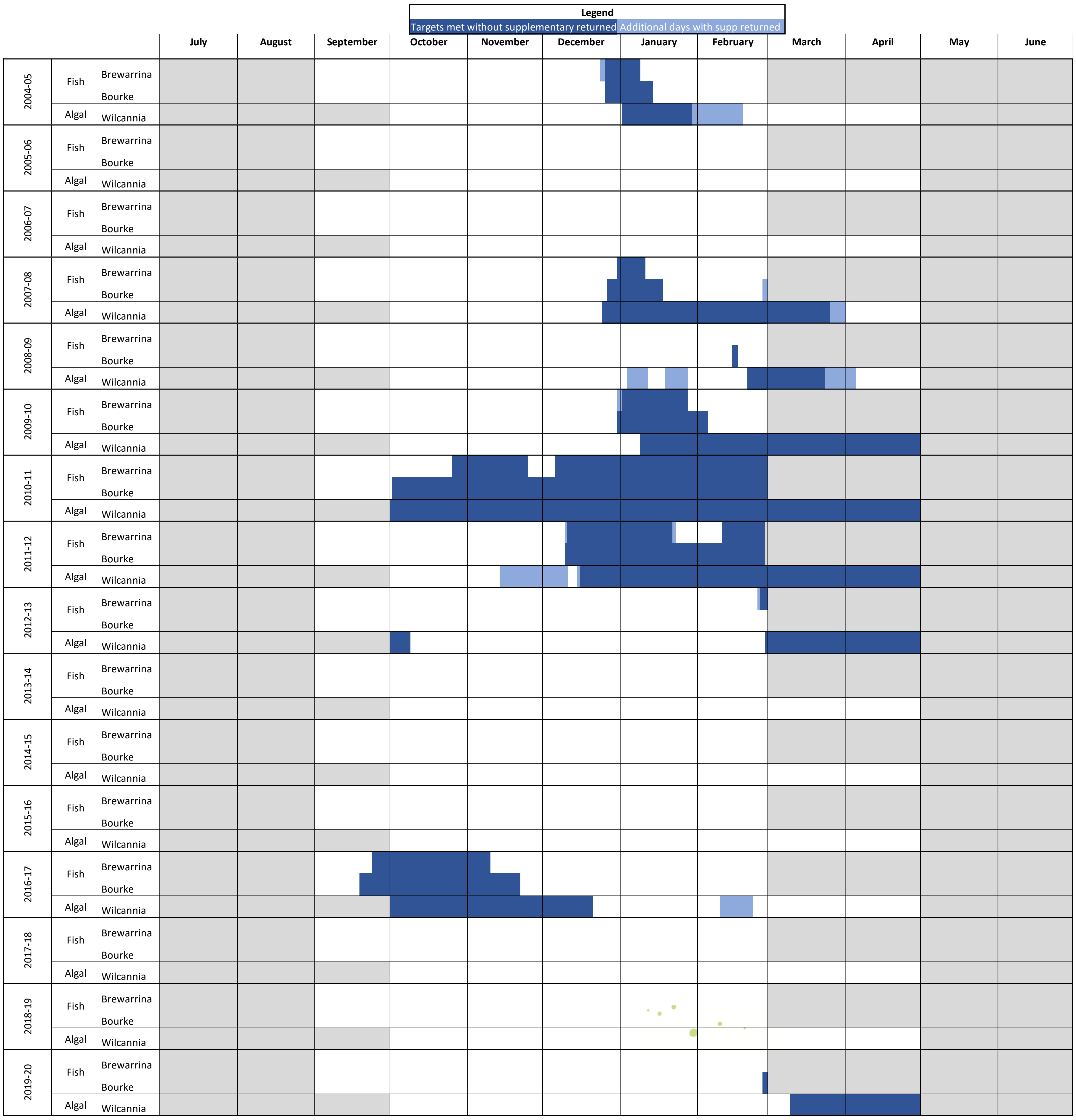
Attachment 5. Comparative analysis for North West Plan flow targets

Comparative analysis for the existing North West Plan riparian targets

Figure 5.1. Comparative analysis for the existing North West Plan riparian targets

Comparative analysis for the North West Plan fish migration and algal suppression targets

Figure 5.2. Comparative analysis for the North West Plan fish migration and algal suppression targets



Attachment 6. Upstream tributary correlation assessment

Table 6.1. Definitions of Table Headings and Format

Term	Definition
Location	Location of critical event in the Barwon-Darling
Date	Date of critical event in the Barwon-Darling
30 Day Total	The sum of flow 30 days prior to a given day, for each tributary location
	For each Barwon-Darling location, the lowest of the 30 day total for each tributary location. If there is more than one tributary upstream, the 30 day total was averaged.
	For each Barwon-Darling location, the highest of the 30 day total for each tributary location. If there is more than one tributary upstream, the 30 day total was averaged.

Table 6.2. Critical event analysis table

Critical Event Analysis						
Location	**Date**	**30 Day Total (ML)**				
		Boggabilla	**Gravesend**	**Boggabri**	**Warren**	**Average**
Brewarrina	29/08/2005	10,199	11,829	9,373	1,109	8,128
Brewarrina	1/09/2005	10,122	10,620	6,809	1,178	7,182
Brewarrina	25/11/2005	8,593	6,489	5,765	39,003	14,963
Brewarrina	16/01/2006	55,824	66,503	29,990	39,843	48,040
Collarenebri	19/01/2006	45,588	73,277	-	-	59,432
Collarenebri	21/01/2006	43,892	81,767	-	-	62,829
Walgett	24/01/2006	50,910	108,954	59,777	-	73,214
Walgett	20/02/2006	63,197	108,705	76,214	-	82,705
Collarenebri	31/01/2008	75,521	21,913	-	-	48,717
Brewarrina	19/11/2008	5,276	12,749	4,194	6,164	7,096
Brewarrina	2/06/2013	12,831	4,716	1,463	4,745	5,939
Walgett	17/06/2013	8,646	5,020	1,831	-	5,166
Walgett	1/12/2013	4,859	57,798	50,059	-	37,572
Walgett	25/03/2014	14,552	28,890	27,032	-	23,491
Mungindi	5/02/2015	32,481	-	-	-	32,481
Collarenebri	21/06/2015	23,246	2,579	-	-	12,913
Walgett	7/01/2016	10,577	30,097	43	-	13,572
Brewarrina	23/01/2016	37,005	40,029	5,245	12,308	23,647
Mungindi	1/02/2016	50,369	-	-	-	50,369
Mungindi	12/02/2016	54,957	-	-	-	54,957
Collarenebri	3/07/2017	20,900	6,704	-	-	13,802
Mungindi	9/07/2017	22,369	-	-	-	22,369
Walgett	17/10/2017	4,327	25,525	17,678	-	15,844

Attachment 7. Flow durations

Exceedance likelihood at Mungindi

Note: Where applicable, in the graphs below ‘updated target’ refers to the recommended revised targets from the main report.

Figure 7.1.1. *Exceedance likelihood at Mungindi*

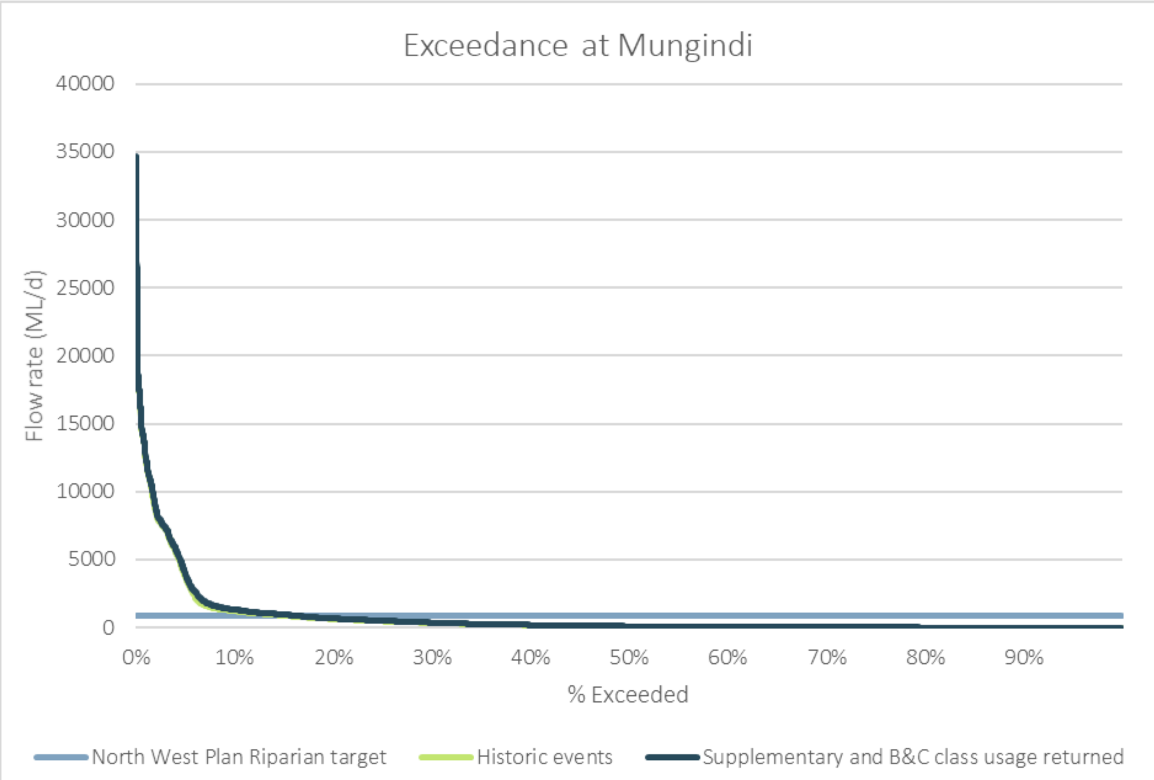
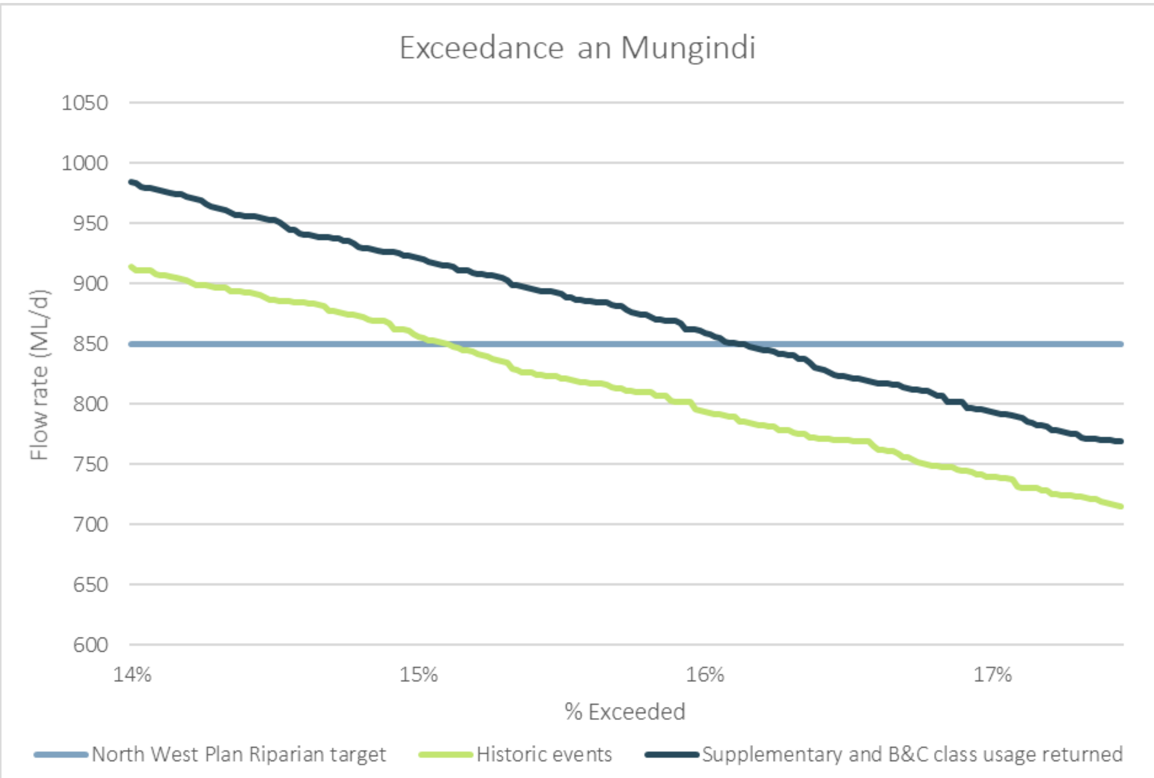


Figure 7.1.2. *Exceedance likelihood at Mungindi*



Exceedance likelihood at Collarenebri

Figure 7.2.1. *Exceedance likelihood at Collarenebri*

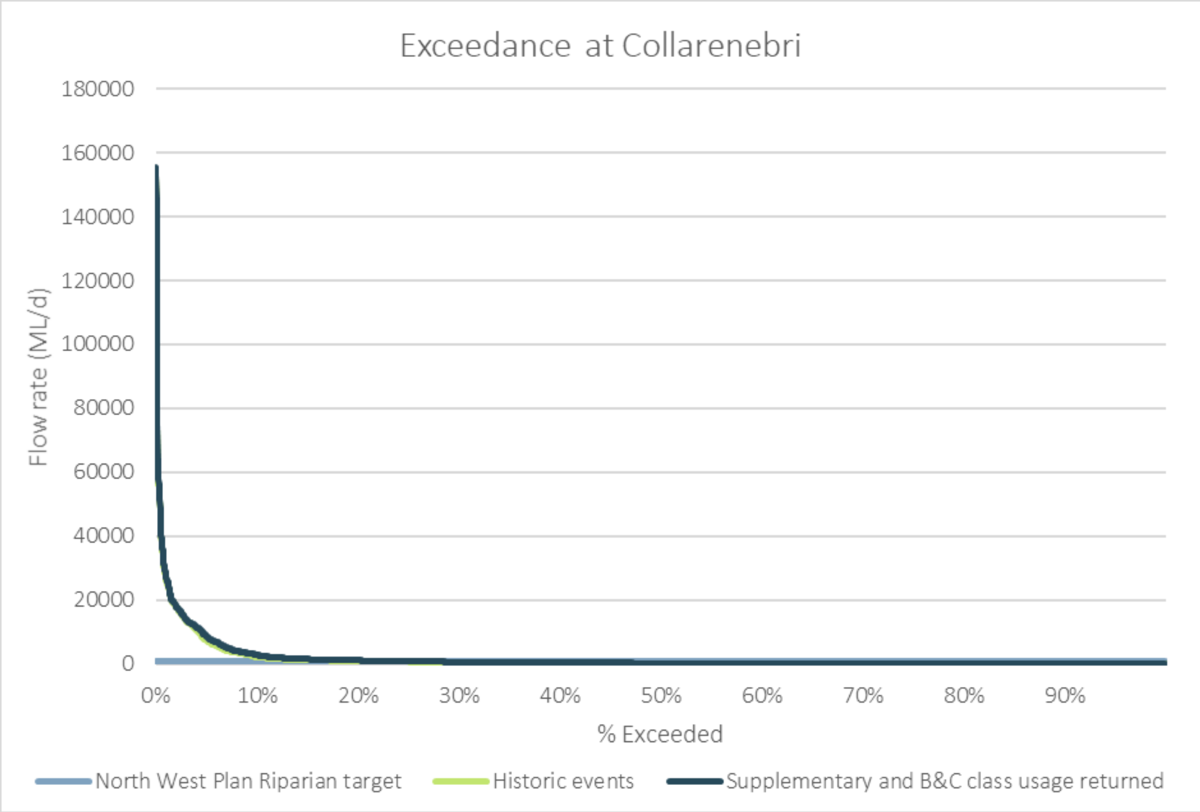
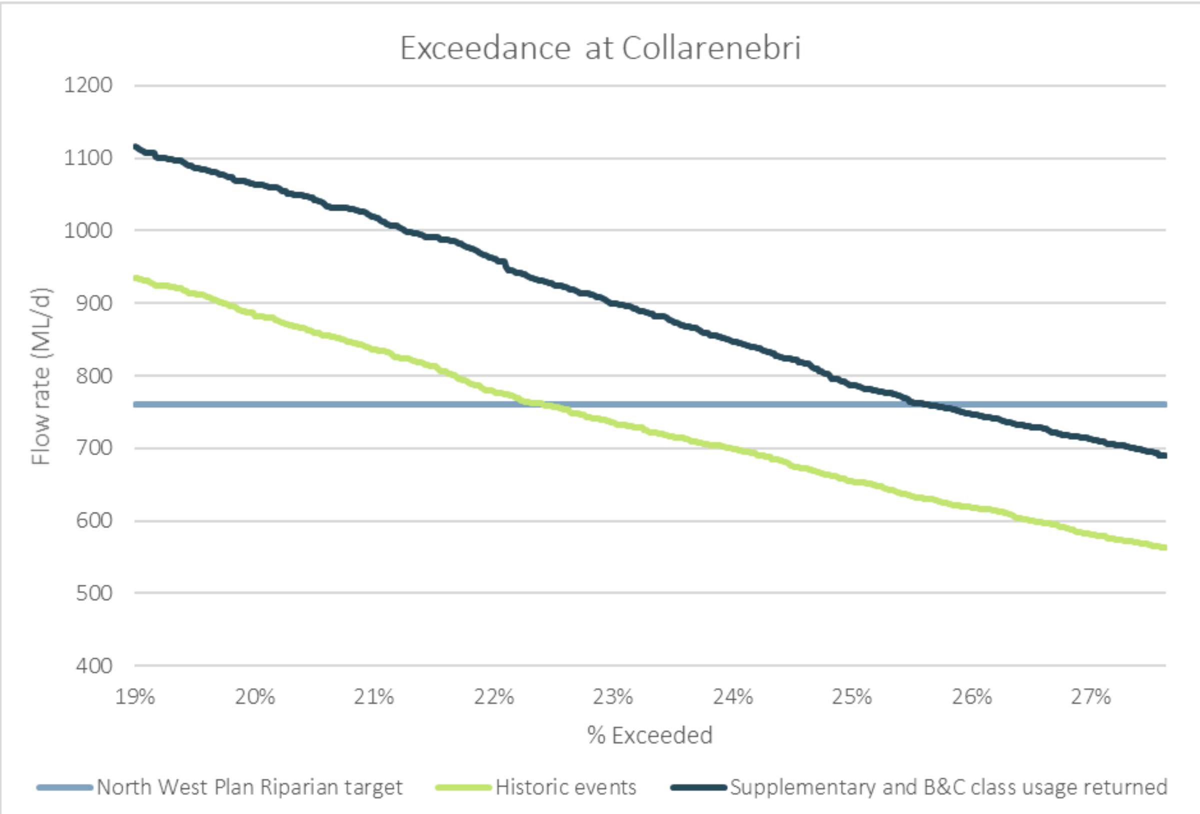


Figure 7.2.2. *Exceedance likelihood at Collarenebri*



Exceedance likelihood at Walgett

Figure 7.3.1. *Exceedance likelihood at Walgett*

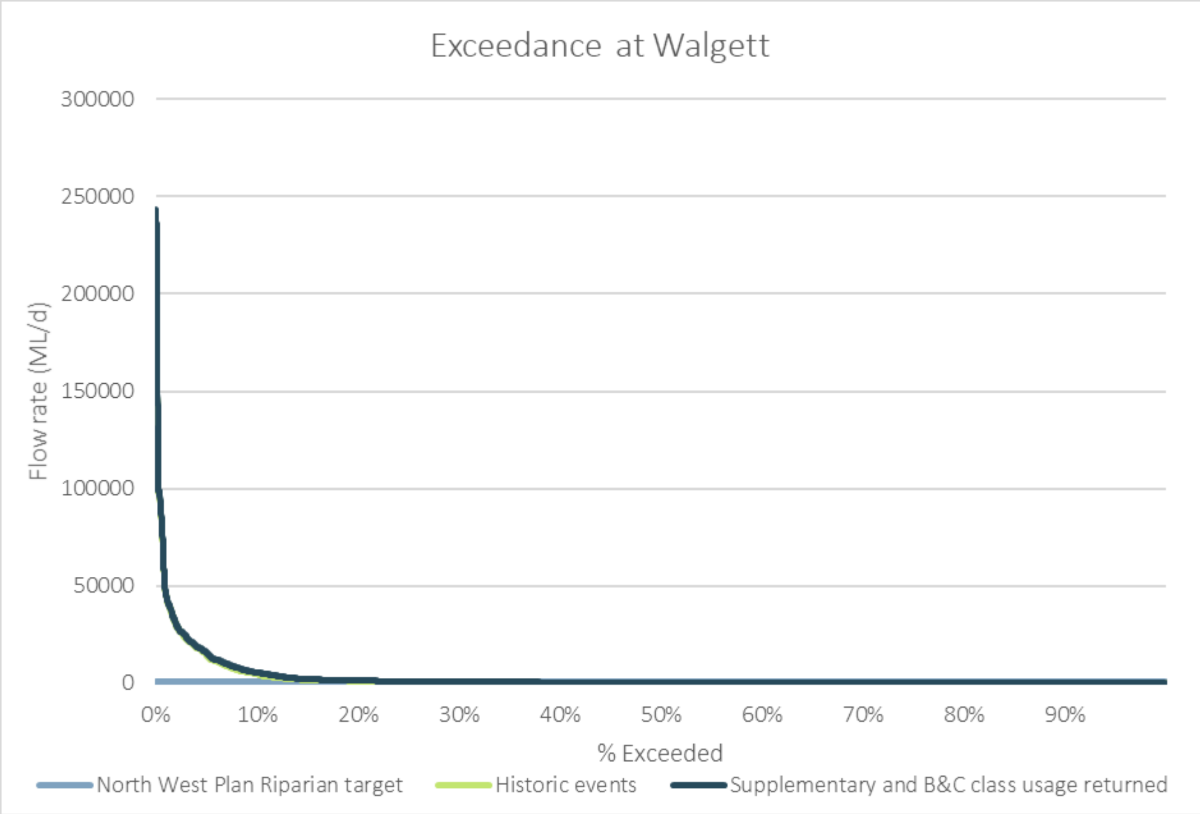
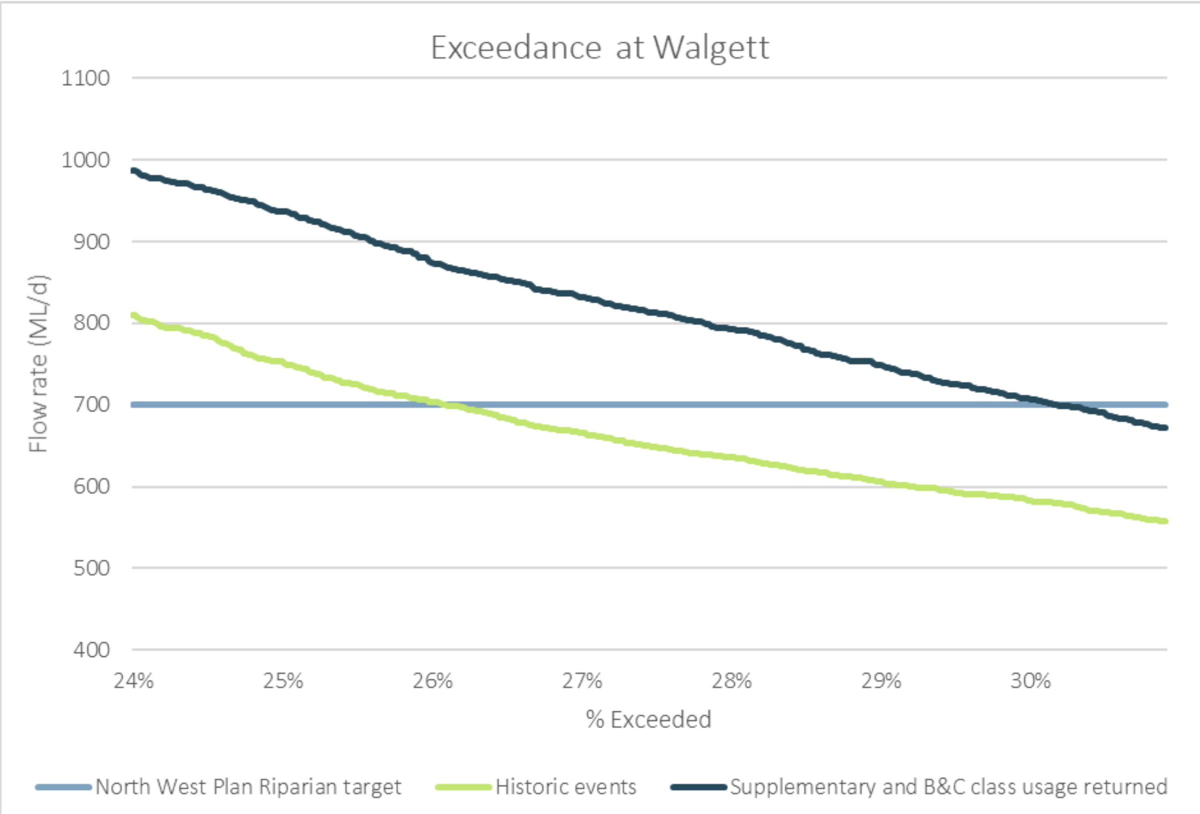


Figure 7.3.2. *Exceedance likelihood at Walgett*



Exceedance likelihood at Brewarrina

Figure 7.4.1. *Exceedance likelihood at Brewarrina*

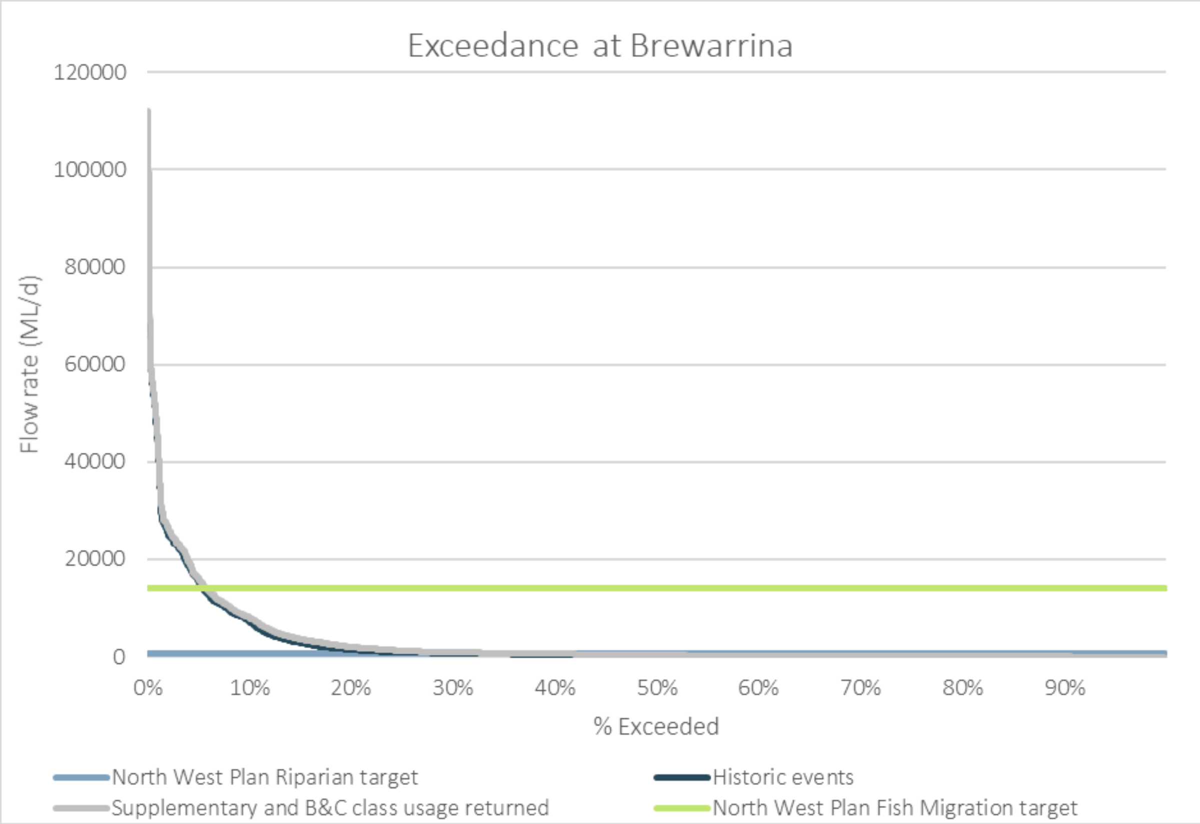
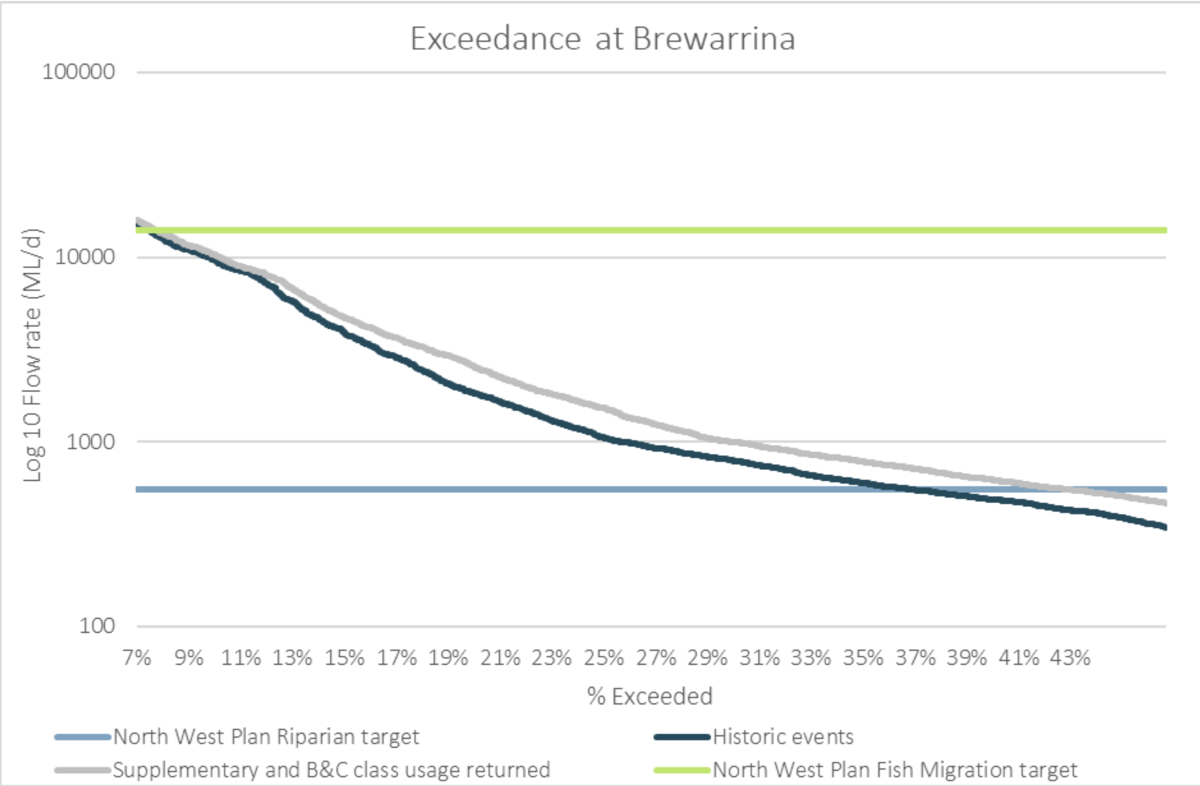


Figure 7.4.2. *Exceedance likelihood at Brewarrina*



Exceedance likelihood at Bourke

Figure 7.5.1. *Exceedance likelihood at Bourke*

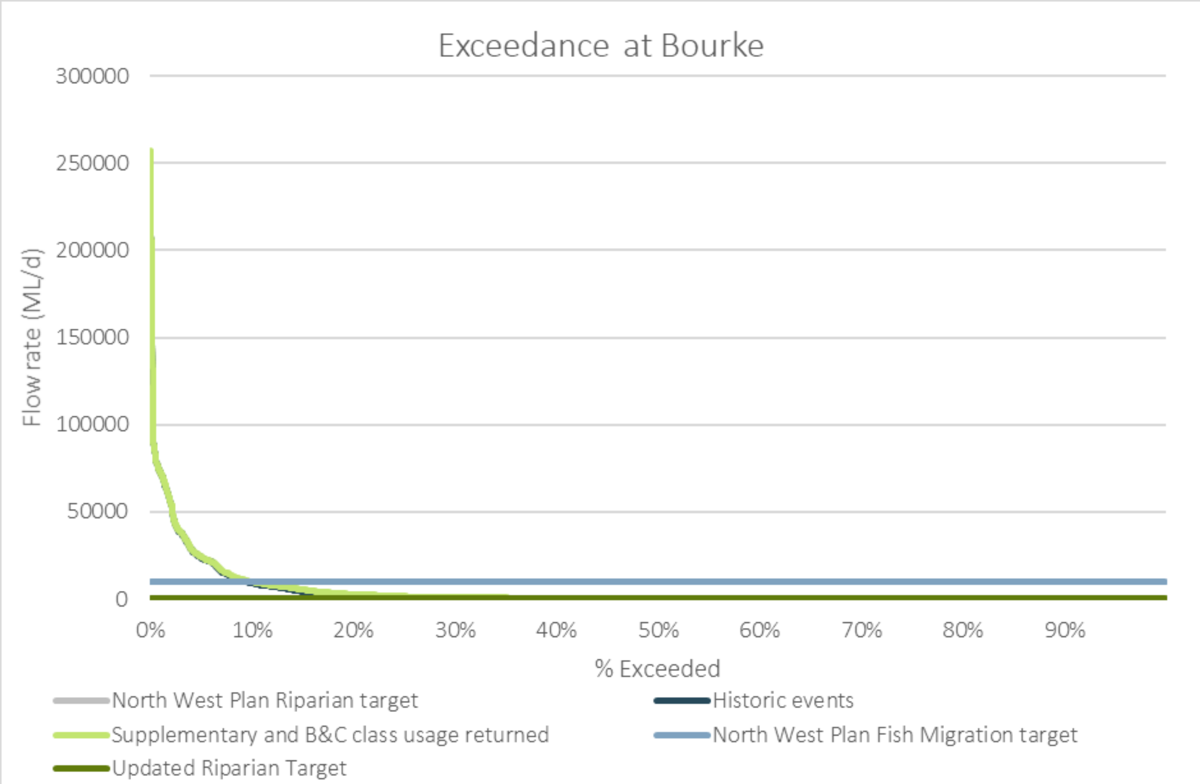
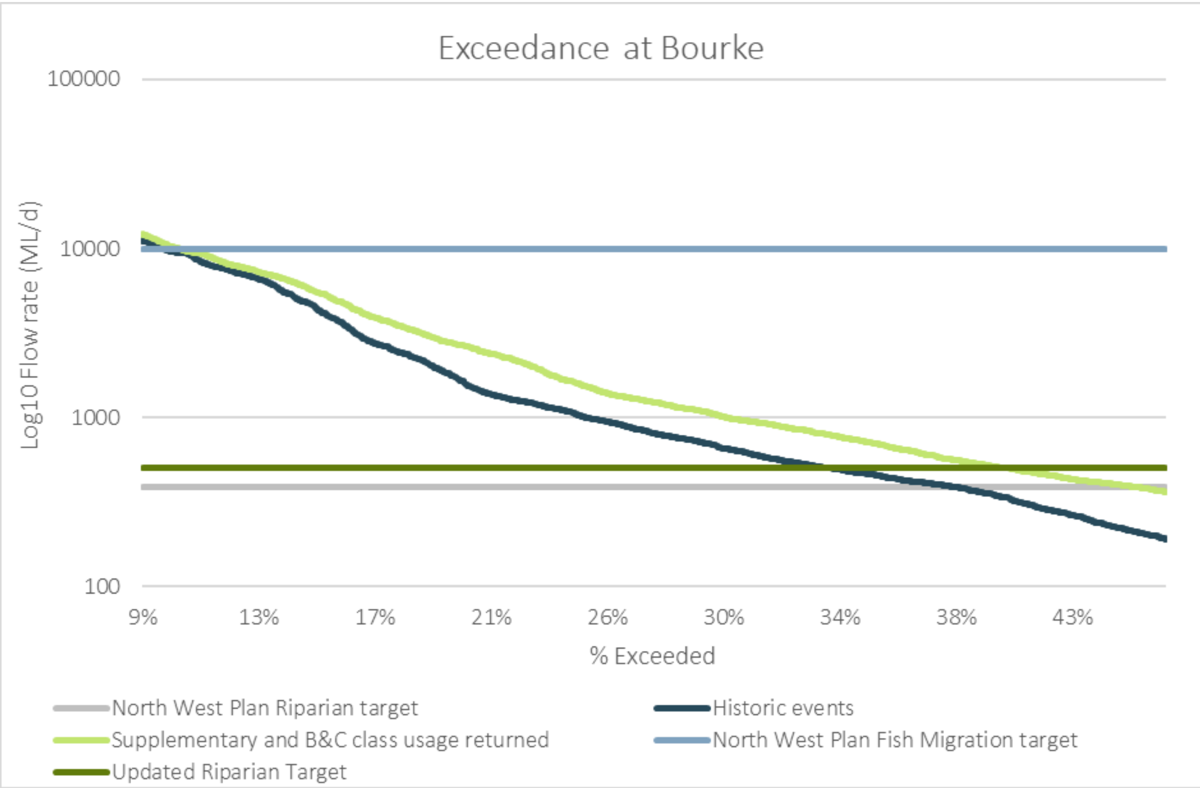


Figure 7.5.2. *Exceedance likelihood at Bourke*



Exceedance likelihood at Louth

Figure 7.6.1. *Exceedance likelihood at Louth*

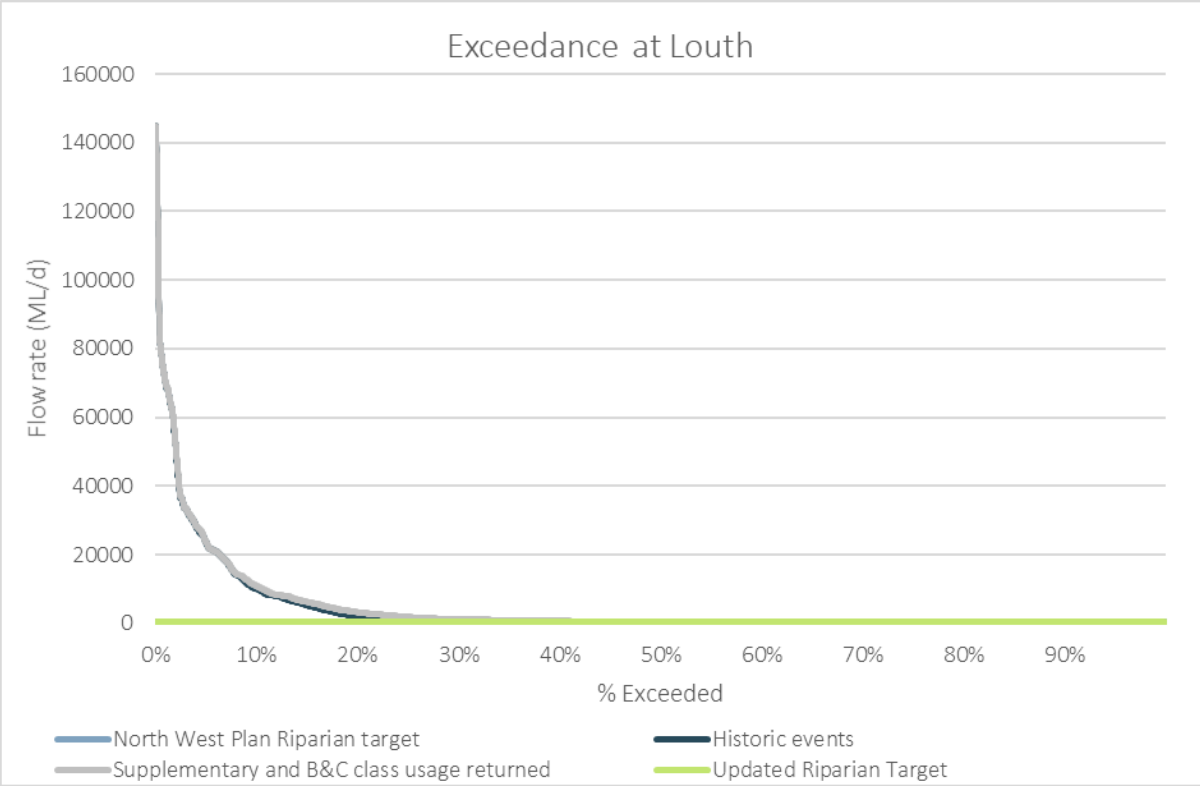
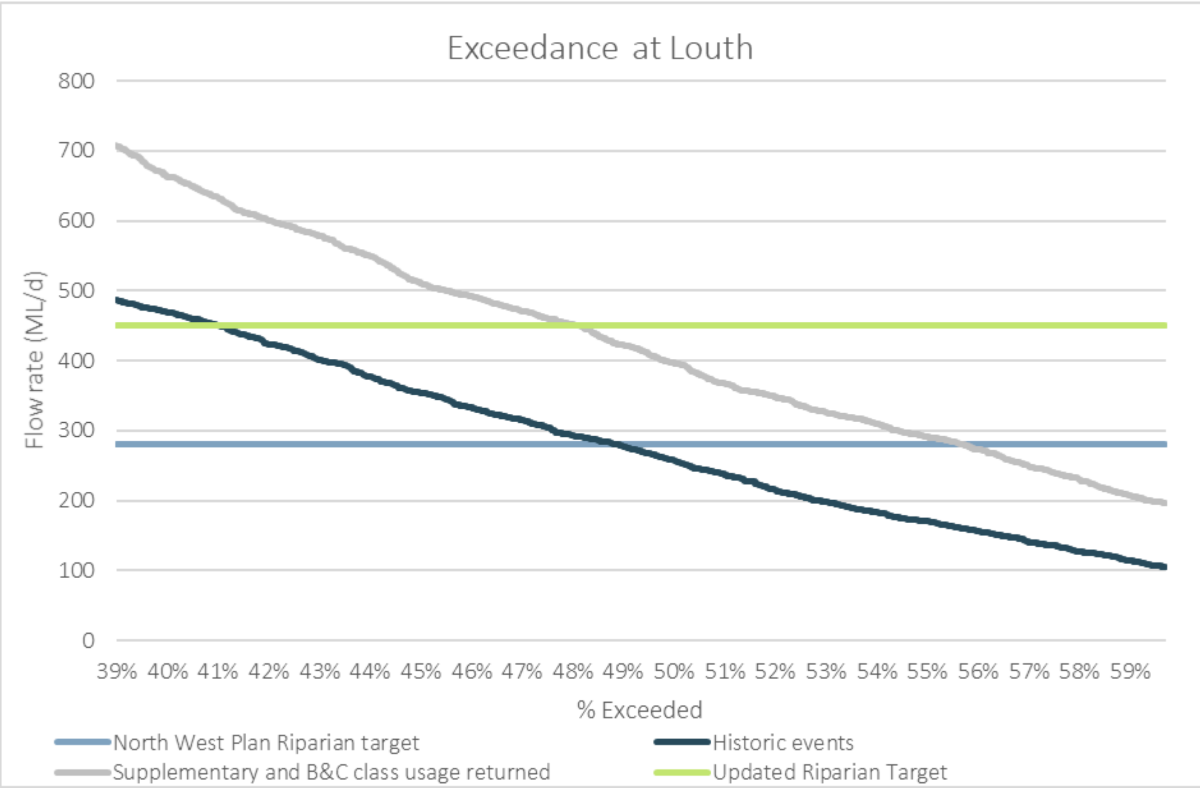


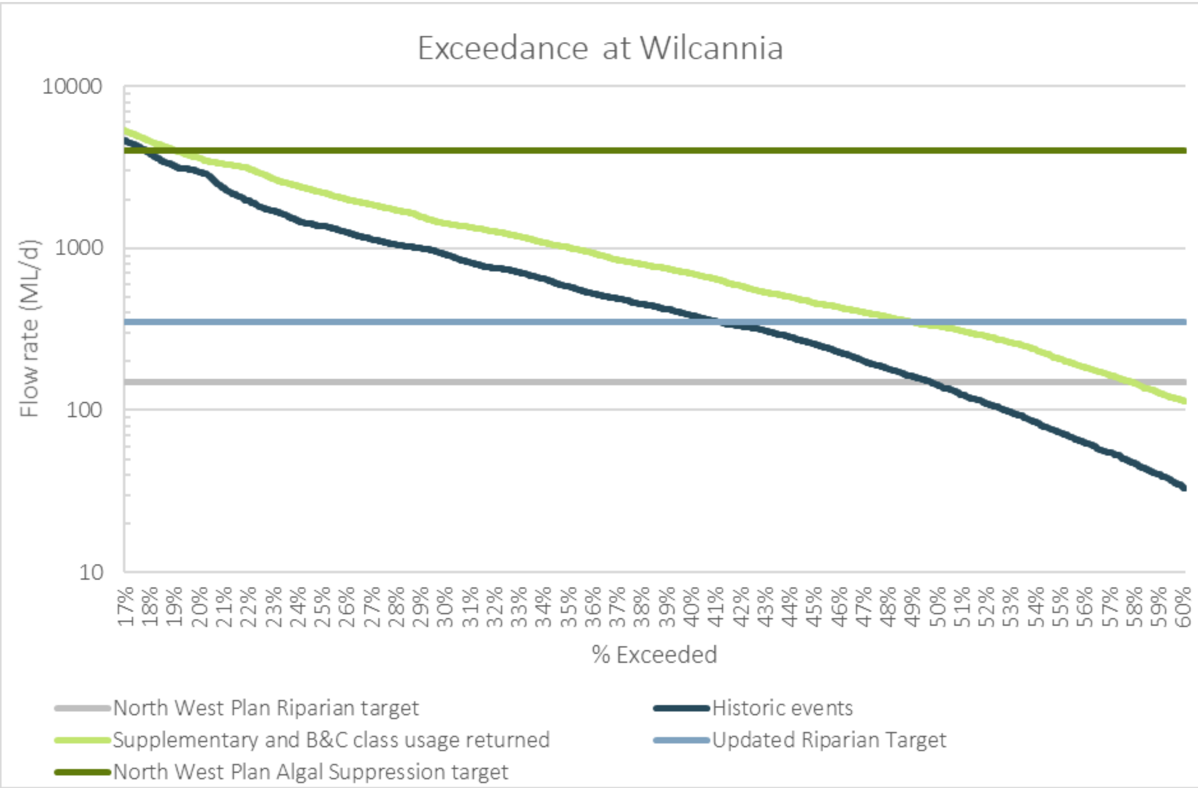
Figure 7.6.2. *Exceedance likelihood at Louth*



Exceedance likelihood at Wilcannia

Figure 7.7.1. *Exceedance likelihood at Wilcannia*

Figure 7.7.2. *Exceedance likelihood at Wilcannia*



Attachment 8. Analysis of events with supplementary returned

Riparian target Events

Event 1 – November and December 2005

Figure 8.1.1. *Mungindi Riparian Target Event 1*

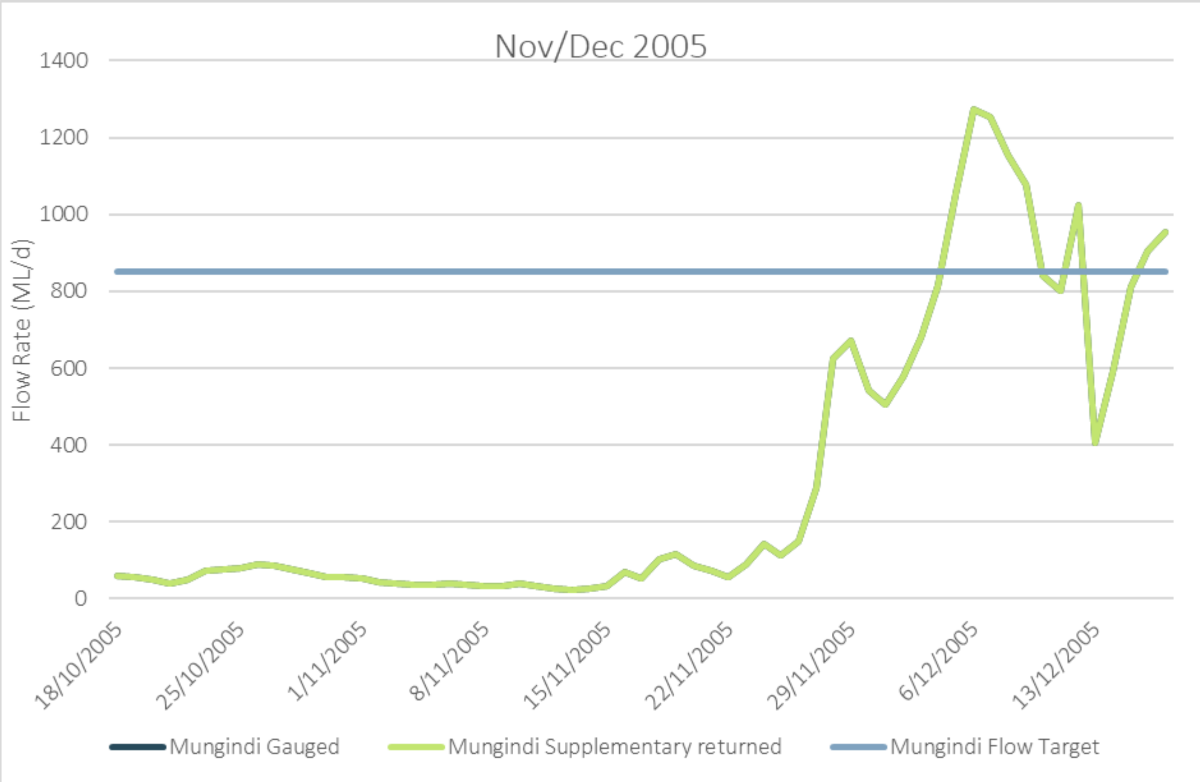


Figure 8.1.2. *Collarenebri Riparian Target Event 1*

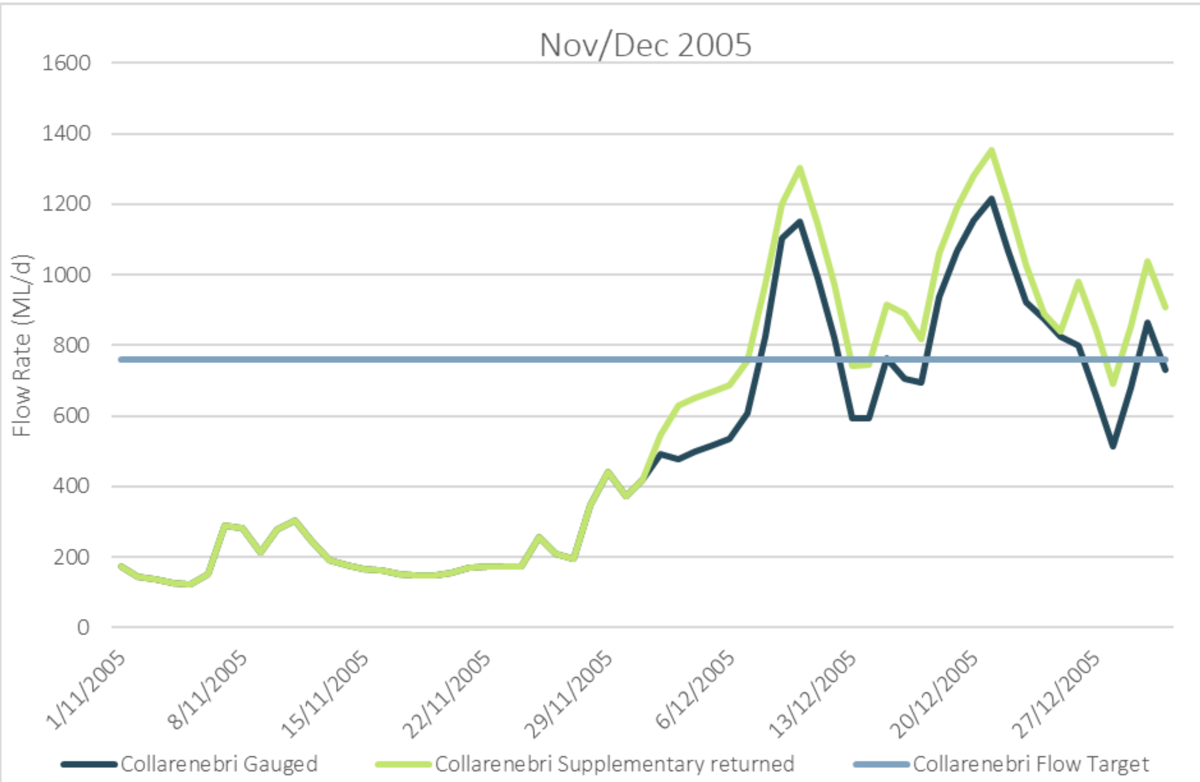


Figure 8.1.3. *Walgett Riparian Target Event 1*

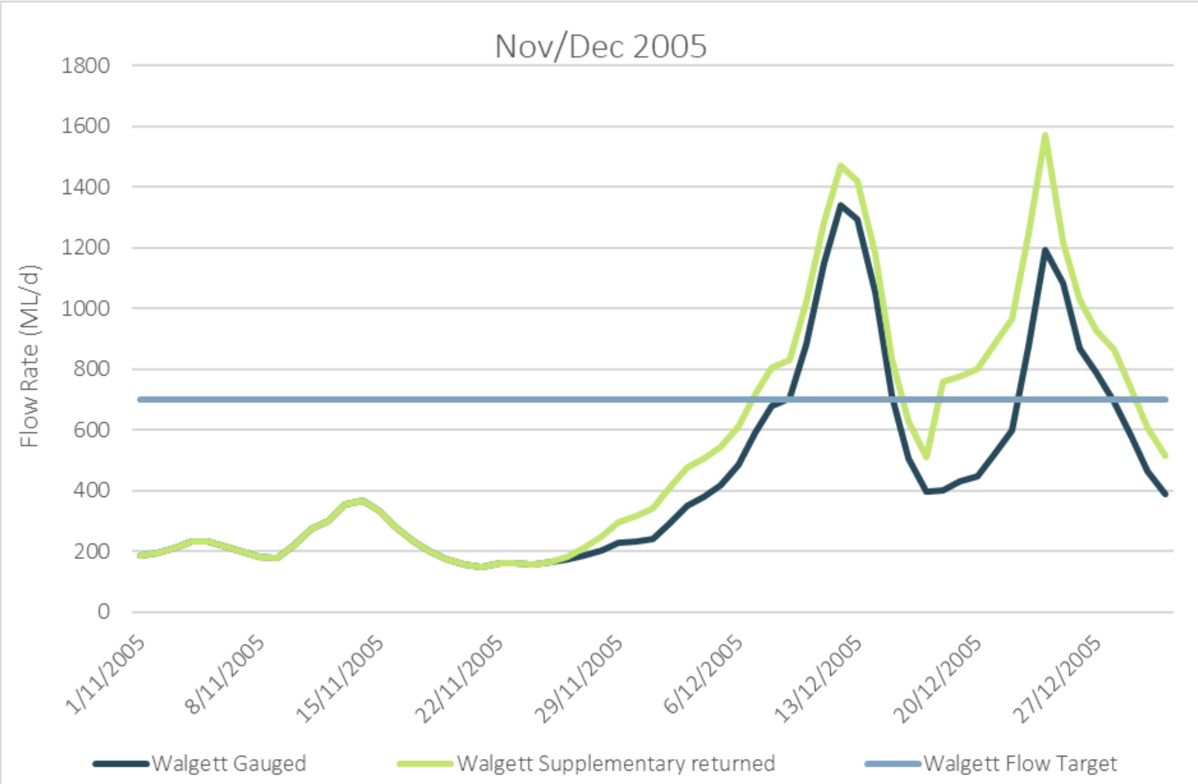


Figure 8.1.4. *Brewarrina Riparian Target Event 1*

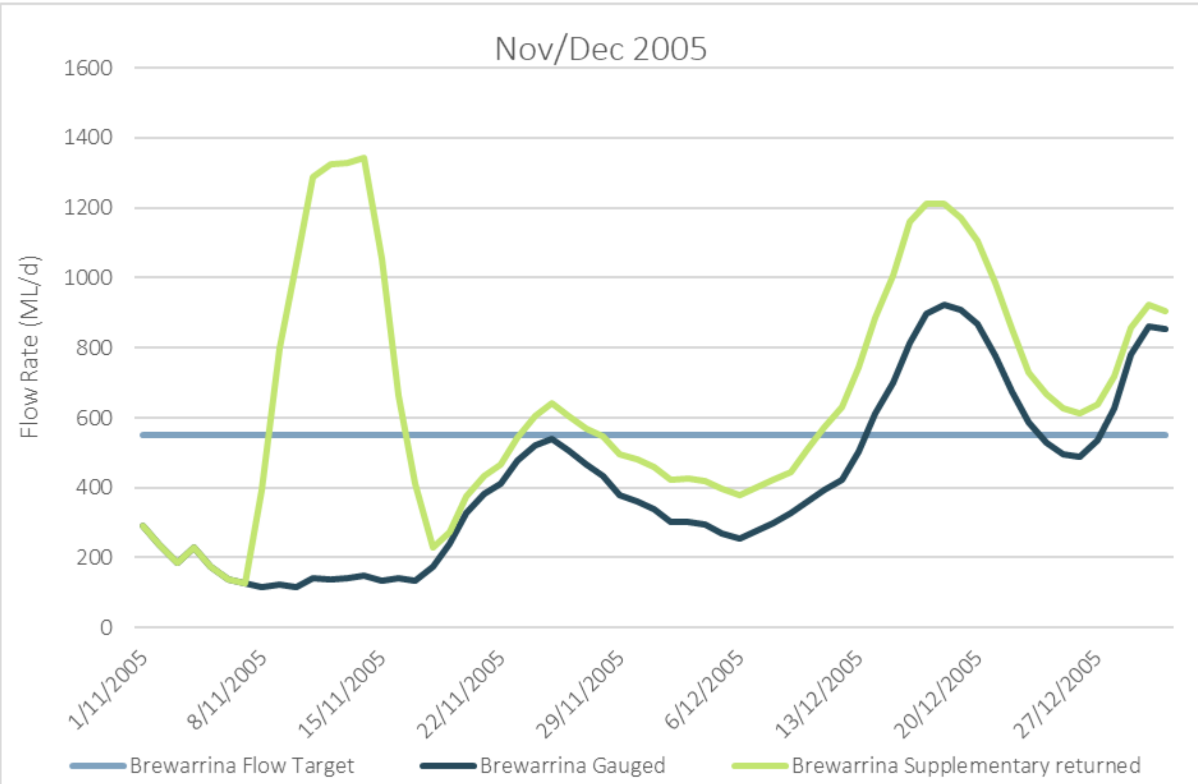


Figure 8.1.5. *Bourke Riparian Target Event 1*

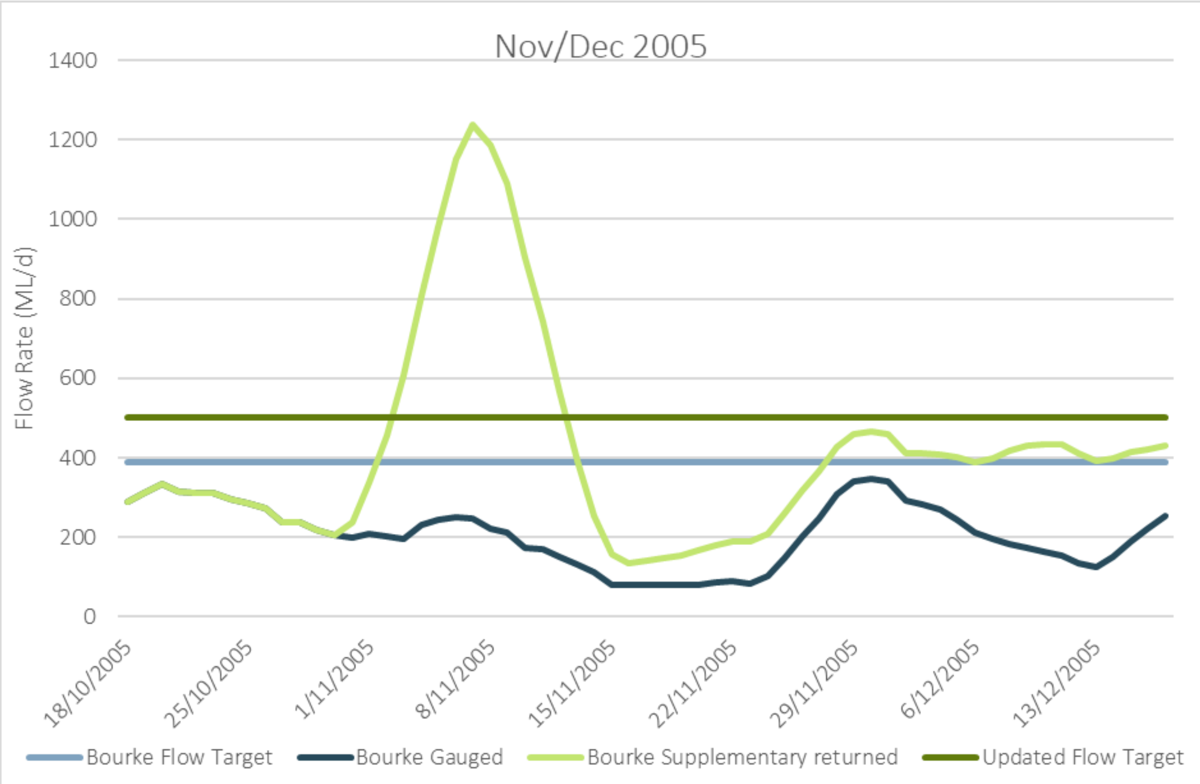


Figure 8.1.6. *Louth Riparian Target Event 1*

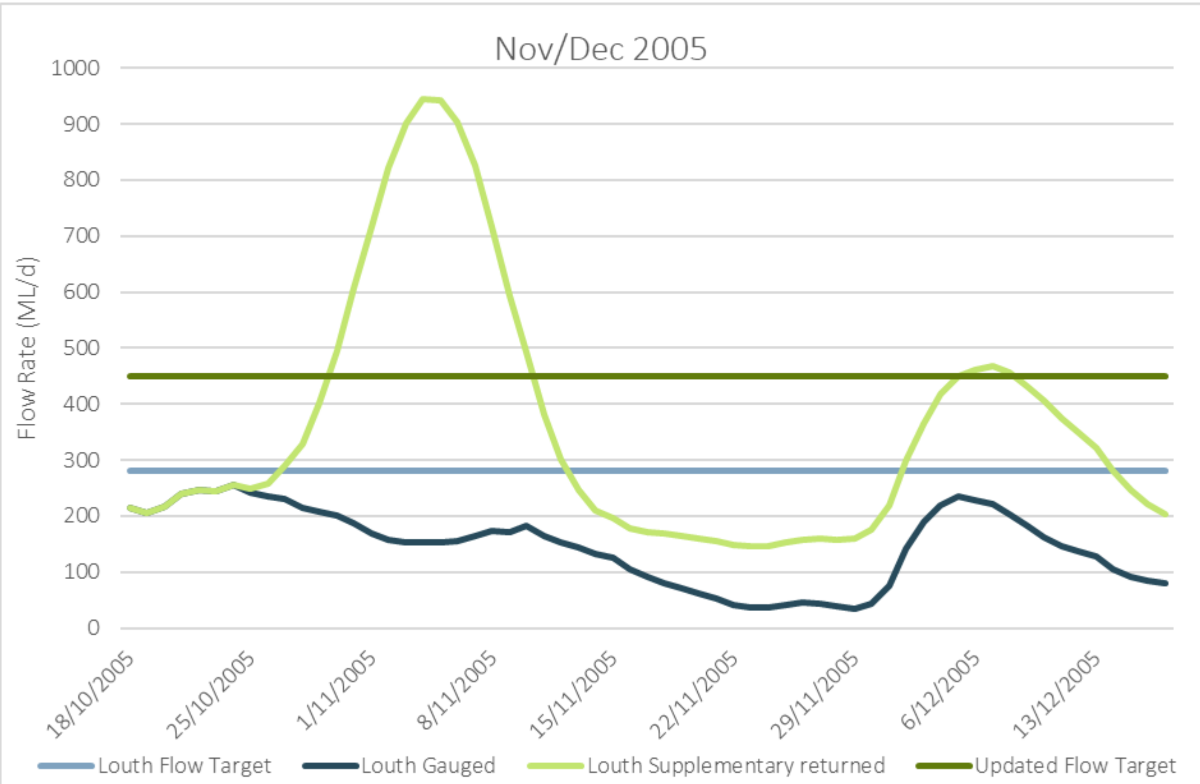
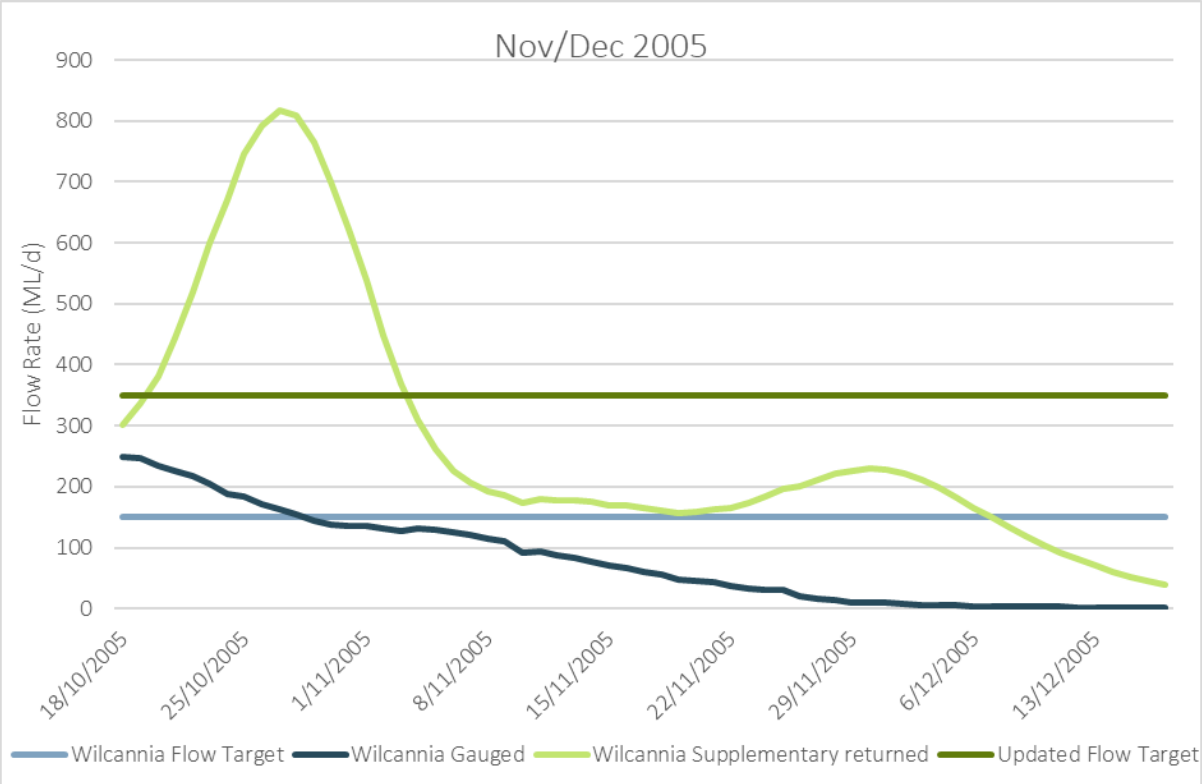


Figure 8.1.7. *Wilcannia Riparian Target Event 1*



Flow Event 2 – March 2017

Figure 8.2.1. *Mungindi Riparian Target Event 2*

Figure 8.2.2. *Collarenebri Riparian Target Event 2*

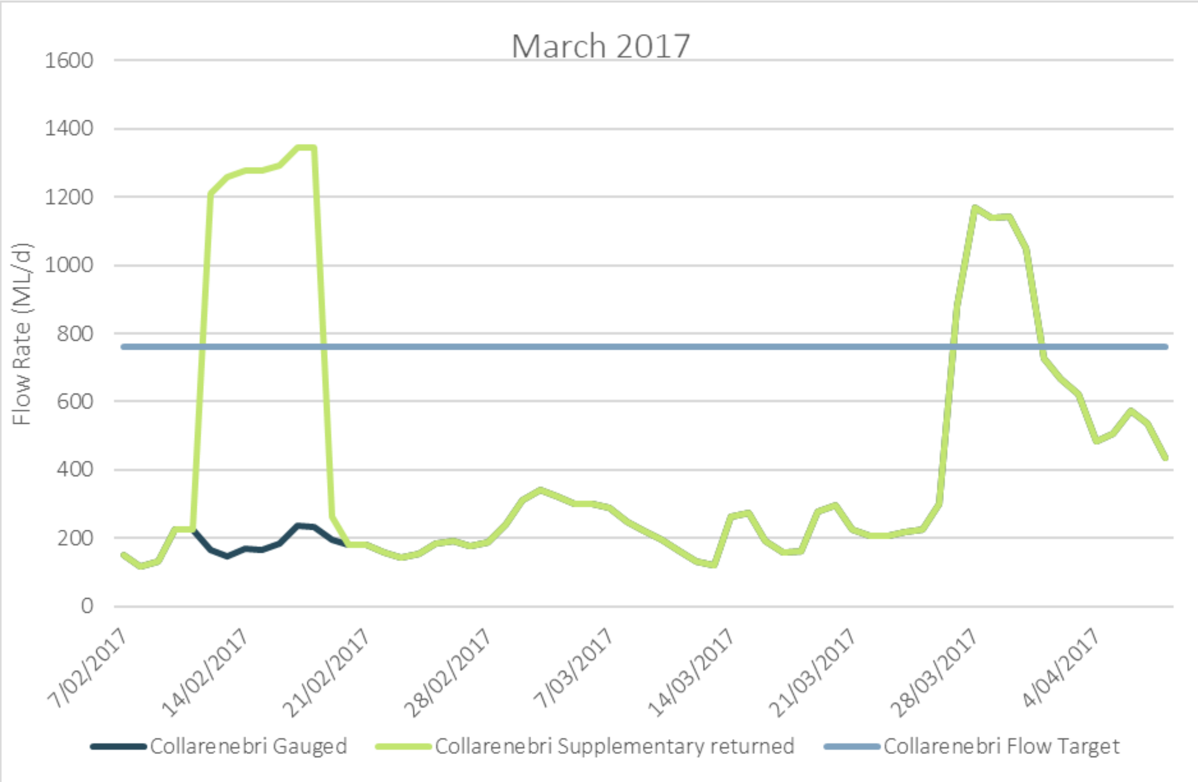


Figure 8.2.3. *Walgett Riparian Target Event 2*

Figure 8.2.4. *Brewarrina Riparian Target Event 2*

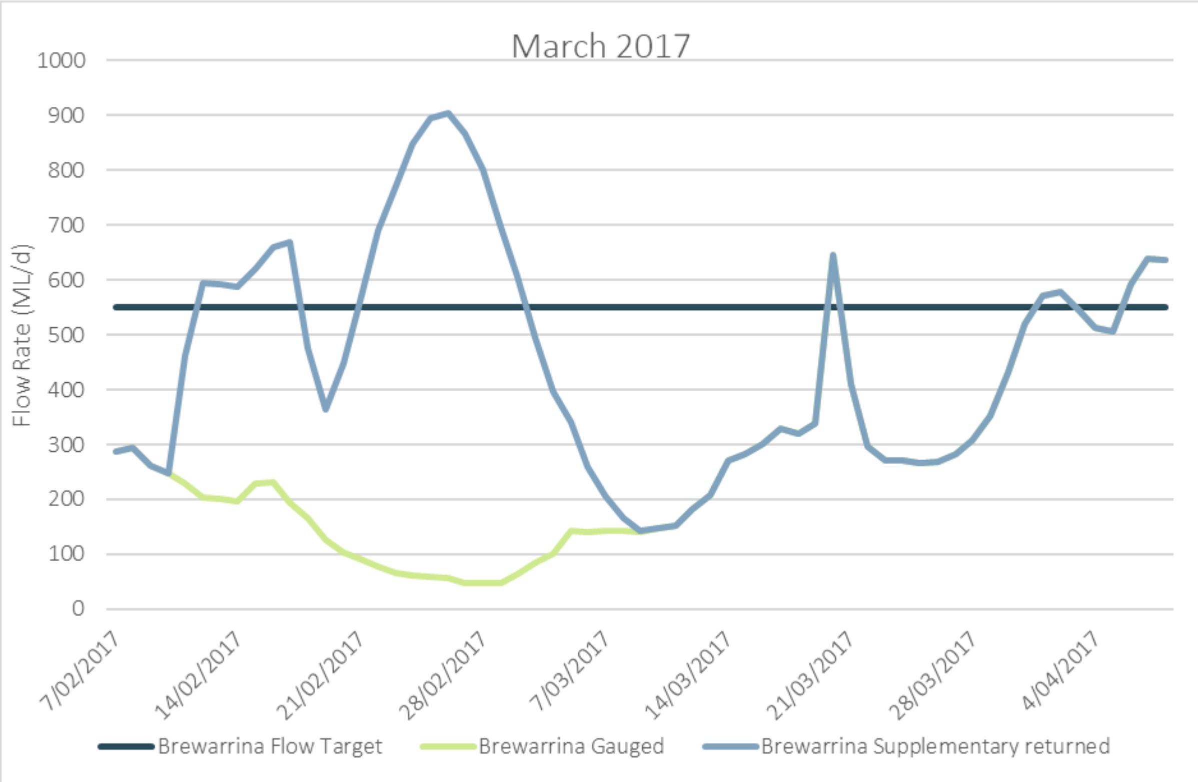


Figure 8.2.5. *Bourke Riparian Target Event 2*

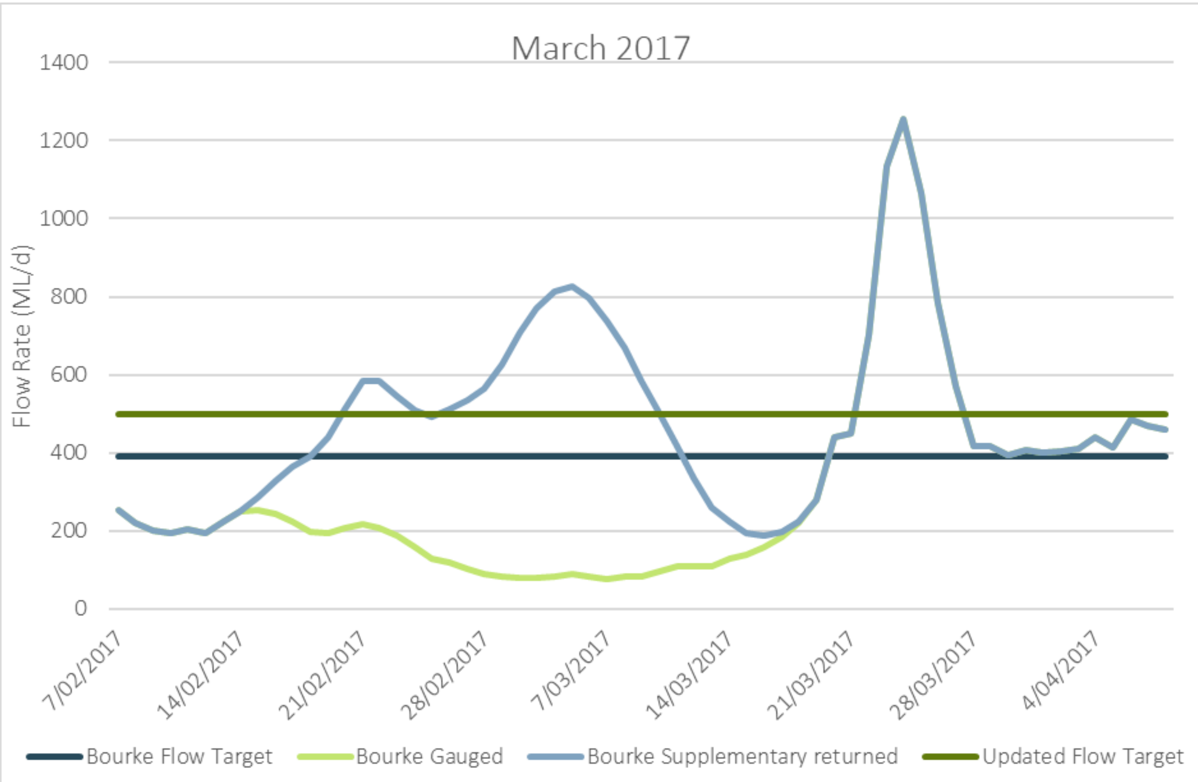


Figure 8.2.6. *Louth Riparian Target Event 2*

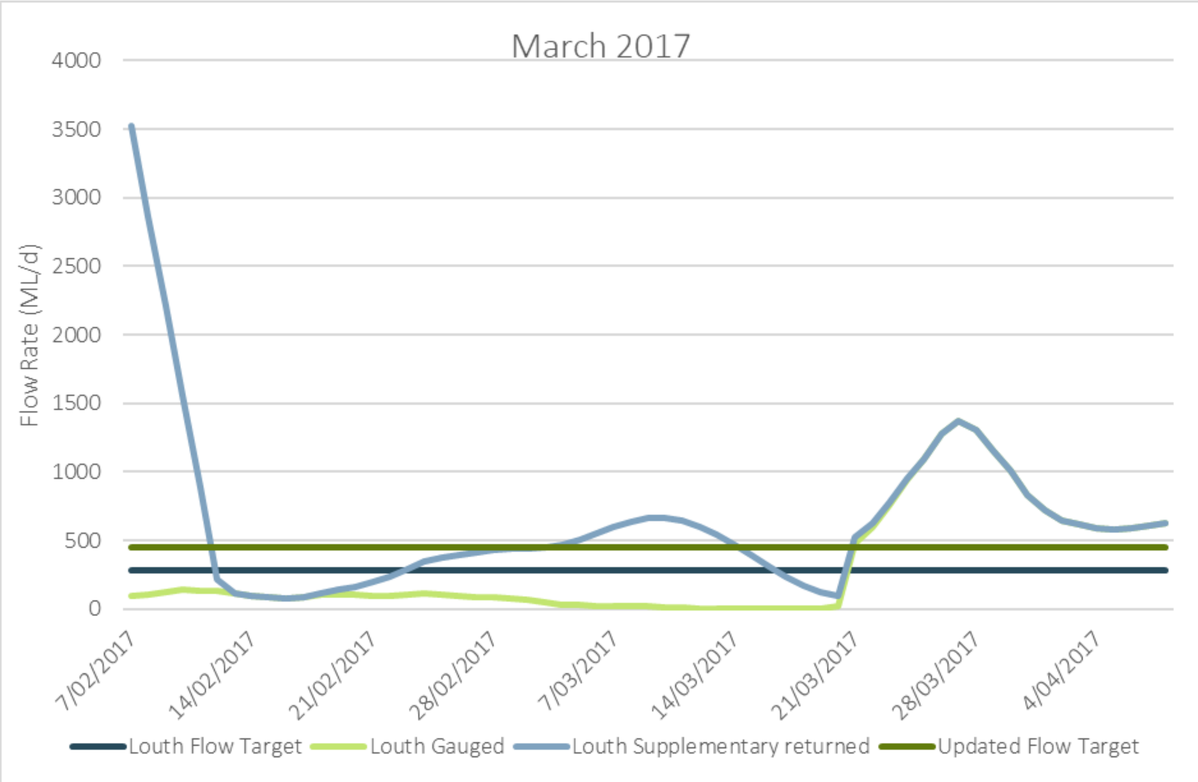
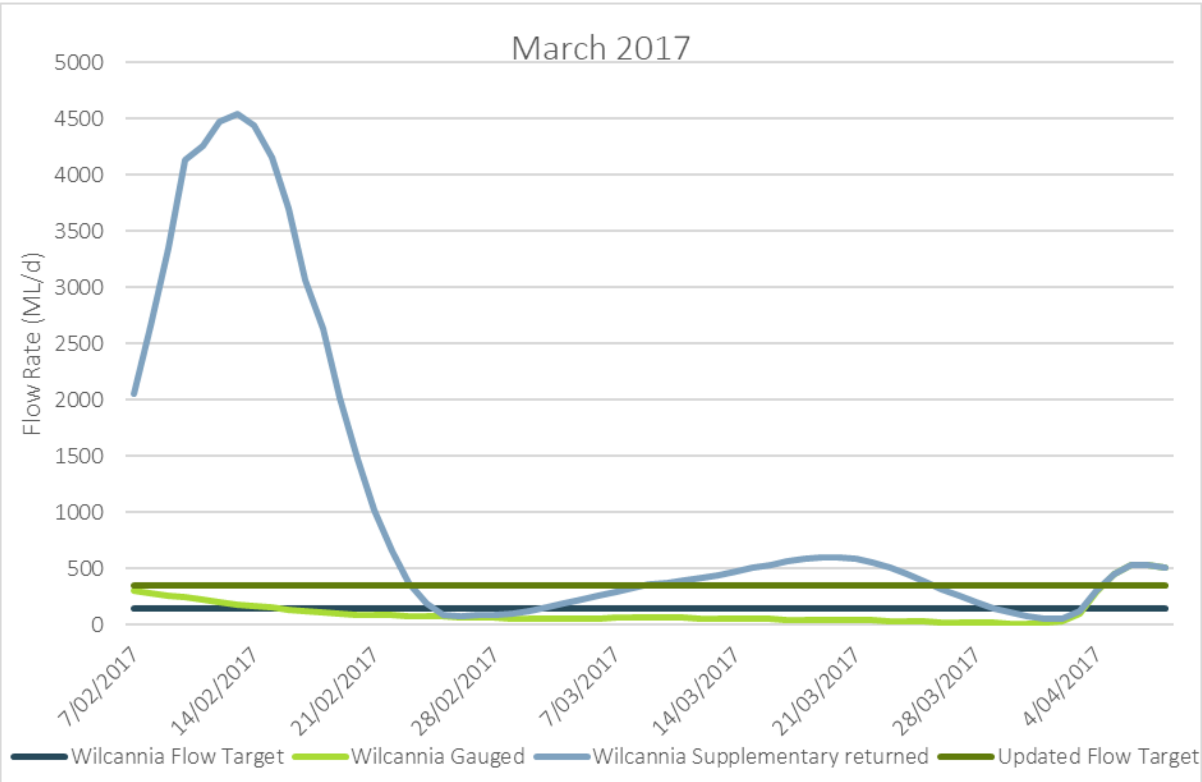


Figure 8.2.7. *Wilcannia Riparian Target Event 2*



Flow Event 3 –October to November 2017

Figure 8.3.1. *Mungindi Riparian Target Event 3*

Figure 8.3.2. *Collarenebri Riparian Target Event 3*

Figure 8.3.3. *Walgett Riparian Target Event 3*

Figure 8.3.4. *Brewarrina Riparian Target Event 3*

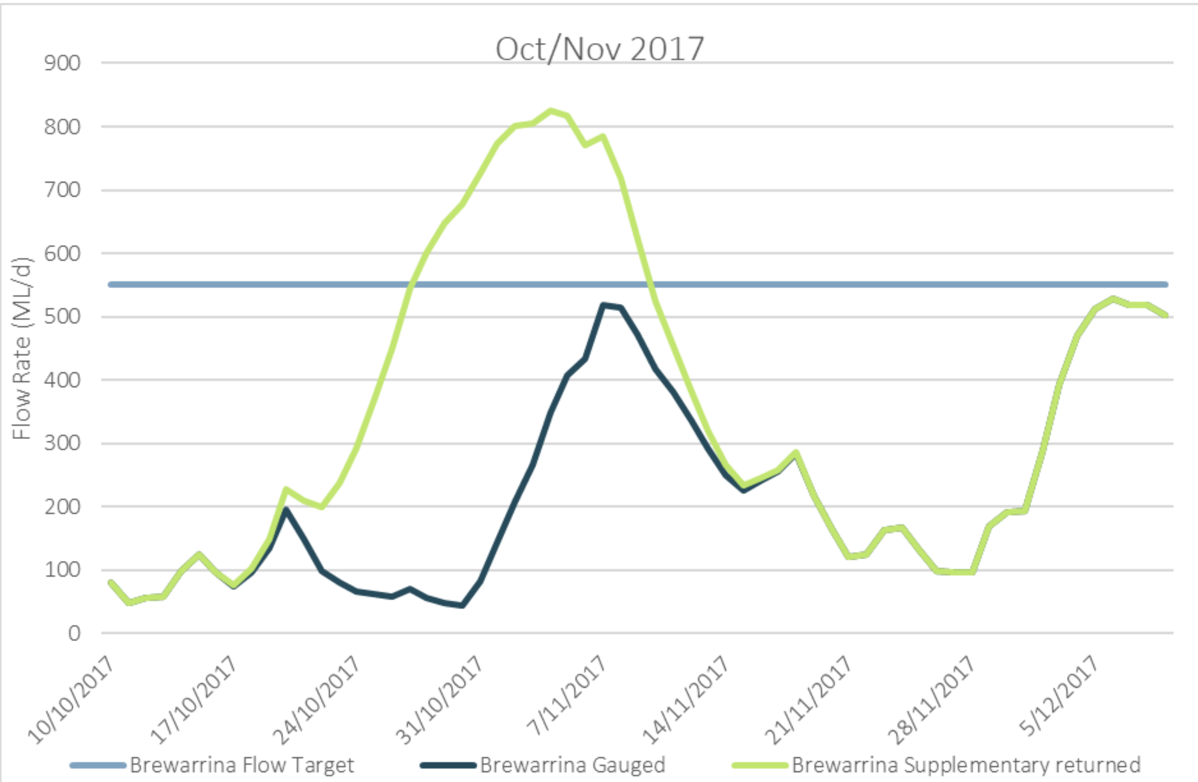


Figure 8.3.5. *Bourke Riparian Target Event 3*

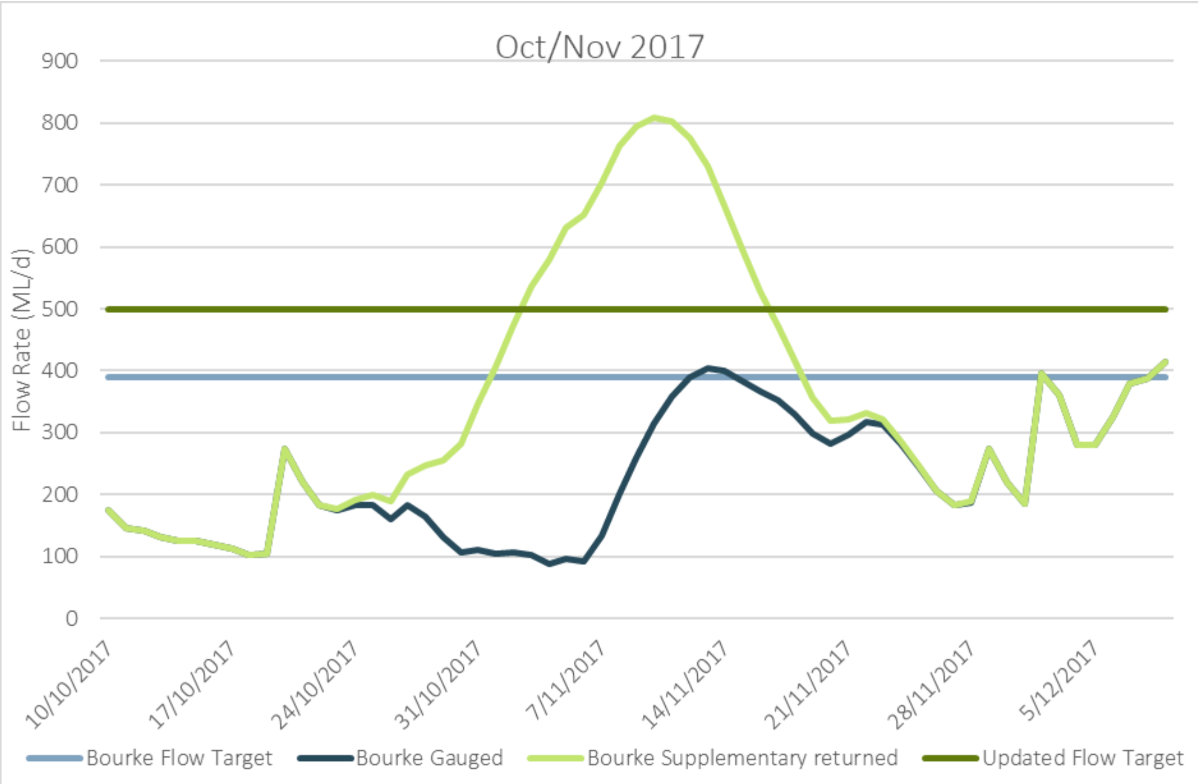


Figure 8.3.6. *Louth Riparian Target Event 3*

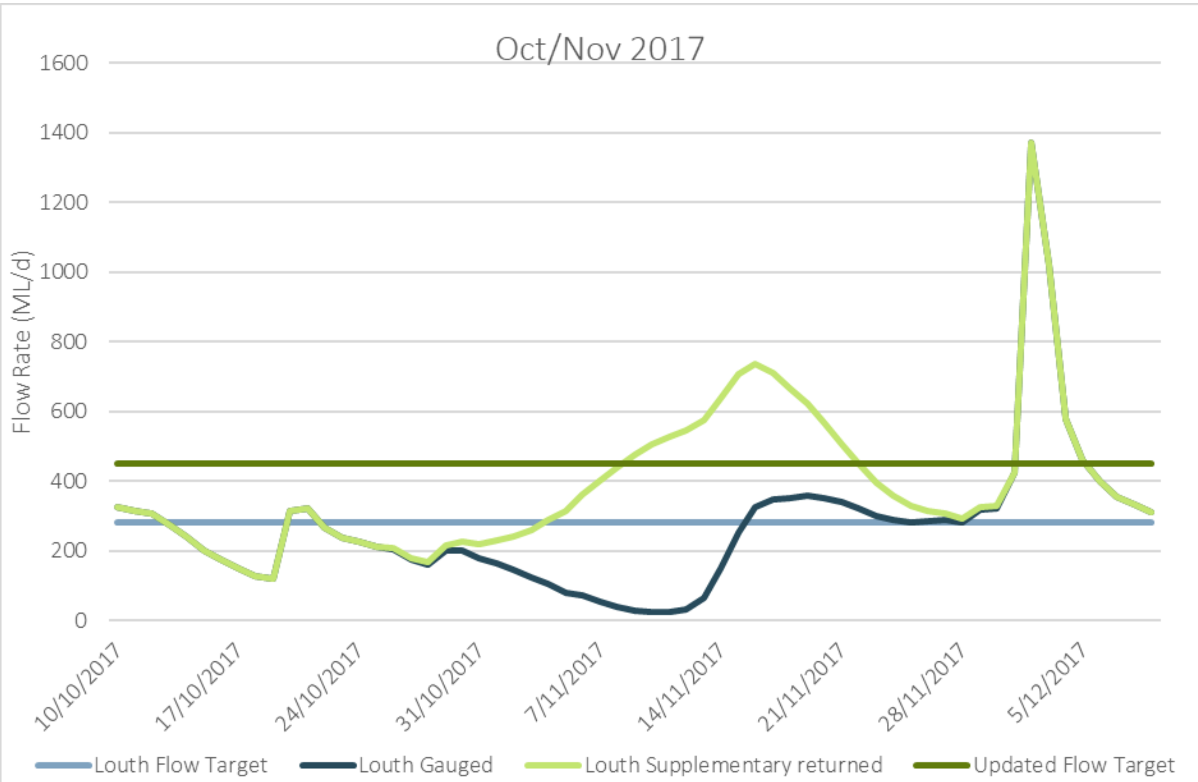
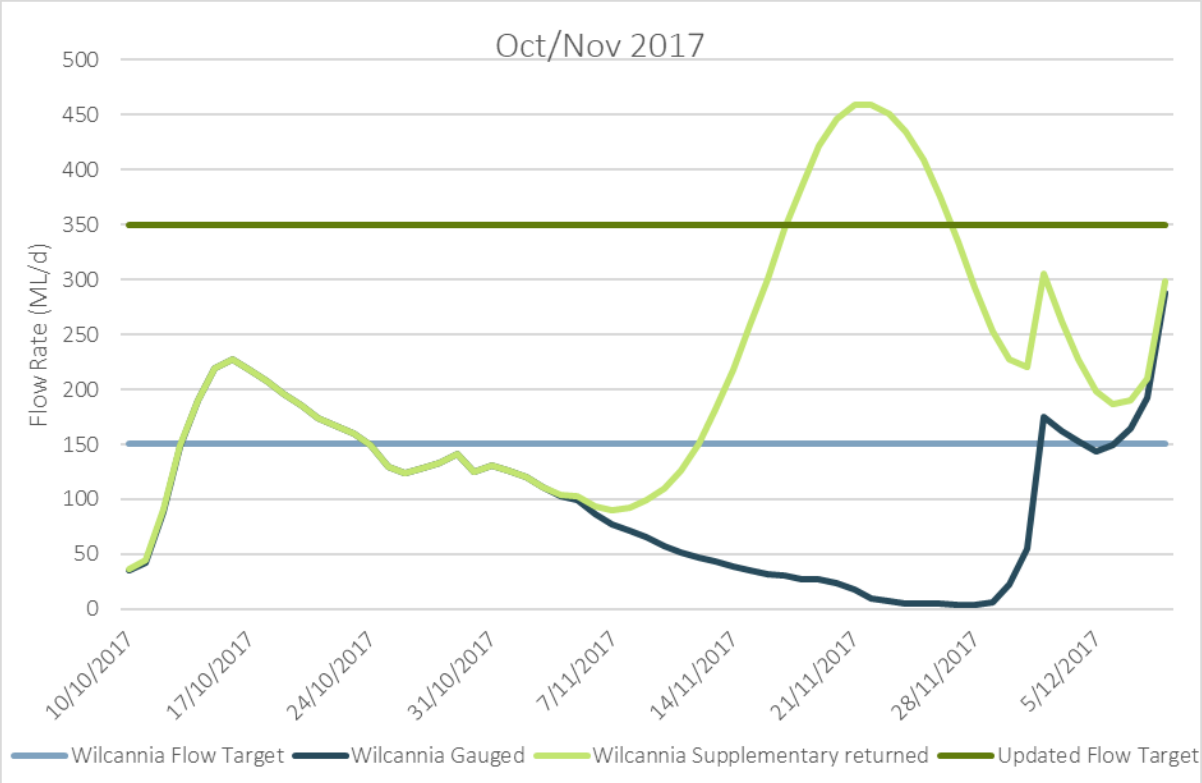


Figure 8.3.7. *Wilcannia Riparian Target Event 3*



Flow Event 4 – July 2018

Figure 8.4.1. *Mungindi Riparian Target Event 4*

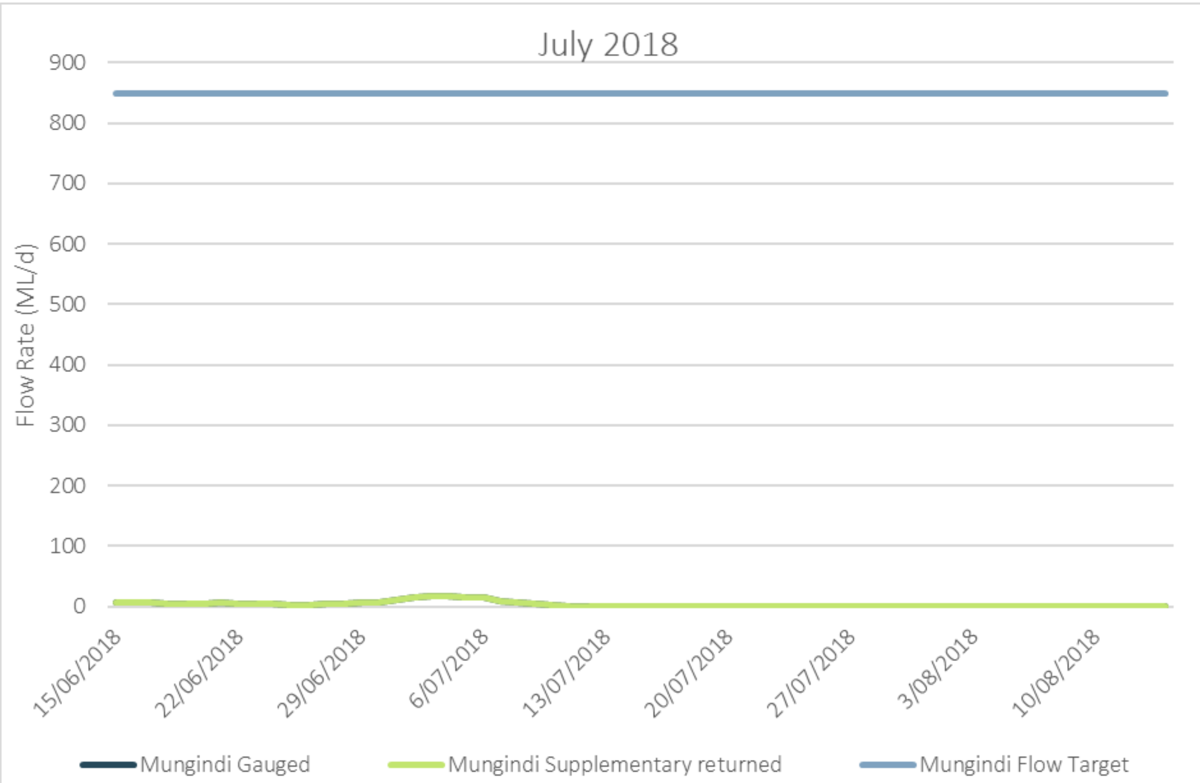


Figure 8.4.2. *Collarenebri Riparian Target Event 4*

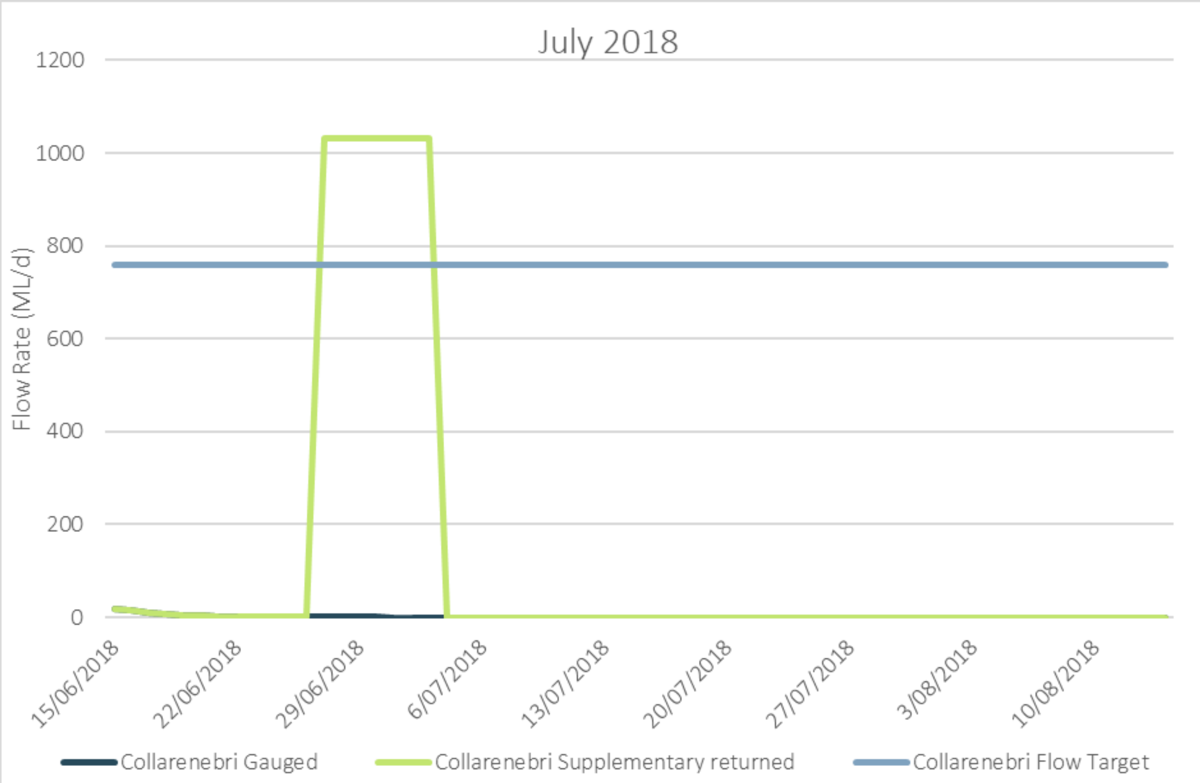


Figure 8.4.3. *Walgett Riparian Target Event 4*

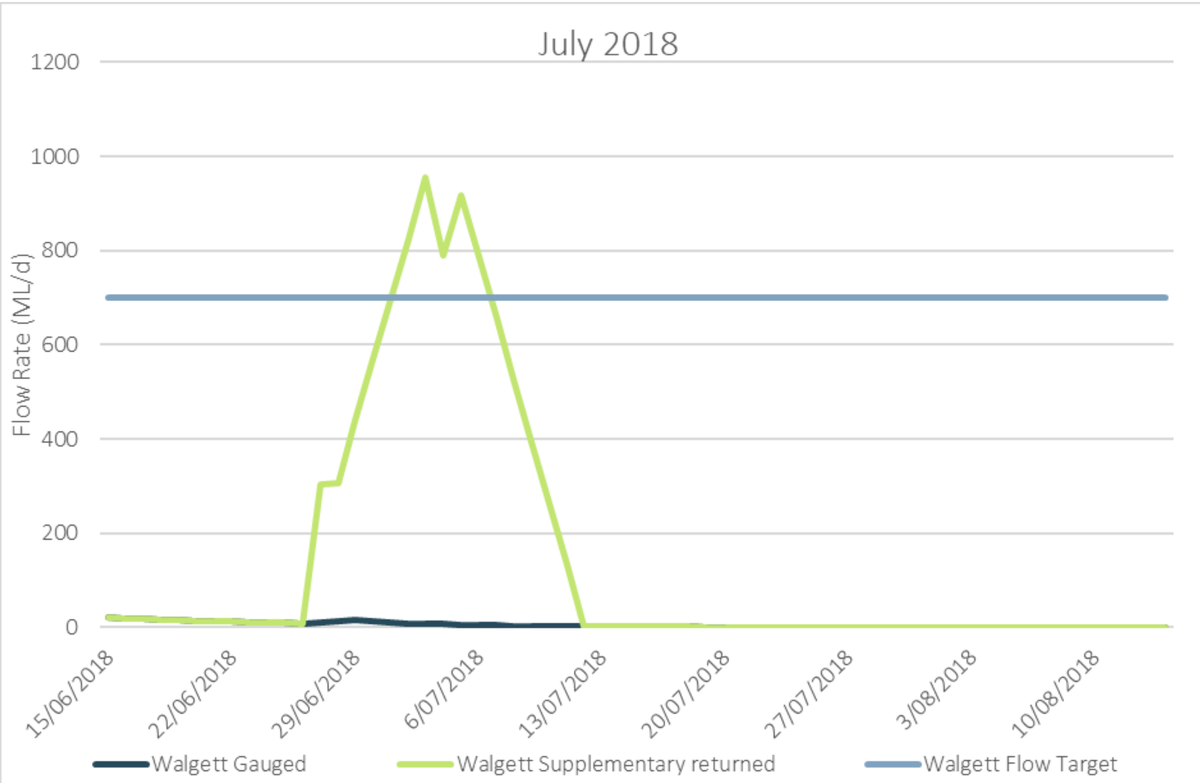


Figure 8.4.4. *Brewarrina Riparian Target Event 4*

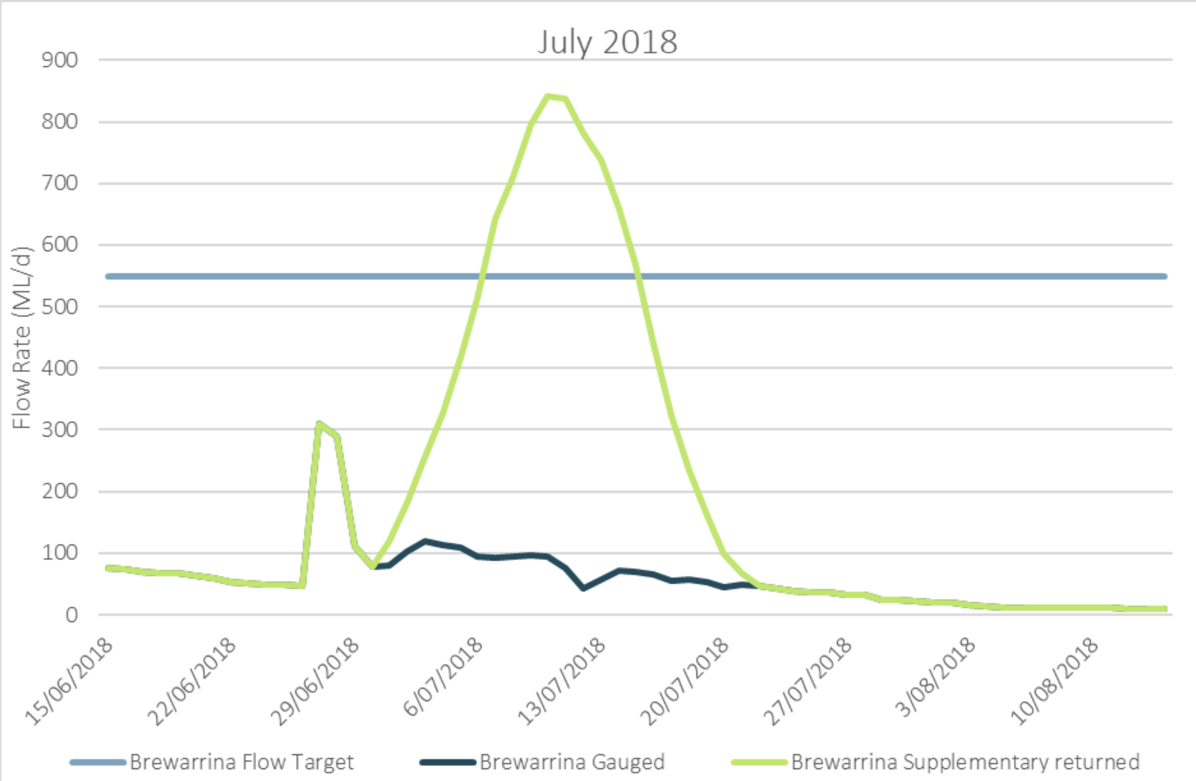


Figure 8.4.5. *Bourke Riparian Target Event 4*

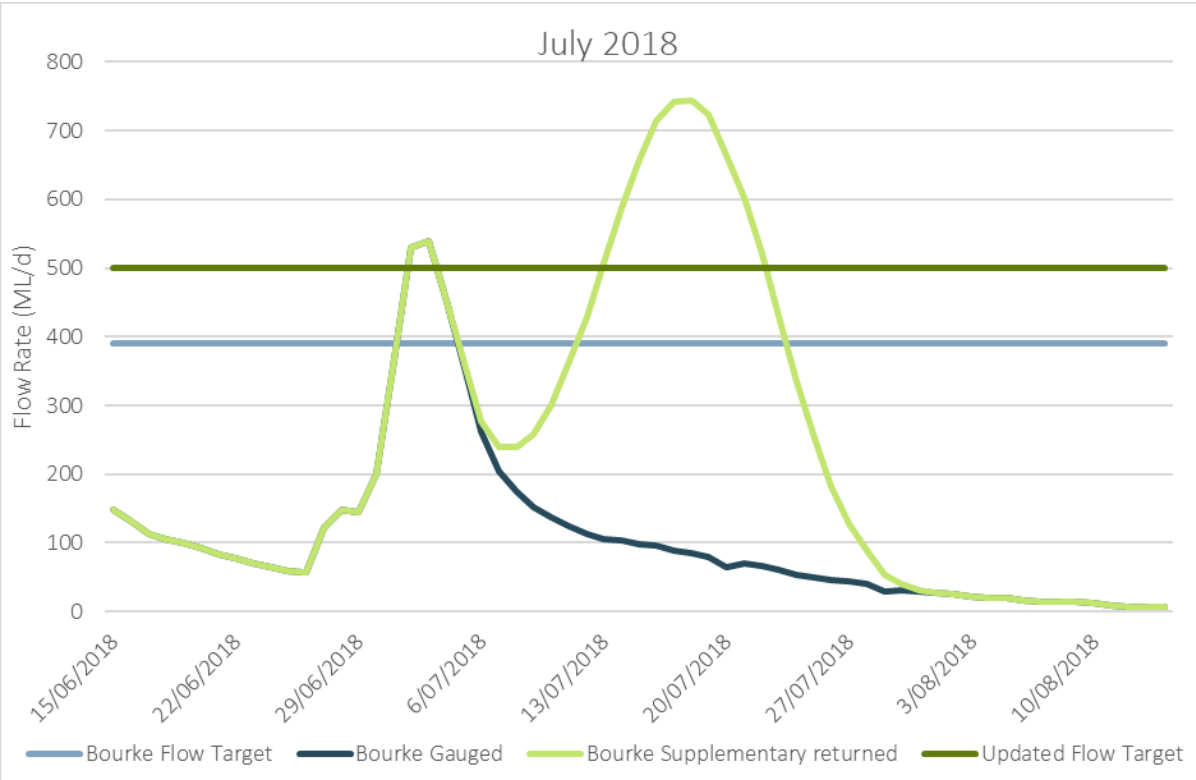


Figure 8.4.6. *Louth Riparian Target Event 4*

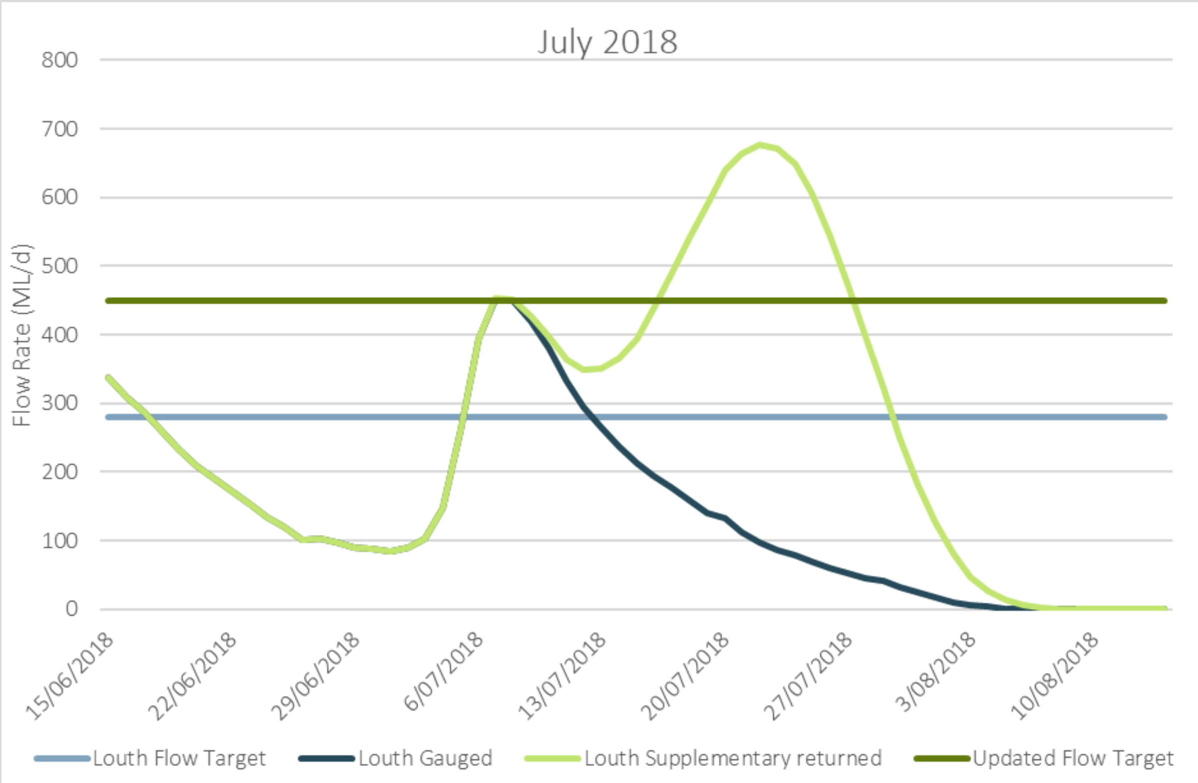
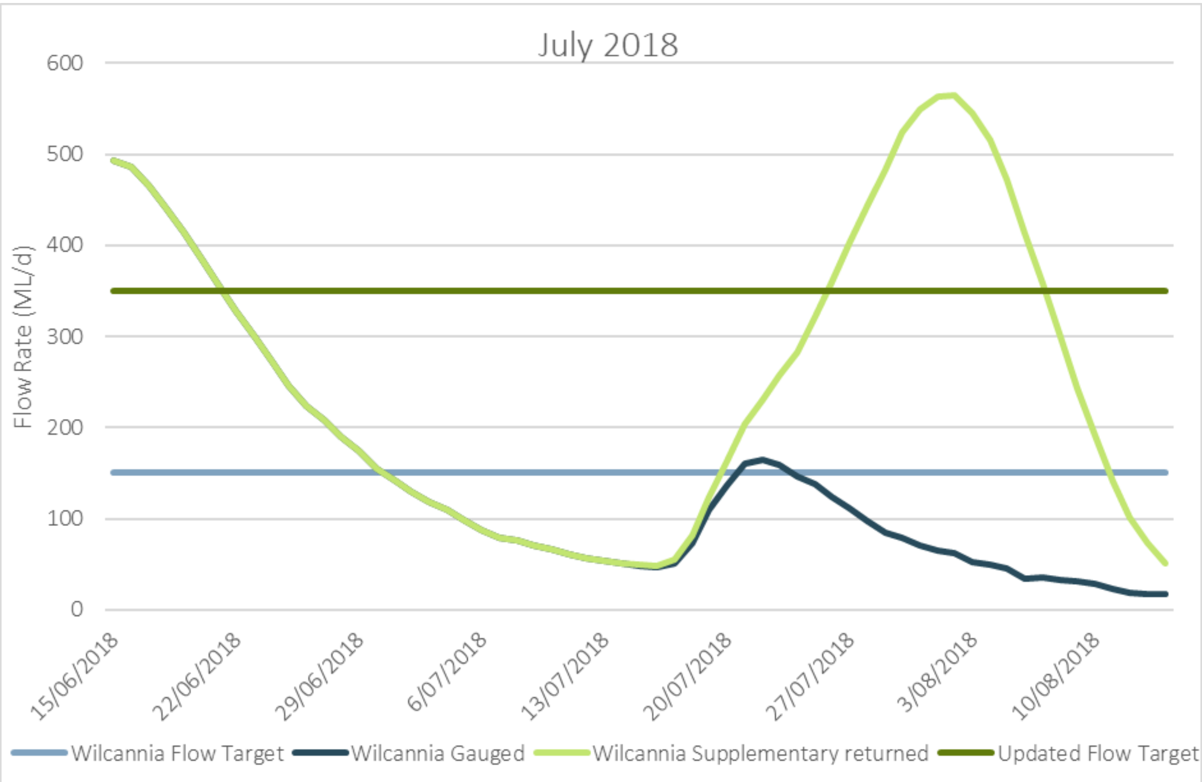


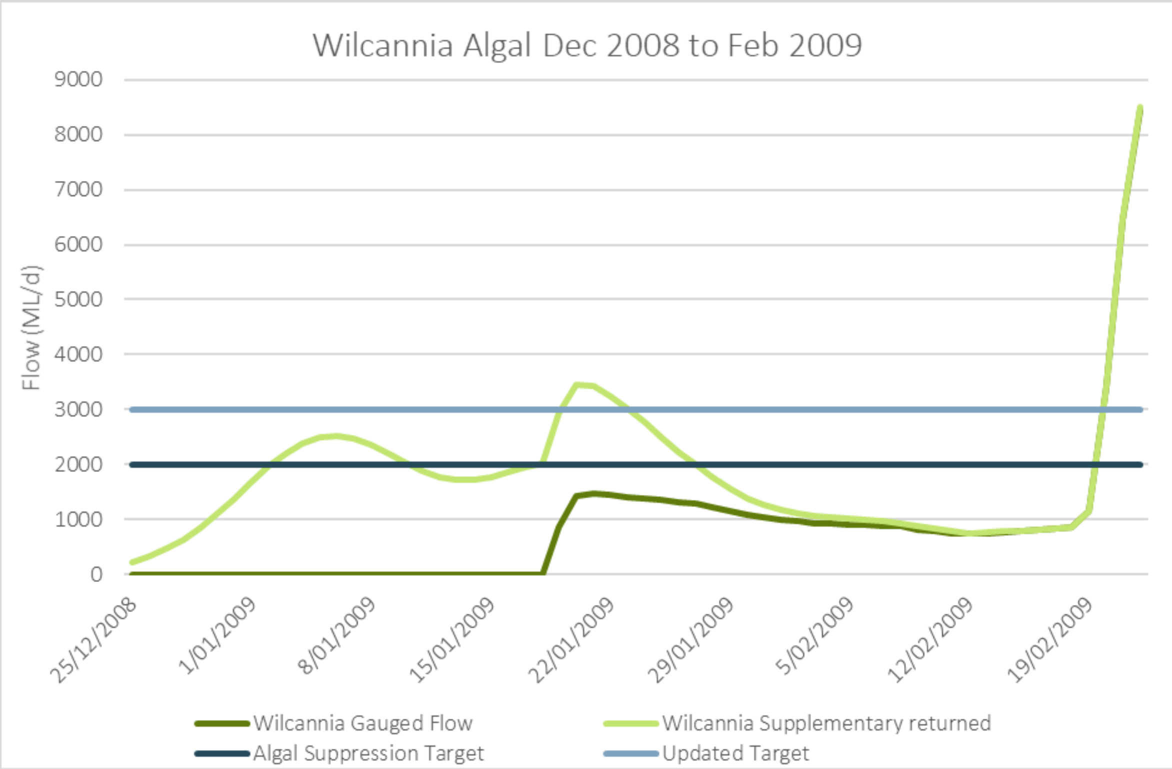
Figure 8.4.7. *Wilcannia Riparian Target Event 4*



Algal suppression at Wilcannia

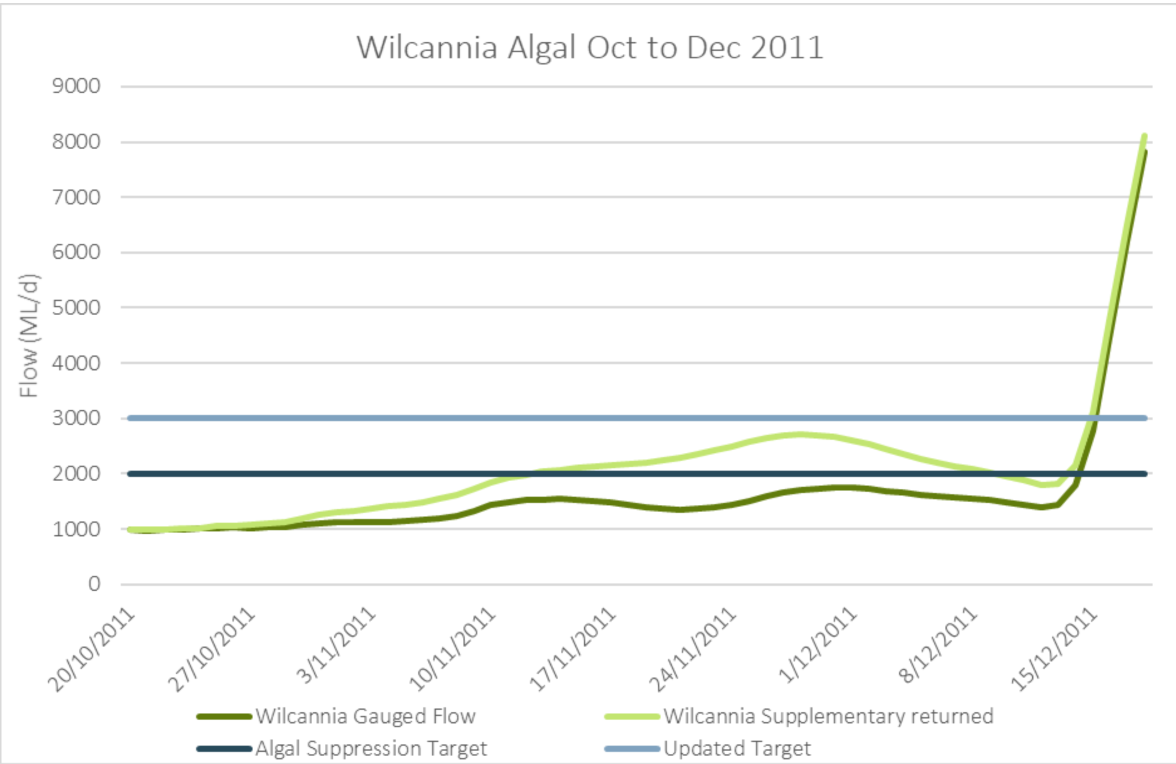
Event 1 – December 2008 to February 2009

Figure 8.5.1. *Algal Suppression at Wilcannia Event 1*



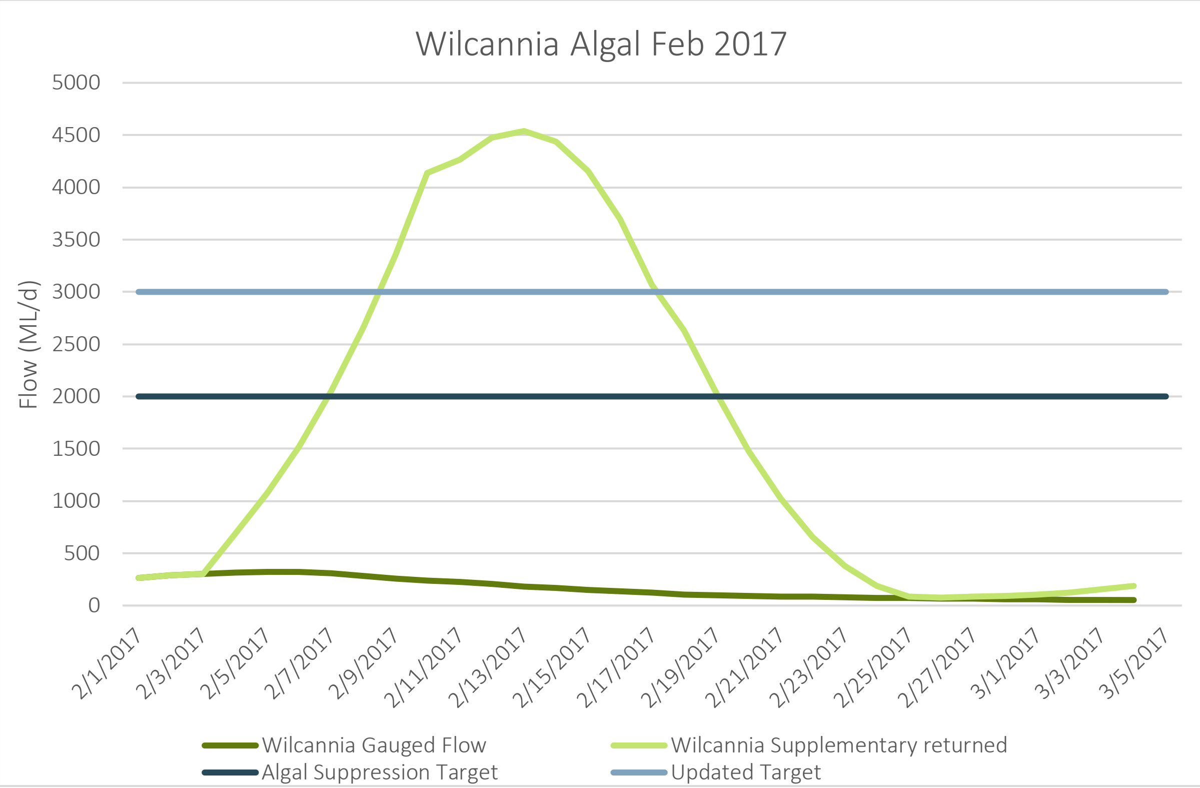
Event 2 – October to December 2011

Figure 8.5.2. *Algal Suppression at Wilcannia Event 2*



Event 3 – February 2017

Figure 8.5.3. *Algal Suppression at Wilcannia Event 3*



Attachment 9. Classification of supplementary events

Table 9.1. Classification types

Classification number	Classification description
1	All existing riparian targets met across all event days
2	Some days existing targets were met, no additional days when supplementary use volumes returned
3	Some days targets were met, some additional days when supplementary use volumes retuned
4	No existing targets met in historic events, some met in when supplementary use volumes retuned
5	No existing targets met in any scenario

Table 9.2. Historic supplementary access events

Valley	Event start	Event end	%	Event Days	Historic flows			Supp use returned			Classification
					Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	
BORDER RIVERS REGULATED RIVER WATER SOURCE	1-Jul-09	31-Jul-09	100	31	83	11.9	38%	84	12.0	39%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	30-Dec-09	22-Jan-10	100	24	131	18.7	78%	152	21.7	90%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	1-Jan-10	4-Jan-10	19	4	20	2.9	71%	26	3.7	93%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	31-Dec-09	31-Jan-10	100	32	172	24.6	77%	194	27.7	87%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	31-Dec-09	4-Jan-10	19	5	25	3.6	71%	31	4.4	89%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	8-Mar-10	19-Mar-10	5	12	84	12.0	100%	84	12.0	100%	1
BORDER RIVERS REGULATED RIVER WATER SOURCE	3-Mar-10	25-Mar-10	100	23	160	22.9	99%	160	22.9	99%	2
BORDER RIVERS REGULATED RIVER WATER SOURCE	5-Jun-10	30-Jun-10	100	26	26	3.7	14%	26	3.7	14%	2
BORDER RIVERS REGULATED RIVER WATER SOURCE	1-Aug-10	30-Nov-10	100	122	831	118.7	97%	831	118.7	97%	2
BORDER RIVERS REGULATED RIVER WATER SOURCE	12-Jul-10	20-Sep-10	100	71	389	55.6	78%	389	55.6	78%	2
BORDER RIVERS REGULATED RIVER WATER SOURCE	24-Nov-10	16-Feb-11	100	85	590	84.3	99%	590	84.3	99%	2
BORDER RIVERS REGULATED RIVER WATER SOURCE	1-Dec-10	15-Mar-11	100	105	689	98.4	94%	689	98.4	94%	2

Valley	Event start	Event end	%	Event Days	Historic flows			Supp use returned			Classification
					Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	
BORDER RIVERS REGULATED RIVER WATER SOURCE	24-Nov-10	22-Feb-11	100	91	632	90.3	99%	632	90.3	99%	2
BORDER RIVERS REGULATED RIVER WATER SOURCE	8-Mar-11	30-Jun-11	100	115	508	72.6	63%	508	72.6	63%	2
BORDER RIVERS REGULATED RIVER WATER SOURCE	18-Jun-11	2-Jul-11	50	15	71	10.1	68%	71	10.1	68%	2
BORDER RIVERS REGULATED RIVER WATER SOURCE	1-Jul-11	27-Sep-11	100	89	416	59.4	67%	416	59.4	67%	2
BORDER RIVERS REGULATED RIVER WATER SOURCE	3-Oct-11	3-Nov-11	70	32	210	30.0	94%	220	31.4	98%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	30-Sep-11	30-Nov-11	100	62	398	56.9	92%	412	58.9	95%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	29-Oct-11	14-Nov-11	26	17	118	16.9	99%	119	17.0	100%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	26-Nov-11	8-Jan-12	100	44	306	43.7	99%	306	43.7	99%	2
BORDER RIVERS REGULATED RIVER WATER SOURCE	26-Nov-11	29-Feb-12	100	96	658	94.0	98%	660	94.3	98%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	16-Jan-12	27-Feb-12	22	43	296	42.3	98%	298	42.6	99%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	30-Jan-12	17-Mar-12	100	48	329	47.0	98%	331	47.3	99%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	2-Feb-12	6-Mar-12	100	34	238	34.0	100%	238	34.0	100%	1
BORDER RIVERS REGULATED RIVER WATER SOURCE	8-May-12	18-May-12	100	11	51	7.3	66%	51	7.3	66%	2
BORDER RIVERS REGULATED RIVER WATER SOURCE	11-Jul-12	31-Aug-12	100	52	296	42.3	81%	296	42.3	81%	2
BORDER RIVERS REGULATED RIVER WATER SOURCE	29-Jun-12	29-Jun-12	100	1	4	0.6	57%	4	0.6	57%	2
BORDER RIVERS REGULATED RIVER WATER SOURCE	19-Jul-12	31-Aug-12	100	44	248	35.4	81%	248	35.4	81%	2
BORDER RIVERS REGULATED RIVER WATER SOURCE	31-Aug-12	31-Aug-12	100	1	4	0.6	57%	4	0.6	57%	2
BORDER RIVERS REGULATED RIVER WATER SOURCE	27-Dec-12	30-Dec-12	100	4	4	0.6	14%	7	1.0	25%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	28-Jan-13	2-Mar-13	100	34	191	27.3	80%	231	33.0	97%	3

Valley	Event start	Event end	%	Event Days	Historic flows			Supp use returned			Classification
					Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	
BORDER RIVERS REGULATED RIVER WATER SOURCE	26-Feb-13	31-Mar-13	100	34	203	29.0	85%	224	32.0	94%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	2-Mar-13	30-Jun-13	100	121	518	74.0	61%	585	83.6	69%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	16-Jun-13	25-Jun-13	6	10	24	3.4	34%	57	8.1	81%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	15-Jun-13	30-Jun-13	100	16	54	7.7	48%	94	13.4	84%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	1-Jul-13	31-Aug-13	100	62	271	38.7	62%	277	39.6	64%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	30-Mar-14	11-Apr-14	6	13	69	9.9	76%	87	12.4	96%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	29-Mar-14	23-Apr-14	100	26	101	14.4	55%	121	17.3	66%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	12-Dec-14	22-Dec-14	100	11	0	0.0	0%	0	0.0	0%	2
BORDER RIVERS REGULATED RIVER WATER SOURCE	29-Dec-14	12-Jan-15	100	15	16	2.3	15%	17	2.4	16%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	29-Jan-15	10-Feb-15	100	13	60	8.6	66%	64	9.1	70%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	10-Apr-15	30-Jun-15	100	82	391	55.9	68%	417	59.6	73%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	1-Jul-15	31-Aug-15	100	62	235	33.6	54%	332	47.4	76%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	26-Jul-15	10-Aug-15	18	16	71	10.1	63%	110	15.7	98%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	26-Aug-15	4-Sep-15	9	10	23	3.3	33%	68	9.7	97%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	1-Sep-15	15-Sep-15	100	15	41	5.9	39%	81	11.6	77%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	7-Nov-15	23-Nov-15	100	17	0	0.0	0%	85	12.1	71%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	7-Nov-15	18-Nov-15	9	12	0	0.0	0%	74	10.6	88%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	30-Dec-15	31-Dec-15	100	2	0	0.0	0%	0	0.0	0%	2
BORDER RIVERS REGULATED RIVER WATER SOURCE	6-Jan-16	12-Jan-16	100	7	0	0.0	0%	0	0.0	0%	2

Valley	Event start	Event end	%	Event Days	Historic flows			Supp use returned			Classification
					Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	
BORDER RIVERS REGULATED RIVER WATER SOURCE	19-Jan-16	25-Jan-16	100	7	16	2.3	33%	29	4.1	59%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	28-Jan-16	15-Feb-16	100	19	64	9.1	48%	119	17.0	89%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	1-Feb-16	12-Feb-16	4	12	36	5.1	43%	78	11.1	93%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	27-Jun-16	30-Jun-16	100	4	19	2.7	68%	24	3.4	86%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	1-Jul-16	24-Nov-16	100	147	890	127.1	86%	891	127.3	87%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	7-Jul-16	19-Jul-16	14	13	56	8.0	62%	56	8.0	62%	2
BORDER RIVERS REGULATED RIVER WATER SOURCE	25-Aug-16	9-Dec-16	100	107	685	97.9	91%	685	97.9	91%	2
BORDER RIVERS REGULATED RIVER WATER SOURCE	3-Jan-17	7-Jan-17	100	5	13	1.9	37%	14	2.0	40%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	17-Mar-17	22-Mar-17	100	6	20	2.9	48%	20	2.9	48%	2
BORDER RIVERS REGULATED RIVER WATER SOURCE	20-Mar-17	23-Apr-17	100	35	190	27.1	78%	190	27.1	78%	2
BORDER RIVERS REGULATED RIVER WATER SOURCE	23-Mar-17	31-Mar-17	100	9	39	5.6	62%	39	5.6	62%	2
BORDER RIVERS REGULATED RIVER WATER SOURCE	1-Apr-17	30-Jun-17	100	91	474	67.7	74%	514	73.4	81%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	1-Jul-17	31-Aug-17	100	62	184	26.3	42%	222	31.7	51%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	3-Jul-17	9-Jul-17	4	7	21	3.0	43%	44	6.3	90%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	14-Oct-17	18-Oct-17	100	5	0	0.0	0%	31	4.4	89%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	15-Oct-17	25-Oct-17	4	11	6	0.9	8%	71	10.1	92%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	25-Feb-20	3-Mar-20	25	8	56	8.0	100%	56	8.0	100%	1
BORDER RIVERS REGULATED RIVER WATER SOURCE	26-Feb-20	16-Mar-20	100	20	139	19.9	99%	140	20.0	100%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	8-Apr-20	15-May-20	100	38	143	20.4	54%	153	21.9	58%	3

Valley	Event start	Event end	%	Event Days	Historic flows			Supp use returned			Classification
					Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	
BORDER RIVERS REGULATED RIVER WATER SOURCE	27-May-20	5-Jun-20	100	10	3	0.4	4%	5	0.7	7%	3
BORDER RIVERS REGULATED RIVER WATER SOURCE	18-Jun-20	30-Jun-20	100	13	0	0.0	0%	4	0.6	4%	3
GWYDIR REGULATED RIVER WATER SOURCE	10-Sep-04	13-Sep-04	5	4	0	0.0	0%	0	0.0	0%	2
GWYDIR REGULATED RIVER WATER SOURCE	22-Nov-04	30-Nov-04	5	9	29	4.1	46%	36	5.1	57%	3
GWYDIR REGULATED RIVER WATER SOURCE	9-Dec-04	7-Jan-05	125	30	131	18.7	62%	154	22.0	73%	3
GWYDIR REGULATED RIVER WATER SOURCE	9-Nov-04	10-Nov-04	5	2	2	0.3	14%	3	0.4	21%	3
GWYDIR REGULATED RIVER WATER SOURCE	22-Nov-04	30-Nov-04	17	9	13	1.9	21%	17	2.4	27%	3
GWYDIR REGULATED RIVER WATER SOURCE	22-Nov-04	30-Nov-04	51	9	4	0.6	6%	9	1.3	14%	3
GWYDIR REGULATED RIVER WATER SOURCE	22-Nov-04	30-Nov-04	125	9	4	0.6	6%	9	1.3	14%	3
GWYDIR REGULATED RIVER WATER SOURCE	29-Jun-05	30-Jun-05	100	2	5	0.7	36%	6	0.9	43%	3
GWYDIR REGULATED RIVER WATER SOURCE	29-Jun-05	30-Jun-05	50	2	5	0.7	36%	6	0.9	43%	3
GWYDIR REGULATED RIVER WATER SOURCE	1-Jul-05	13-Jul-05	100	13	47	6.7	52%	49	7.0	54%	3
GWYDIR REGULATED RIVER WATER SOURCE	7-Sep-05	9-Sep-05	30	3	9	1.3	43%	9	1.3	43%	2
GWYDIR REGULATED RIVER WATER SOURCE	3-Dec-05	5-Dec-05	20	3	0	0.0	0%	3	0.4	14%	3
GWYDIR REGULATED RIVER WATER SOURCE	20-Jan-06	26-Jan-06	20	7	7	1.0	14%	19	2.7	39%	3
GWYDIR REGULATED RIVER WATER SOURCE	19-Jan-06	27-Jan-06	30	9	9	1.3	14%	25	3.6	40%	3
GWYDIR REGULATED RIVER WATER SOURCE	16-Feb-06	28-Feb-06	30	13	28	4.0	31%	43	6.1	47%	3
GWYDIR REGULATED RIVER WATER SOURCE	16-Feb-06	3-Mar-06	5	16	36	5.1	32%	56	8.0	50%	3
GWYDIR REGULATED RIVER WATER SOURCE	16-Feb-06	3-Mar-06	25	16	36	5.1	32%	56	8.0	50%	3

Valley	Event start	Event end	%	Event Days	Historic flows			Supp use returned			Classification
					Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	
GWYDIR REGULATED RIVER WATER SOURCE	16-Feb-06	3-Mar-06	50	16	36	5.1	32%	56	8.0	50%	3
GWYDIR REGULATED RIVER WATER SOURCE	16-Feb-06	3-Mar-06	200	16	36	5.1	32%	56	8.0	50%	3
GWYDIR REGULATED RIVER WATER SOURCE	19-Jul-06	21-Jul-06	10	3	0	0.0	0%	0	0.0	0%	2
GWYDIR REGULATED RIVER WATER SOURCE	18-Dec-05	23-Dec-05	30	6	18	2.6	43%	24	3.4	57%	3
GWYDIR REGULATED RIVER WATER SOURCE	7-Jan-08	8-Jan-08	50	2	12	1.7	86%	12	1.7	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	8-Jan-08	9-Jan-08	50	2	11	1.6	79%	12	1.7	86%	3
GWYDIR REGULATED RIVER WATER SOURCE	22-Jan-08	23-Jan-08	3	2	8	1.1	57%	8	1.1	57%	2
GWYDIR REGULATED RIVER WATER SOURCE	22-Jan-08	23-Jan-08	3	2	8	1.1	57%	8	1.1	57%	2
GWYDIR REGULATED RIVER WATER SOURCE	27-Jan-08	29-Jan-08	3	3	14	2.0	67%	14	2.0	67%	2
GWYDIR REGULATED RIVER WATER SOURCE	9-Feb-08	21-Feb-08	15	13	78	11.1	86%	78	11.1	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	7-Feb-08	15-Feb-08	25	9	54	7.7	86%	54	7.7	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	7-Feb-08	15-Feb-08	15	9	54	7.7	86%	54	7.7	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	8-Feb-08	13-Feb-08	23	6	36	5.1	86%	36	5.1	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	6-Feb-08	16-Feb-08	31	11	66	9.4	86%	66	9.4	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	7-Feb-08	17-Feb-08	63	11	66	9.4	86%	66	9.4	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	6-Feb-08	17-Feb-08	100	12	72	10.3	86%	72	10.3	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	22-Feb-08	24-Feb-08	2	3	18	2.6	86%	18	2.6	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	12-Feb-08	22-Feb-08	25	11	66	9.4	86%	66	9.4	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	22-Nov-08	24-Nov-08	3	3	0	0.0	0%	0	0.0	0%	2

Valley	Event start	Event end	%	Event Days	Historic flows			Supp use returned			Classification
					Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	
GWYDIR REGULATED RIVER WATER SOURCE	27-Nov-08	30-Nov-08	10	4	0	0.0	0%	1	0.1	4%	3
GWYDIR REGULATED RIVER WATER SOURCE	28-Nov-08	4-Dec-08	5	7	0	0.0	0%	7	1.0	14%	3
GWYDIR REGULATED RIVER WATER SOURCE	27-Nov-08	30-Nov-08	10	4	0	0.0	0%	1	0.1	4%	3
GWYDIR REGULATED RIVER WATER SOURCE	21-Nov-08	2-Dec-08	8	12	0	0.0	0%	3	0.4	4%	3
GWYDIR REGULATED RIVER WATER SOURCE	1-Dec-08	4-Dec-08	4	4	0	0.0	0%	6	0.9	21%	3
GWYDIR REGULATED RIVER WATER SOURCE	1-Dec-08	4-Dec-08	3	4	0	0.0	0%	6	0.9	21%	3
GWYDIR REGULATED RIVER WATER SOURCE	5-Dec-08	7-Dec-08	2	3	1	0.1	5%	7	1.0	33%	3
GWYDIR REGULATED RIVER WATER SOURCE	15-Dec-08	21-Dec-08	6	7	19	2.7	39%	30	4.3	61%	3
GWYDIR REGULATED RIVER WATER SOURCE	29-Dec-08	30-Dec-08	6	2	10	1.4	71%	12	1.7	86%	3
GWYDIR REGULATED RIVER WATER SOURCE	29-Dec-08	30-Dec-08	9	2	10	1.4	71%	12	1.7	86%	3
GWYDIR REGULATED RIVER WATER SOURCE	24-Jan-09	28-Jan-09	7	5	23	3.3	66%	26	3.7	74%	3
GWYDIR REGULATED RIVER WATER SOURCE	24-Jan-09	29-Jan-09	9	6	27	3.9	64%	32	4.6	76%	3
GWYDIR REGULATED RIVER WATER SOURCE	16-Feb-09	23-Feb-09	10	8	44	6.3	79%	48	6.9	86%	3
GWYDIR REGULATED RIVER WATER SOURCE	16-Feb-09	23-Feb-09	15	8	44	6.3	79%	48	6.9	86%	3
GWYDIR REGULATED RIVER WATER SOURCE	16-Feb-09	25-Feb-09	18	10	56	8.0	80%	60	8.6	86%	3
GWYDIR REGULATED RIVER WATER SOURCE	16-Feb-09	25-Feb-09	10	10	56	8.0	80%	60	8.6	86%	3
GWYDIR REGULATED RIVER WATER SOURCE	17-Feb-09	25-Feb-09	20	9	50	7.1	79%	54	7.7	86%	3
GWYDIR REGULATED RIVER WATER SOURCE	16-Feb-09	25-Feb-09	30	10	56	8.0	80%	60	8.6	86%	3
GWYDIR REGULATED RIVER WATER SOURCE	16-Feb-09	25-Feb-09	44	10	56	8.0	80%	60	8.6	86%	3

Valley	Event start	Event end	%	Event Days	Historic flows			Supp use returned			Classification
					Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	
GWYDIR REGULATED RIVER WATER SOURCE	18-Feb-09	25-Feb-09	100	8	44	6.3	79%	48	6.9	86%	3
GWYDIR REGULATED RIVER WATER SOURCE	4-Jan-10	10-Jan-10	10	7	33	4.7	67%	38	5.4	78%	3
GWYDIR REGULATED RIVER WATER SOURCE	6-Jan-10	10-Jan-10	10	5	25	3.6	71%	29	4.1	83%	3
GWYDIR REGULATED RIVER WATER SOURCE	5-Jan-10	10-Jan-10	10	6	29	4.1	69%	34	4.9	81%	3
GWYDIR REGULATED RIVER WATER SOURCE	5-Jan-10	10-Jan-10	10	6	29	4.1	69%	34	4.9	81%	3
GWYDIR REGULATED RIVER WATER SOURCE	5-Jan-10	10-Jan-10	5	6	29	4.1	69%	34	4.9	81%	3
GWYDIR REGULATED RIVER WATER SOURCE	2-Aug-10	6-Aug-10	16	5	7	1.0	20%	7	1.0	20%	2
GWYDIR REGULATED RIVER WATER SOURCE	2-Aug-10	6-Aug-10	20	5	7	1.0	20%	7	1.0	20%	2
GWYDIR REGULATED RIVER WATER SOURCE	6-Aug-10	12-Aug-10	20	7	27	3.9	55%	27	3.9	55%	2
GWYDIR REGULATED RIVER WATER SOURCE	6-Aug-10	12-Aug-10	9	7	27	3.9	55%	27	3.9	55%	2
GWYDIR REGULATED RIVER WATER SOURCE	2-Aug-10	20-Aug-10	20	19	78	11.1	59%	78	11.1	59%	2
GWYDIR REGULATED RIVER WATER SOURCE	3-Aug-10	20-Aug-10	30	18	77	11.0	61%	77	11.0	61%	2
GWYDIR REGULATED RIVER WATER SOURCE	12-Aug-10	16-Aug-10	20	5	27	3.9	77%	27	3.9	77%	2
GWYDIR REGULATED RIVER WATER SOURCE	12-Aug-10	20-Aug-10	10	9	51	7.3	81%	51	7.3	81%	2
GWYDIR REGULATED RIVER WATER SOURCE	12-Aug-10	30-Aug-10	13	19	111	15.9	83%	111	15.9	83%	2
GWYDIR REGULATED RIVER WATER SOURCE	12-Aug-10	20-Aug-10	10	9	51	7.3	81%	51	7.3	81%	2
GWYDIR REGULATED RIVER WATER SOURCE	12-Aug-10	23-Aug-10	15	12	69	9.9	82%	69	9.9	82%	2
GWYDIR REGULATED RIVER WATER SOURCE	13-Aug-10	17-Aug-10	8	5	28	4.0	80%	28	4.0	80%	2
GWYDIR REGULATED RIVER WATER SOURCE	24-Aug-10	27-Aug-10	10	4	24	3.4	86%	24	3.4	86%	2

Valley	Event start	Event end	%	Event Days	Historic flows			Supp use returned			Classification
					Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	
GWYDIR REGULATED RIVER WATER SOURCE	24-Aug-10	31-Aug-10	5	8	48	6.9	86%	48	6.9	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	24-Aug-10	31-Aug-10	5	8	48	6.9	86%	48	6.9	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	24-Aug-10	31-Aug-10	10	8	48	6.9	86%	48	6.9	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	24-Aug-10	31-Aug-10	15	8	48	6.9	86%	48	6.9	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	1-Sep-10	2-Sep-10	5	2	12	1.7	86%	12	1.7	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	1-Sep-10	2-Sep-10	10	2	12	1.7	86%	12	1.7	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	1-Sep-10	6-Sep-10	10	6	36	5.1	86%	36	5.1	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	6-Sep-10	8-Sep-10	10	3	18	2.6	86%	18	2.6	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	7-Sep-10	8-Sep-10	5	2	12	1.7	86%	12	1.7	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	10-Sep-10	13-Sep-10	10	4	24	3.4	86%	24	3.4	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	12-Sep-10	16-Sep-10	13	5	30	4.3	86%	30	4.3	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	7-Sep-10	10-Sep-10	20	4	24	3.4	86%	24	3.4	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	7-Sep-10	9-Sep-10	10	3	18	2.6	86%	18	2.6	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	7-Sep-10	11-Sep-10	5	5	30	4.3	86%	30	4.3	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	8-Sep-10	10-Sep-10	5	3	18	2.6	86%	18	2.6	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	11-Sep-10	13-Sep-10	10	3	18	2.6	86%	18	2.6	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	11-Sep-10	20-Sep-10	10	10	60	8.6	86%	60	8.6	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	11-Sep-10	14-Sep-10	10	4	24	3.4	86%	24	3.4	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	12-Sep-10	16-Sep-10	10	5	30	4.3	86%	30	4.3	86%	2

Valley	Event start	Event end	%	Event Days	Historic flows			Supp use returned			Classification
					Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	
GWYDIR REGULATED RIVER WATER SOURCE	12-Sep-10	13-Sep-10	5	2	12	1.7	86%	12	1.7	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	13-Sep-10	16-Sep-10	10	4	24	3.4	86%	24	3.4	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	14-Sep-10	18-Sep-10	10	5	30	4.3	86%	30	4.3	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	14-Sep-10	20-Sep-10	4	7	42	6.0	86%	42	6.0	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	15-Sep-10	19-Sep-10	10	5	30	4.3	86%	30	4.3	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	20-Sep-10	21-Sep-10	10	2	12	1.7	86%	12	1.7	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	20-Sep-10	23-Sep-10	9	4	24	3.4	86%	24	3.4	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	24-Sep-10	25-Sep-10	9	2	12	1.7	86%	12	1.7	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	24-Sep-10	26-Sep-10	5	3	18	2.6	86%	18	2.6	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	24-Sep-10	25-Sep-10	5	2	12	1.7	86%	12	1.7	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	26-Sep-10	27-Sep-10	5	2	12	1.7	86%	12	1.7	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	26-Sep-10	27-Sep-10	5	2	12	1.7	86%	12	1.7	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	27-Sep-10	28-Sep-10	5	2	12	1.7	86%	12	1.7	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	28-Sep-10	30-Sep-10	3	3	18	2.6	86%	18	2.6	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	2-Oct-10	2-Oct-10	10	1	6	0.9	86%	6	0.9	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	2-Oct-10	2-Oct-10	8	1	6	0.9	86%	6	0.9	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	16-Oct-10	19-Oct-10	20	4	24	3.4	86%	24	3.4	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	17-Oct-10	20-Oct-10	20	4	24	3.4	86%	24	3.4	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	17-Oct-10	25-Oct-10	15	9	54	7.7	86%	54	7.7	86%	2

Valley	Event start	Event end	%	Event Days	Historic flows			Supp use returned			Classification
					Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	
GWYDIR REGULATED RIVER WATER SOURCE	17-Oct-10	24-Oct-10	25	8	48	6.9	86%	48	6.9	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	18-Oct-10	27-Oct-10	15	10	60	8.6	86%	60	8.6	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	20-Oct-10	20-Oct-10	3	1	6	0.9	86%	6	0.9	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	19-Oct-10	19-Oct-10	6	1	6	0.9	86%	6	0.9	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	20-Oct-10	20-Oct-10	28	1	6	0.9	86%	6	0.9	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	22-Oct-10	26-Oct-10	10	5	30	4.3	86%	30	4.3	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	22-Oct-10	24-Oct-10	5	3	18	2.6	86%	18	2.6	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	25-Oct-10	25-Oct-10	15	1	6	0.9	86%	6	0.9	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	25-Oct-10	25-Oct-10	10	1	6	0.9	86%	6	0.9	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	25-Oct-10	25-Oct-10	5	1	6	0.9	86%	6	0.9	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	27-Oct-10	29-Oct-10	10	3	18	2.6	86%	18	2.6	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	27-Oct-10	27-Oct-10	10	1	6	0.9	86%	6	0.9	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	28-Oct-10	31-Oct-10	15	4	24	3.4	86%	24	3.4	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	28-Oct-10	29-Oct-10	4	2	12	1.7	86%	12	1.7	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	28-Oct-10	30-Oct-10	10	3	18	2.6	86%	18	2.6	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	2-Nov-10	3-Nov-10	10	2	12	1.7	86%	12	1.7	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	14-Nov-10	18-Nov-10	20	5	30	4.3	86%	30	4.3	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	19-Nov-10	30-Nov-10	15	12	72	10.3	86%	72	10.3	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	20-Nov-10	30-Nov-10	10	11	66	9.4	86%	66	9.4	86%	2

Valley	Event start	Event end	%	Event Days	Historic flows			Supp use returned			Classification
					Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	
GWYDIR REGULATED RIVER WATER SOURCE	20-Nov-10	22-Nov-10	20	3	18	2.6	86%	18	2.6	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	22-Nov-10	4-Dec-10	10	13	78	11.1	86%	78	11.1	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	3-Oct-10	3-Oct-10	100	1	6	0.9	86%	6	0.9	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	25-Nov-10	30-Nov-10	15	6	36	5.1	86%	36	5.1	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	4-Dec-10	11-Dec-10	25	8	48	6.9	86%	48	6.9	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	4-Dec-10	7-Dec-10	8	4	24	3.4	86%	24	3.4	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	3-Dec-10	6-Dec-10	7	4	24	3.4	86%	24	3.4	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	6-Dec-10	11-Dec-10	17	6	36	5.1	86%	36	5.1	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	8-Dec-10	17-Dec-10	15	10	60	8.6	86%	60	8.6	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	12-Dec-10	15-Dec-10	10	4	24	3.4	86%	24	3.4	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	15-Dec-10	20-Dec-10	10	6	36	5.1	86%	36	5.1	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	13-Dec-10	19-Dec-10	7	7	42	6.0	86%	42	6.0	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	15-Dec-10	18-Dec-10	6	4	24	3.4	86%	24	3.4	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	13-Dec-10	16-Dec-10	10	4	24	3.4	86%	24	3.4	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	12-Dec-10	17-Dec-10	5	6	36	5.1	86%	36	5.1	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	11-Dec-10	14-Dec-10	6	4	24	3.4	86%	24	3.4	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	12-Dec-10	17-Dec-10	8	6	36	5.1	86%	36	5.1	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	13-Dec-10	16-Dec-10	7	4	24	3.4	86%	24	3.4	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	20-Dec-10	23-Dec-10	8	4	24	3.4	86%	24	3.4	86%	2

Valley	Event start	Event end	%	Event Days	Historic flows			Supp use returned			Classification
					Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	
GWYDIR REGULATED RIVER WATER SOURCE	20-Dec-10	23-Dec-10	11	4	24	3.4	86%	24	3.4	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	17-Dec-10	21-Dec-10	10	5	30	4.3	86%	30	4.3	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	8-Jan-11	11-Jan-11	5	4	24	3.4	86%	24	3.4	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	8-Jan-11	9-Jan-11	2	2	12	1.7	86%	12	1.7	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	8-Jan-11	10-Jan-11	7	3	18	2.6	86%	18	2.6	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	11-Jan-11	13-Jan-11	11	3	18	2.6	86%	18	2.6	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	14-Jan-11	17-Jan-11	8	4	24	3.4	86%	24	3.4	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	16-Jan-11	20-Jan-11	15	5	30	4.3	86%	30	4.3	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	17-Jan-11	19-Jan-11	10	3	18	2.6	86%	18	2.6	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	18-Jan-11	24-Jan-11	15	7	42	6.0	86%	42	6.0	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	6-Jan-11	8-Jan-11	15	3	18	2.6	86%	18	2.6	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	22-Jan-11	23-Jan-11	15	2	12	1.7	86%	12	1.7	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	18-Jun-11	25-Jun-11	10	8	26	3.7	46%	26	3.7	46%	2
GWYDIR REGULATED RIVER WATER SOURCE	3-Oct-11	6-Oct-11	15	4	23	3.3	82%	24	3.4	86%	3
GWYDIR REGULATED RIVER WATER SOURCE	3-Oct-11	9-Oct-11	19	7	38	5.4	78%	42	6.0	86%	3
GWYDIR REGULATED RIVER WATER SOURCE	16-Oct-11	19-Oct-11	8	4	24	3.4	86%	24	3.4	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	16-Oct-11	17-Oct-11	10	2	12	1.7	86%	12	1.7	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	16-Oct-11	20-Oct-11	35	5	30	4.3	86%	30	4.3	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	16-Oct-11	25-Oct-11	5	10	60	8.6	86%	60	8.6	86%	2

Valley	Event start	Event end	%	Event Days	Historic flows			Supp use returned			Classification
					Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	
GWYDIR REGULATED RIVER WATER SOURCE	16-Oct-11	27-Oct-11	20	12	72	10.3	86%	72	10.3	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	17-Oct-11	18-Oct-11	20	2	12	1.7	86%	12	1.7	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	18-Oct-11	21-Oct-11	30	4	24	3.4	86%	24	3.4	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	18-Oct-11	24-Oct-11	10	7	42	6.0	86%	42	6.0	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	18-Oct-11	24-Oct-11	20	7	42	6.0	86%	42	6.0	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	25-Nov-11	31-Dec-11	100	37	221	31.6	85%	222	31.7	86%	3
GWYDIR REGULATED RIVER WATER SOURCE	25-Nov-11	2-Jan-12	100	39	233	33.3	85%	234	33.4	86%	3
GWYDIR REGULATED RIVER WATER SOURCE	25-Nov-11	3-Jan-12	100	40	239	34.1	85%	240	34.3	86%	3
GWYDIR REGULATED RIVER WATER SOURCE	25-Nov-11	5-Jan-12	100	42	251	35.9	85%	252	36.0	86%	3
GWYDIR REGULATED RIVER WATER SOURCE	26-Nov-11	7-Jan-12	100	43	258	36.9	86%	258	36.9	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	26-Nov-11	1-Jan-12	100	37	222	31.7	86%	222	31.7	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	26-Nov-11	2-Jan-12	100	38	228	32.6	86%	228	32.6	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	26-Nov-11	1-Jan-12	100	37	222	31.7	86%	222	31.7	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	18-Jan-12	23-Jan-12	17	6	36	5.1	86%	36	5.1	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	19-Jan-12	21-Jan-12	5	3	18	2.6	86%	18	2.6	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	23-Jan-12	23-Jan-12	0	1	6	0.9	86%	6	0.9	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	27-Jan-12	4-Feb-12	27	9	54	7.7	86%	54	7.7	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	1-Feb-12	19-Mar-12	100	48	288	41.1	86%	288	41.1	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	6-Jun-12	12-Jun-12	30	7	32	4.6	65%	32	4.6	65%	2

Valley	Event start	Event end	%	Event Days	Historic flows			Supp use returned			Classification
					Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	
GWYDIR REGULATED RIVER WATER SOURCE	14-Jul-12	14-Aug-12	100	32	190	27.1	85%	191	27.3	85%	3
GWYDIR REGULATED RIVER WATER SOURCE	29-Dec-12	31-Dec-12	8	3	3	0.4	14%	3	0.4	14%	2
GWYDIR REGULATED RIVER WATER SOURCE	29-Jan-13	8-Feb-13	60	11	21	3.0	27%	36	5.1	47%	3
GWYDIR REGULATED RIVER WATER SOURCE	2-Mar-13	15-Mar-13	100	14	70	10.0	71%	84	12.0	86%	3
GWYDIR REGULATED RIVER WATER SOURCE	15-Mar-13	26-Mar-13	15	12	60	8.6	71%	72	10.3	86%	3
GWYDIR REGULATED RIVER WATER SOURCE	28-Mar-14	3-Apr-14	100	7	26	3.7	53%	29	4.1	59%	3
GWYDIR REGULATED RIVER WATER SOURCE	28-Mar-14	2-Apr-14	15	6	22	3.1	52%	24	3.4	57%	3
GWYDIR REGULATED RIVER WATER SOURCE	29-Mar-14	3-Apr-14	25	6	23	3.3	55%	25	3.6	60%	3
GWYDIR REGULATED RIVER WATER SOURCE	28-Mar-14	30-Mar-14	5	3	10	1.4	48%	12	1.7	57%	3
GWYDIR REGULATED RIVER WATER SOURCE	28-Mar-14	5-Apr-14	20	9	35	5.0	56%	39	5.6	62%	3
GWYDIR REGULATED RIVER WATER SOURCE	3-Jan-15	5-Jan-15	2	3	0	0.0	0%	0	0.0	0%	2
GWYDIR REGULATED RIVER WATER SOURCE	7-Apr-15	7-Apr-15	9	1	0	0.0	0%	0	0.0	0%	2
GWYDIR REGULATED RIVER WATER SOURCE	19-Jun-15	24-Jun-15	9	6	18	2.6	43%	22	3.1	52%	3
GWYDIR REGULATED RIVER WATER SOURCE	25-Jul-15	28-Jul-15	9	4	12	1.7	43%	13	1.9	46%	3
GWYDIR REGULATED RIVER WATER SOURCE	28-Jul-15	3-Aug-15	14	7	27	3.9	55%	40	5.7	82%	3
GWYDIR REGULATED RIVER WATER SOURCE	30-Jul-15	1-Aug-15	5	3	12	1.7	57%	18	2.6	86%	3
GWYDIR REGULATED RIVER WATER SOURCE	25-Aug-15	27-Aug-15	15	3	12	1.7	57%	17	2.4	81%	3
GWYDIR REGULATED RIVER WATER SOURCE	26-Aug-15	28-Aug-15	5	3	12	1.7	57%	18	2.6	86%	3
GWYDIR REGULATED RIVER WATER SOURCE	25-Aug-15	8-Sep-15	12	15	56	8.0	53%	89	12.7	85%	3

Valley	Event start	Event end	%	Event Days	Historic flows			Supp use returned			Classification
					Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	
GWYDIR REGULATED RIVER WATER SOURCE	25-Aug-15	30-Aug-15	10	6	24	3.4	57%	35	5.0	83%	3
GWYDIR REGULATED RIVER WATER SOURCE	25-Aug-15	30-Aug-15	10	6	24	3.4	57%	35	5.0	83%	3
GWYDIR REGULATED RIVER WATER SOURCE	5-Nov-15	14-Nov-15	13	10	22	3.1	31%	28	4.0	40%	3
GWYDIR REGULATED RIVER WATER SOURCE	6-Jan-16	7-Jan-16	8	2	0	0.0	0%	0	0.0	0%	2
GWYDIR REGULATED RIVER WATER SOURCE	7-Jan-16	9-Jan-16	8	3	0	0.0	0%	0	0.0	0%	2
GWYDIR REGULATED RIVER WATER SOURCE	31-Jan-16	2-Feb-16	10	3	7	1.0	33%	8	1.1	38%	3
GWYDIR REGULATED RIVER WATER SOURCE	23-Jun-16	30-Jun-16	20	8	26	3.7	46%	36	5.1	64%	3
GWYDIR REGULATED RIVER WATER SOURCE	23-Jun-16	27-Jun-16	10	5	14	2.0	40%	21	3.0	60%	3
GWYDIR REGULATED RIVER WATER SOURCE	25-Jun-16	27-Jun-16	20	3	9	1.3	43%	14	2.0	67%	3
GWYDIR REGULATED RIVER WATER SOURCE	27-Jun-16	29-Jun-16	10	3	11	1.6	52%	15	2.1	71%	3
GWYDIR REGULATED RIVER WATER SOURCE	30-Jun-16	8-Jul-16	15	9	37	5.3	59%	46	6.6	73%	3
GWYDIR REGULATED RIVER WATER SOURCE	6-Aug-16	8-Aug-16	7	3	13	1.9	62%	13	1.9	62%	2
GWYDIR REGULATED RIVER WATER SOURCE	25-Aug-16	31-Aug-16	20	7	37	5.3	76%	37	5.3	76%	2
GWYDIR REGULATED RIVER WATER SOURCE	25-Aug-16	31-Aug-16	13	7	37	5.3	76%	37	5.3	76%	2
GWYDIR REGULATED RIVER WATER SOURCE	29-Aug-16	31-Aug-16	15	3	15	2.1	71%	15	2.1	71%	2
GWYDIR REGULATED RIVER WATER SOURCE	25-Aug-16	10-Sep-16	11	17	87	12.4	73%	87	12.4	73%	2
GWYDIR REGULATED RIVER WATER SOURCE	26-Aug-16	27-Aug-16	10	2	11	1.6	79%	11	1.6	79%	2
GWYDIR REGULATED RIVER WATER SOURCE	26-Aug-16	17-Sep-16	35	23	120	17.1	75%	120	17.1	75%	2
GWYDIR REGULATED RIVER WATER SOURCE	3-Sep-16	7-Sep-16	20	5	25	3.6	71%	25	3.6	71%	2

Valley	Event start	Event end	%	Event Days	Historic flows			Supp use returned			Classification
					Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	
GWYDIR REGULATED RIVER WATER SOURCE	3-Sep-16	12-Sep-16	10	10	50	7.1	71%	50	7.1	71%	2
GWYDIR REGULATED RIVER WATER SOURCE	3-Sep-16	15-Sep-16	10	13	67	9.6	74%	67	9.6	74%	2
GWYDIR REGULATED RIVER WATER SOURCE	3-Sep-16	9-Sep-16	15	7	35	5.0	71%	35	5.0	71%	2
GWYDIR REGULATED RIVER WATER SOURCE	3-Sep-16	19-Sep-16	50	17	91	13.0	76%	91	13.0	76%	2
GWYDIR REGULATED RIVER WATER SOURCE	6-Sep-16	9-Sep-16	10	4	20	2.9	71%	20	2.9	71%	2
GWYDIR REGULATED RIVER WATER SOURCE	6-Sep-16	7-Sep-16	10	2	10	1.4	71%	10	1.4	71%	2
GWYDIR REGULATED RIVER WATER SOURCE	11-Sep-16	16-Sep-16	10	6	33	4.7	79%	33	4.7	79%	2
GWYDIR REGULATED RIVER WATER SOURCE	12-Sep-16	17-Sep-16	10	6	34	4.9	81%	34	4.9	81%	2
GWYDIR REGULATED RIVER WATER SOURCE	12-Sep-16	18-Sep-16	10	7	40	5.7	82%	40	5.7	82%	2
GWYDIR REGULATED RIVER WATER SOURCE	12-Sep-16	30-Sep-16	125	19	112	16.0	84%	112	16.0	84%	2
GWYDIR REGULATED RIVER WATER SOURCE	12-Sep-16	16-Sep-16	10	5	28	4.0	80%	28	4.0	80%	2
GWYDIR REGULATED RIVER WATER SOURCE	14-Sep-16	26-Sep-16	125	13	78	11.1	86%	78	11.1	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	15-Sep-16	5-Oct-16	125	21	126	18.0	86%	126	18.0	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	15-Sep-16	15-Oct-16	125	31	186	26.6	86%	186	26.6	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	15-Sep-16	24-Oct-16	125	40	240	34.3	86%	240	34.3	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	15-Sep-16	25-Oct-16	125	41	246	35.1	86%	246	35.1	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	23-Sep-16	26-Sep-16	125	4	24	3.4	86%	24	3.4	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	13-Sep-16	28-Sep-16	125	16	95	13.6	85%	95	13.6	85%	2
GWYDIR REGULATED RIVER WATER SOURCE	15-Sep-16	26-Sep-16	125	12	72	10.3	86%	72	10.3	86%	2

Valley	Event start	Event end	%	Event Days	Historic flows			Supp use returned			Classification
					Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	
GWYDIR REGULATED RIVER WATER SOURCE	15-Sep-16	15-Oct-16	125	31	186	26.6	86%	186	26.6	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	24-Oct-16	10-Nov-16	10	18	108	15.4	86%	108	15.4	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	25-Dec-16	5-Jan-17	35	12	34	4.9	40%	34	4.9	40%	2
GWYDIR REGULATED RIVER WATER SOURCE	20-Mar-17	29-Mar-17	7	10	23	3.3	33%	32	4.6	46%	3
GWYDIR REGULATED RIVER WATER SOURCE	6-Jul-17	10-Jul-17	10	5	15	2.1	43%	30	4.3	86%	3
GWYDIR REGULATED RIVER WATER SOURCE	15-Oct-17	19-Oct-17	20	5	5	0.7	14%	9	1.3	26%	3
GWYDIR REGULATED RIVER WATER SOURCE	13-Oct-17	18-Oct-17	8	6	5	0.7	12%	8	1.1	19%	3
GWYDIR REGULATED RIVER WATER SOURCE	15-Oct-17	17-Oct-17	15	3	3	0.4	14%	5	0.7	24%	3
GWYDIR REGULATED RIVER WATER SOURCE	13-Oct-17	21-Oct-17	25	9	10	1.4	16%	17	2.4	27%	3
GWYDIR REGULATED RIVER WATER SOURCE	21-Oct-17	26-Oct-17	7	6	4	0.6	10%	16	2.3	38%	3
GWYDIR REGULATED RIVER WATER SOURCE	16-Oct-17	17-Oct-17	15	2	2	0.3	14%	4	0.6	29%	3
GWYDIR REGULATED RIVER WATER SOURCE	14-Feb-20	16-Feb-20	20	3	6	0.9	29%	6	0.9	29%	2
GWYDIR REGULATED RIVER WATER SOURCE	14-Feb-20	20-Feb-20	10	7	18	2.6	37%	18	2.6	37%	2
GWYDIR REGULATED RIVER WATER SOURCE	26-Feb-20	3-Mar-20	16	7	35	5.0	71%	35	5.0	71%	2
GWYDIR REGULATED RIVER WATER SOURCE	27-Feb-20	29-Feb-20	4	3	15	2.1	71%	15	2.1	71%	2
GWYDIR REGULATED RIVER WATER SOURCE	28-Feb-20	2-Mar-20	17	4	20	2.9	71%	20	2.9	71%	2
GWYDIR REGULATED RIVER WATER SOURCE	6-Mar-20	8-Mar-20	7	3	18	2.6	86%	18	2.6	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	11-Mar-20	15-Mar-20	5	5	30	4.3	86%	30	4.3	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	11-Mar-20	17-Mar-20	10	7	42	6.0	86%	42	6.0	86%	2

Valley	Event start	Event end	%	Event Days	Historic flows			Supp use returned			Classification
					Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	
GWYDIR REGULATED RIVER WATER SOURCE	11-Mar-20	16-Mar-20	8	6	36	5.1	86%	36	5.1	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	11-Mar-20	13-Mar-20	4	3	18	2.6	86%	18	2.6	86%	2
GWYDIR REGULATED RIVER WATER SOURCE	26-Mar-20	31-Mar-20	7	6	29	4.1	69%	36	5.1	86%	3
GWYDIR REGULATED RIVER WATER SOURCE	9-Apr-20	14-Apr-20	9	6	30	4.3	71%	30	4.3	71%	2
GWYDIR REGULATED RIVER WATER SOURCE	12-Apr-20	15-Apr-20	9	4	20	2.9	71%	20	2.9	71%	2
GWYDIR REGULATED RIVER WATER SOURCE	12-Apr-20	18-Apr-20	10	7	35	5.0	71%	35	5.0	71%	2
GWYDIR REGULATED RIVER WATER SOURCE	13-Apr-20	19-Jun-20	10	68	215	30.7	45%	226	32.3	47%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	11-Dec-04	17-Dec-04	100	7	35	5.0	71%	35	5.0	71%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	11-Dec-04	19-Dec-04	100	9	36	5.1	57%	36	5.1	57%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	10-Dec-04	20-Dec-04	100	11	37	5.3	48%	39	5.6	51%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	10-Dec-04	23-Dec-04	100	14	47	6.7	48%	50	7.1	51%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	10-Dec-04	26-Dec-04	100	17	59	8.4	50%	63	9.0	53%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	28-Dec-04	31-Dec-04	29	4	16	2.3	57%	20	2.9	71%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	28-Dec-04	1-Jan-05	45	5	20	2.9	57%	25	3.6	71%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	28-Dec-04	2-Jan-05	45	6	25	3.6	60%	30	4.3	71%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	10-Dec-04	20-Dec-04	100	11	35	5.0	45%	38	5.4	49%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	28-Dec-04	1-Jan-05	45	5	20	2.9	57%	25	3.6	71%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	30-Jun-05	30-Jun-05	100	1	2	0.3	29%	2	0.3	29%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	1-Jul-05	5-Jul-05	100	5	9	1.3	26%	10	1.4	29%	3

Valley	Event start	Event end	%	Event Days	Historic flows			Supp use returned			Classification
					Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	
LOWER NAMOI REGULATED RIVER WATER SOURCE	15-Jul-05	18-Jul-05	100	4	20	2.9	71%	20	2.9	71%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	17-Dec-05	20-Dec-05	50	4	6	0.9	21%	9	1.3	32%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	17-Dec-05	20-Dec-05	50	4	6	0.9	21%	9	1.3	32%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	24-Dec-07	26-Dec-07	14	3	15	2.1	71%	15	2.1	71%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	24-Dec-07	4-Jan-08	96	12	60	8.6	71%	60	8.6	71%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	24-Dec-07	29-Dec-07	80	6	30	4.3	71%	30	4.3	71%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	24-Dec-07	27-Dec-07	0	4	20	2.9	71%	20	2.9	71%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	26-Jan-08	28-Jan-08	10	3	13	1.9	62%	13	1.9	62%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	7-Feb-08	12-Feb-08	11	6	30	4.3	71%	30	4.3	71%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	30-Nov-08	9-Dec-08	100	10	2	0.3	3%	10	1.4	14%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	1-Dec-08	6-Dec-08	55	6	0	0.0	0%	4	0.6	10%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	15-Dec-08	21-Dec-08	49	7	15	2.1	31%	26	3.7	53%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	15-Dec-08	19-Dec-08	49	5	9	1.3	26%	18	2.6	51%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	15-Dec-08	24-Dec-08	77	10	24	3.4	34%	39	5.6	56%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	15-Feb-09	17-Mar-09	15	31	149	21.3	69%	150	21.4	69%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	29-Dec-09	15-Jan-10	100	18	78	11.1	62%	78	11.1	62%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	28-Dec-09	13-Jan-10	100	17	70	10.0	59%	70	10.0	59%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	28-Dec-09	30-Jan-10	95	34	150	21.4	63%	153	21.9	64%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	28-Dec-09	15-Jan-10	95	19	80	11.4	60%	80	11.4	60%	2

Valley	Event start	Event end	%	Event Days	Historic flows			Supp use returned			Classification
					Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	
LOWER NAMOI REGULATED RIVER WATER SOURCE	28-Dec-09	20-Jan-10	100	24	105	15.0	63%	105	15.0	63%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	14-Feb-10	18-Feb-10	100	5	24	3.4	69%	25	3.6	71%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	2-Aug-10	30-Aug-10	14	29	122	17.4	60%	122	17.4	60%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	13-Nov-10	30-Nov-10	100	18	90	12.9	71%	90	12.9	71%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	14-Nov-10	2-Dec-10	47	19	95	13.6	71%	95	13.6	71%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	3-Dec-10	8-Dec-10	10000	6	30	4.3	71%	30	4.3	71%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	6-Dec-10	2-Jan-11	100	28	140	20.0	71%	140	20.0	71%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	29-Dec-10	9-Jan-11	100	12	60	8.6	71%	60	8.6	71%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	1-Jan-11	7-Jan-11	100	7	35	5.0	71%	35	5.0	71%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	3-Jan-11	10-Jan-11	100	8	40	5.7	71%	40	5.7	71%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	8-Jan-11	26-Jan-11	30	19	95	13.6	71%	95	13.6	71%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	29-Dec-10	7-Jan-11	100	10	50	7.1	71%	50	7.1	71%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	18-Jun-11	30-Jun-11	10	13	41	5.9	45%	41	5.9	45%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	1-Jul-11	10-Jul-11	10	10	31	4.4	44%	31	4.4	44%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	3-Oct-11	12-Oct-11	69	10	50	7.1	71%	50	7.1	71%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	25-Nov-11	2-Jan-12	100	39	194	27.7	71%	195	27.9	71%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	31-Jan-12	22-Mar-12	100	52	260	37.1	71%	260	37.1	71%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	31-Jan-12	22-Mar-12	100	52	260	37.1	71%	260	37.1	71%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	1-Feb-12	22-Mar-12	100	51	255	36.4	71%	255	36.4	71%	2

Valley	Event start	Event end	%	Event Days	Historic flows			Supp use returned			Classification
					Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	
LOWER NAMOI REGULATED RIVER WATER SOURCE	1-Feb-12	22-Mar-12	100	51	255	36.4	71%	255	36.4	71%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	10-May-12	11-May-12	100	2	8	1.1	57%	8	1.1	57%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	15-Jul-12	15-Jul-12	1	1	4	0.6	57%	5	0.7	71%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	16-Jul-12	1-Aug-12	14	17	85	12.1	71%	85	12.1	71%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	29-Jan-13	15-Feb-13	100	18	37	5.3	29%	53	7.6	42%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	29-Jan-13	5-Feb-13	100	8	10	1.4	18%	16	2.3	29%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	2-Feb-13	4-Feb-13	10	3	4	0.6	19%	6	0.9	29%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	2-Mar-13	17-Mar-13	35	16	64	9.1	57%	80	11.4	71%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	2-Mar-13	20-Mar-13	30	19	76	10.9	57%	95	13.6	71%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	24-Jul-13	24-Jul-13	2	1	4	0.6	57%	4	0.6	57%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	26-Nov-13	7-Dec-13	6	12	0	0.0	0%	5	0.7	6%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	28-Mar-14	8-May-14	14	42	123	17.6	42%	150	21.4	51%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	28-Mar-14	8-Apr-14	20	12	38	5.4	45%	42	6.0	50%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	24-Jul-15	4-Aug-15	100	12	43	6.1	51%	50	7.1	60%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	31-Jul-15	14-Aug-15	100	15	57	8.1	54%	75	10.7	71%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	31-Aug-15	13-Sep-15	100	14	47	6.7	48%	70	10.0	71%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	12-Nov-15	12-Nov-15	100	1	3	0.4	43%	3	0.4	43%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	28-Jan-16	6-Feb-16	55	10	17	2.4	24%	18	2.6	26%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	6-Jun-16	14-Jun-16	100	9	4	0.6	6%	4	0.6	6%	2

Valley	Event start	Event end	%	Event Days	Historic flows			Supp use returned			Classification
					Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	
LOWER NAMOI REGULATED RIVER WATER SOURCE	22-Jun-16	30-Jun-16	100	9	28	4.0	44%	34	4.9	54%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	23-Jun-16	24-Jun-16	10	2	5	0.7	36%	7	1.0	50%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	26-Jun-16	30-Jun-16	200	5	18	2.6	51%	20	2.9	57%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	1-Jul-16	20-Aug-16	100	51	229	32.7	64%	235	33.6	66%	3
LOWER NAMOI REGULATED RIVER WATER SOURCE	24-Aug-16	30-Sep-16	91	38	187	26.7	70%	187	26.7	70%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	24-Aug-16	30-Sep-16	45	38	187	26.7	70%	187	26.7	70%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	15-Sep-16	6-Oct-16	100	22	110	15.7	71%	110	15.7	71%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	15-Sep-16	4-Oct-16	100	20	100	14.3	71%	100	14.3	71%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	25-Feb-20	27-Feb-20	100	3	12	1.7	57%	12	1.7	57%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	11-Mar-20	16-Mar-20	100	6	30	4.3	71%	30	4.3	71%	2
LOWER NAMOI REGULATED RIVER WATER SOURCE	7-Apr-20	20-Apr-20	100	14	68	9.7	69%	70	10.0	71%	3
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	10-Nov-05	25-Nov-05	0	16	0	0.0	0%	44	6.3	39%	3
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	12-Jun-07	19-Jun-07	0	8	0	0.0	0%	7	1.0	13%	3
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	1-Jan-08	2-Jan-08	0	2	6	0.9	43%	6	0.9	43%	2
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	29-Dec-09	4-Jan-10	0	7	19	2.7	39%	19	2.7	39%	2
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	16-Feb-10	19-Feb-10	0	4	15	2.1	54%	16	2.3	57%	3

Valley	Event start	Event end	%	Event Days	Historic flows			Supp use returned			Classification
					Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	1-Aug-10	2-Aug-10	100	2	2	0.3	14%	2	0.3	14%	2
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	1-Aug-10	12-Aug-10	100	12	25	3.6	30%	25	3.6	30%	2
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	12-Aug-10	22-Aug-10	100	11	44	6.3	57%	44	6.3	57%	2
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	6-Sep-10	14-Sep-10	100	9	36	5.1	57%	36	5.1	57%	2
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	11-Sep-10	18-Sep-10	100	8	32	4.6	57%	32	4.6	57%	2
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	13-Sep-10	19-Sep-10	100	7	28	4.0	57%	28	4.0	57%	2
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	16-Sep-10	23-Sep-10	100	8	32	4.6	57%	32	4.6	57%	2
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	18-Sep-10	24-Sep-10	100	7	28	4.0	57%	28	4.0	57%	2
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	18-Oct-10	24-Oct-10	100	7	28	4.0	57%	28	4.0	57%	2
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	16-Nov-10	24-Nov-10	100	9	36	5.1	57%	36	5.1	57%	2
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	1-Dec-10	30-Jan-11	100	61	244	34.9	57%	244	34.9	57%	2
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	4-Mar-12	10-Apr-12	100	38	152	21.7	57%	152	21.7	57%	2

Valley	Event start	Event end	%	Event Days	Historic flows			Supp use returned			Classification
					Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	12-Jul-12	18-Jul-12	100	7	28	4.0	57%	28	4.0	57%	2
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	13-Jul-12	9-Aug-12	100	28	112	16.0	57%	112	16.0	57%	2
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	22-Jun-16	1-Jul-16	100	10	28	4.0	40%	28	4.0	40%	2
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	22-Jun-16	29-Jun-16	100	8	22	3.1	39%	22	3.1	39%	2
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	9-Jul-16	17-Jul-16	100	9	35	5.0	56%	36	5.1	57%	3
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	13-Jul-16	17-Jul-16	100	5	20	2.9	57%	20	2.9	57%	2
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	21-Jul-16	31-Jul-16	100	11	44	6.3	57%	44	6.3	57%	2
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	4-Aug-16	13-Aug-16	100	10	40	5.7	57%	40	5.7	57%	2
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	2-Sep-16	11-Nov-16	100	71	284	40.6	57%	284	40.6	57%	2
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	14-Nov-16	18-Nov-16	100	5	20	2.9	57%	20	2.9	57%	2
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	17-Dec-16	23-Dec-16	100	7	28	4.0	57%	28	4.0	57%	2
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	20-Feb-20	26-Feb-20	100	7	15	2.1	31%	15	2.1	31%	2

Valley	Event start	Event end	%	Event Days	Historic flows			Supp use returned			Classification
					Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	Total existing target days – all gauges	Average existing target days per gauge	Portion days met (%)	
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	5-Apr-20	13-Apr-20	100	9	36	5.1	57%	36	5.1	57%	2
MACQUARIE AND CUDGEGONG REGULATED RIVERS WATER SOURCE	11-Apr-20	21-Apr-20	100	11	44	6.3	57%	44	6.3	57%	2