NSW GOVERNMENT

Natural Resources Commission

Final report

Review of the Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources 2012

September 2019

Acknowledgement of Country

The Natural Resource Commission acknowledges and pays respect to all the traditional owners and their Nations of the Murray-Darling Basin and the Barwon-Darling area. The Commission recognises and acknowledges that the traditional owners have a deep cultural, social, environmental, spiritual and economic connection to their lands and waters. We value and respect the knowledge and cultural values in natural resource management and the contributions of earlier generations, including the Elders.

In relation to the Barwon-Darling River, the Commission pays its respects to Barkandji, Gomeroi, Murrawarri, Ngemba, Ngiyampaa, Wangaaypuwan and Wayilwan traditional owners past, present and future, as well as those of other nations for whom this river is significant. The Commission hopes that the involvement of Aboriginal nations throughout the review process will help to shape collaborative water planning and sharing that is beneficial to their people and their country.

Aboriginal and Torres Strait Islander people are advised that this report may contain images and quotes of deceased persons

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Cover image: The dry Darling River on the boundary of a graziers' property, south of Wilcannia. The remaining water is saline and thick with algae. The river usually acts as their boundary and supplies water for stock and domestic uses (Natural Resources Commission, April 2019).

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Glossary, acronyms and scientific units

Act	*Water Management Act 2000* (NSW)
cm	Centimetre (unit of length equal to one hundredth (1×10^{-2}) of a metre)
Commission	the Natural Resources Commission
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DoI-Water	(former) NSW Department of Industry – Water
DPI-Fisheries	Department of Primary Industries - Fisheries
DPIE-EES	Department of Planning, Industry and Environment – Environment, Energy and Science (the former Office of Environment and Heritage)
DPIE-Water	Department of Planning, Industry and Environment – Water
GL	Gigalitre (unit of volume equivalent to one billion (1×10^{9}) litres)
IDEL	Individual Daily Extraction Limit
IT	Information Technology
IWG	Interagency Working Group
L	Litre (unit of volume)
LGA	Local Government Area
LTAAEL	Long-Term Average Annual Extraction Limit
m	Metre (unit of length)
MDBA	Murray-Darling Basin Authority
MER Plan	Monitoring, Evaluation and Reporting Plan
MLDRIN	Murray Lower Darling Rivers Indigenous Nations
ML	Megalitre (unit of volume equivalent to one million (1×10^{6}) litres)
µg	Microgram (unit of mass equal to one millionth (1×10^{-6}) of a gram)
µS	MicroSiemens (unit of electric conductivity equal to one millionth (1×10^{-6}) of a Siemens)
mm	Millimetre (unit of length equal to one thousandth (1×10^{-3}) of a metre)
mS	MilliSiemens (unit of electric conductivity equal to one thousandth (1×10^{-3}) of a Siemens)
NBAN	Northern Basin Aboriginal Nations
NSW	New South Wales
NTU	Nephelometric Turbidity Unit
OEH	(former) Office of Environment and Heritage
Plan	the *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources 2012* (NSW)
SMART	Specific, Measurable, Achievable, Realistic, Time-bound
TDEL	Total Daily Extraction Limit

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Executive summary

The Barwon-Darling is an ecosystem in crisis. The current cease to flow period is the longest since records began. Communities that live along the river are under serious stress. The catchment, including its upstream tributaries, have been highly modified by development over the past several decades, impacting the systems' resilience. An intense drought, significant upstream water extraction, an apparent climate shift and the rules in the *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources 2012* (the Plan) have all contributed to poor ecological, social and cultural outcomes.

Communities who can no longer fish, swim or drink the river water have called for the Plan to be fundamentally overhauled. These calls have been matched by graziers who have struggled to provide for their stock as the river has dried up. At the same time, irrigators have been criticised even as they too have been unable to pump due to cease to flow events increasing in frequency and duration.

As a result of these events, the former Minister for Regional Water, the Hon Niall Blair MLC, requested that the Natural Resources Commission (the Commission) bring forward its statutory review of the Plan. This review considers the extent to which the Plan has contributed to environmental, social and economic outcomes, and provides advice on whether changes to some provisions of the Plan are warranted. The Commission's draft report was released for public consultation on 24 July 2019. The significant public interest in the Plan and the draft report resulted in the Commission receiving 1,231 submissions, including 121 unique submissions.[1] These submissions were considered in this, the final report, which was delivered to the Minister for Water, the Hon Melinda Pavey MP on 6 September 2019.

The *Water Management Act 2000* (the Act) clearly prioritises protection of the water source and dependent ecosystems, followed by basic landholder rights including native title, and then other extractive uses. The current Plan has not effectively achieved this prioritisation.

The riverine ecosystems in the Barwon-Darling are under great pressure as indicated by recent mass fish deaths immediately downstream of the Barwon-Darling Plan area. Aquatic species such as the river mussel have suffered losses that will take decades to recover, if they recover at all. A highly variable, unregulated river such as the Barwon-Darling needs to be managed not just for long term averages, but for its extremes. Instead, changes to the water sharing rules in the Plan area have resulted in an increased allowance for extractive use at lower flow classes that are critical to the environment. These provisions benefit the economic interests of a few upstream users over the ecological and social needs of the many.

The Commission recognises that altering the rules of the Plan cannot in itself fix all of the issues and concerns identified for the river system. However, there is clear evidence to indicate that the Plan rules are resulting in more frequent and longer cease to flow periods. The current cease to flow period of over 11 months is the longest in recorded history and is likely to continue. It should also be recognised that the Barwon-Darling is a unique and complex system, and development of the Plan is inherently complex. The Plan must be able to cope with a significant amount of uncertainty and risk, with a wide range of potential impacts from upstream extraction, and climate variability.

[1] Most submissions supported the Commission's draft report and called on the government to act promptly in implementing its recommendations.

In amending and then remaking the Plan, the Minister for Water and Minister for Energy and Environment should first and foremost ensure environmental flow needs and basic landholder rights are met, delivering water when and where it is needed to protect dependent threatened species and support communities that also depend upon the river.

Positive progress is being made by Government

The NSW Government has put a considerable amount of effort into responding to the recommendations from the Ken Matthews report. The Commission recognises the NSW Department of Planning, Industry and Environment – Water (DPIE-Water) has undertaken significant and commendable reform since 2017; however, steps to improve water management need to be accelerated and further extended.

The Water Renewal Taskforce has sought to address concerns through improved metering, transparency, compliance and enforcement, and management of environmental water. Further, in recognition of the environmental and social needs of the system, the Government has put in place a number of section 324 orders under the Act over the past year to ensure that water held and released for the environment is not available for extraction. These are all much needed reforms and the Government has progressed them significantly in a relatively short period of time. The creation of the Natural Resources Access Regulator, for instance, is a stand out achievement. The Commission recognises that many of the recommendations in this report have already been put forth by the Interagency Working Group (IWG) for better management of environmental water. It is to the NSW and Commonwealth Governments' credit that there has already been sufficient work on these issues such that the Commission's recommendations can be implemented now or in the near future.

The Commission also notes recent NSW Government announcements to protect native fish at risk of more fish deaths.[2]

In the upcoming amendments to the Plan, DPIE-Water is proposing to include or enhance provisions for individual daily extraction rates, protection of resumption of flows, active management, and protection of upstream held environmental water. DPIE-Water is also working with the relevant Commonwealth departments to secure A Class licences, which have access to low flows.

These actions are the first steps towards delivering on the Act's priorities and rebuilding community trust in governments' management of water sources. It is critical that the proposed amendments are carried through and that in settling the details of these rules, the protection of the environment and basic landholder rights are prioritised in accordance with the Act.

Additional protections needed to enhance environmental and social outcomes

While the Commission recognises and supports the efforts described above, more needs to be done to address the limitations of the Plan that are contributing to poor outcomes. In particular, further action is needed to address the extraction of water during critical low flow periods. Using best available evidence the Commission has identified new flow targets to protect critical ecosystems and enhance river health. The Plan rules need to be adjusted to ensure these flow targets are met. Most critically, this will require further adjustment of rules for A Class licences, including raising the cease to pump level, in addition to the reforms proposed by DPIE-Water.

2 Minister for Agriculture, Minister for Western NSW Adam Marshall (2019), *Media release: combating horror summer of fish kills*, available at https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/1154650/Combating-horror-summer-of-fish-kills.pdf

The Commission recommends removal of the 'imminent flow' allowance. In addition, the Commission recommends protection of flows under new provisions that enable the implementation of an updated *Interim Unregulated Flow Management Plan for the North- West* (the *Interim Flow Plan*). The Commission also supports securing A Class licences to reduce exposure to extraction in low flow classes. It is also important that there is acknowledgement of native title rights to water in the Plan, and provision of interim allocations for Aboriginal nations and organisations.

The amendments provide an opportunity to reverse the current trend towards collapse of the river system so that the river and its dependent species, communities and industries are put on a path towards long term health and resilience. To ensure that the necessary steps are taken as quickly as possible, the Commission recommends action in three stages:

1. DPIE-Water should make a set of immediate amendments to the Plan by 2020 as part of the Murray-Darling Basin Authority (MDBA) accreditation process to provide a safety net for the environment and landholders and to rebuild social licence for water management in local communities.
2. DPIE-Water should commence work on remaking the Plan in line with the Act's priorities to enable a new Plan to be implemented in 1 July 2023, when the current Plan expires. This should be an open, evidence based and independently peer reviewed process to develop a new Plan consistent with the principles in the Act and current best practice of active and adaptive management.[3]
3. DPIE-Water should take steps to improve management of connectivity across the Northern Basin, including review of upstream water sharing plans for their connectivity to the Barwon-Darling and contribution to improved outcomes.

The Commission has identified 17 recommendations to guide and further detail these three stages (see **Table 1**). These recommendations are based upon sound science and legislative obligations. It is recognised there will be impacts upon A Class license irrigators. However, the Act is clear that firstly the needs of the river and its dependent ecosystems and secondly the provision of basic landholder rights must not be prejudiced by other uses.

In addition to the changes recommended for the Plan, the Commission also supports efforts to address the reduction of inflows, and encourages more to be done in this regard. In particular, the provisions enabling the current *Interim Flow Plan* should be updated based on best available information and trialled as soon as possible to identify and address technical implementation issues. Held environmental water from upstream should also be protected throughout the Basin and not be re-regulated at the start of each plan area, as this water would not historically have been available. This would ensure that these flows cannot be extracted and are available for ecosystems downstream.

The Commission recognises that several commendable initiatives are being rolled out in NSW such as: improved management of floodplain harvesting; improved gauging, metering and telemetry; and active management in other unregulated tributaries. These initiatives should all assist in meeting the Plan objectives. Further, the *Murray-Darling Basin Plan* (the *Basin Plan*) itself, including the sustainable diversion limits and implementation of the *Northern Basin Toolkit*, should also have a positive effect. These steps will be critical for enabling the Plan to

[3] The Commission acknowledges many community submissions called for a full and immediate implementation of the draft report recommendations. However, we consider the timing and sequencing of our recommendations, as presented in our roadmap towards a new Plan in 2023, to be reasonable in the context of the extensive work involved.

fully meet its objectives. However, these planned initiatives should not deter immediate steps from being taken to enhance the Plan itself. Many of the earliest steps that can be taken are policy changes, recognising that infrastructure changes would take longer.

Changed flow regime combined with Plan rules resulting in poor outcomes

Current Plan provisions fail to protect ecologically important flow pulses and low flows, which are under increased stress from upstream extraction and drought conditions. Analysis of gauging data in the Barwon-Darling shows that cease to flow periods have become longer at the downstream gauges in recent years, with annual cease to flow periods of over 80 days at Wilcannia since 2013.[4] The recent Vertessy report indicated that extraction under A Class rules is effectively reducing the volume, duration and magnitude of low flows downstream, and prolonging the associated environmental and social impacts.[5] The rules effectively prioritise upstream water users, resulting in impacts increasing further downstream.

In Brewarrina, Bourke and Wilcannia there have been longer periods between algal suppression flows under the Plan compared to during both the Millennium drought in 2000-10 and in the period 1990-99.[6] The risk of decreasing water quality and increasing algal blooms has elevated under the Plan rules.

The Plan also affords no formalised protection of held environmental water – that is, the licenced water purchased by the Commonwealth government for environmental purposes. Instead, it allows for the extraction of these flows unless temporary Ministerial water restrictions (section 324 orders) are put in place. The discretionary nature of these restrictions reduces certainty and is administratively cumbersome.

Some stakeholders argue that the Plan is fully achieving its desired environmental outcomes if extraction is within the long-term average annual extraction limit (LTAAEL), and that 94 percent of water is allocated to the environment. Use of this statistic as an indicator of environmental outcomes is highly misleading as this percentage is based on an average taken over more than 100 years and includes major floods that significantly skew the average. While the LTAAEL has a function in assessing long-term compliance with extraction limits, adherence to the LTAAEL is not appropriate for assessing whether the Plan has met its environmental and social objectives, particularly for such a highly variable system. When and where the water is taken is critically important in this system, not just volume extracted over many years.

While measurement of flows and take at a point in the system are not directly comparable to the 94 percent figure based on modelling, they do provide a clearer sense of the variability of actual take. DPIE-Water have provided tributary inflow data for the Barwon-Darling for the Plan period. Based on this data, average annual percentage take between 2012-13 and 2018-19, compared to Barwon-Darling tributary inflow volumes was about 13 percent. An even greater proportion of water (just over 28 percent in 2013-14) was taken in years with lower flows, provided water levels were not below cease to pump thresholds. The Commission recognises that in years of very low flows, cease to pump thresholds may not be reached and this is reflected in extraction volumes such as 2018-19 when extraction was 0.1 percent of tributary inflows.

4 Carlile, P. (2017), *Hydrological impacts of water management arrangements on low flows in the Barwon-Darling River system*, advice to the Commonwealth Environmental Water Office

5 Vertessy, R., Barma, D., Baumgartner, L., Mitrovic, S., Sheldon, F., Bond, N. (2019), *Independent Assessment of the 2018-19 fish deaths in the lower Darling – Final Report*, for the Australian Government, 29 March 2019.

6 MDBA (2018), *Ecological needs of low flows in the Barwon-Darling*, available at https://www.mdba.gov.au/sites/default/files/pubs/ecological-needs-low-flows-barwon-darling_0.docx.

Environmental, social and cultural impacts

Before flow regulation across the Northern Basin, the Barwon-Darling at Wilcannia flowed 94 percent of the time,[7] supporting a flowing water ecology. Extended cease to flow conditions significantly disadvantage those species that require flowing water (Golden Perch, Silver Perch, Murray Cod, river mussels, river snails).[8] The Sustainable Rivers Audit indicates that populations of Silver Perch, a previously abundant species, have seriously declined.[9]

Site visits conducted in 2019 indicated large numbers of dead river mussels varying in number from a few to thousands, with live mussels only found in one location, in Tilpa. These surveys appeared to encompass most of the river mussel population of the Barwon-Darling, representing a far greater impact on riverine biota than the fish deaths that triggered two independent reports. The decline in river mussels is indicative of a broader, longer-term decline in river health that affects endangered species including Murray Cod and Silver Perch.

Social outcomes under the Plan have also been unsatisfactory especially for towns, graziers and Aboriginal communities. Many councils have had to implement critical water supply management strategies and are shifting to bore water for the provision of town drinking water, despite utility water having priority over other licenced uses in the Plan. Community stakeholders are broadly dissatisfied with the provision of water under the Plan. Water scarcity, poor water quality and water restrictions are impacting residents' physical and mental health, and limiting recreational activities such as swimming, fishing, sports and gardening. Further, basic landholder rights are being negatively impacted by allowable upstream extraction in the Plan area, despite the Act requirement that these rights take priority.[10]

While the drought and upstream diversions are major contributors to the poor social outcomes, the same Plan provisions noted to be impacting on environmental outcomes also impact on social outcomes. Extractions following the commencement of the 2012 Plan rules have impacted significantly on baseflows, particularly downstream of Bourke. This has affected those communities and landholders reliant on the river for domestic and stock water supplies, town water supply, community and social needs.[11]

Cultural outcomes as stated in the Plan have also not been achieved, particularly in relation to native title. Act provisions specify that the water required to exercise native title rights are reserved as basic landholder rights. However, the Plan has not been updated to reflect the Barkandji's native title rights determined in 2015 and 2017, part of which is in the Plan area.[12]

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7 Mallen-Cooper, M. (2019), *Barwon-Darling Water Sharing Plan: opportunities to link ecology, river hydraulics, culture, and social values to meet the objectives of the Water Management Act*, discussion paper for the Natural Resources Commission.

8 Ibid.

9 MDBA (2012), *Sustainable Rivers Audit 2: The ecological health of rivers in the Murray–Darling Basin at the end of the Millennium Drought (2008–2010)*, available at https://www.mdba.gov.au/publications/mdba-reports/sustainable-rivers-audit-2

10 Basic landholder rights include domestic and stock rights, native title rights and harvestable rights (dams).

11 MDBA (2017), *Observed flows in the Barwon-Darling 1990-2017, a hydrological investigation*, available at https://www.mdba.gov.au/sites/default/files/pubs/observed-flows-barwon-darling.pdf; Vertessy, R., Barma, D., Baumgartner, L., Mitrovic, M., Sheldon, F., Bond, N. (2019), *Independent Assessment of the 2018-19 fish deaths in the lower Darling – Final Report*, for the Australian Government, 29 March 2019; Sheldon, F. (2019), *Technical review of the water sharing plan for the Barwon-Darling unregulated and alluvial water sources 2012*, advice to the Natural Resources Commission.

12 *Barkandji Traditional Owners #8 v Attorney-General of New South Wales 2015 and Barkandji Traditional Owners #8 (Part B) v Attorney-General of New South Wales 2017.*

The health and well-being of Aboriginal people is strongly connected to the health of the river. Aboriginal community members repeatedly told the Commission that the lack of flows since 2012 has resulted in poor water quality, an inability to swim or fish, damage to culturally significant places, lack of social cohesion and a decline in cultural practices.

> "*In the last five years our elders are giving up and dying. Then our young people are committing suicide. And it's hurting because of the river. How can I teach culture when they're taking our beloved Barka away? There's nothing to teach if there's no river. The river is everything. It's my life, my culture. You take the water away from us, we've got nothing*." Barkandji Elder, Badger Bates in the submission from Murray Lower Darling River Indigenous Nations 2019.

Although the Plan generally meets its economic objectives around flexible access and trade opportunities for licence holders, its narrow focus on extractive uses such as irrigation ignores the potential costs and benefits to other local industries. For example, stakeholders are concerned that the local pastoral, tourism and recreation industries are being impacted by poor water quality and water shortages. There are also costs borne by consumers and ratepayers associated with additional treatment or maintenance requirements from poor quality water, or the need to shift to alternative water sources such as tankered or bottled water.

A new approach

A healthy and resilient river system is in the best interest of all stakeholders. Government should seize this opportunity to strengthen the Plan rules so that it can better achieve the requirements of the Act, restore stakeholder trust in the water planning process and increase the ability of the river ecosystem to absorb future shocks.

The Plan rules should be redesigned starting with the priorities clearly specified in the Act for water sharing. Environmental protection and basic landholder rights cannot be detrimentally impacted from lesser priorities such as extractions for irrigation. A clear set of environmental, social and economic objectives and outcomes reflecting those priorities is needed. The Plan should also allow for improved adaptability to deal with uncertainty around climate change projections, and steps should be taken to enhance transparency and reporting around Plan implementation.

DPIE-Water has developed new draft objectives, outcomes and strategies that are a considerable improvement over the current Plan. However, the Commission recommends additional improvements. DPIE-Water should include clear environmental flow targets in the amended Plan based on the best available evidence. The revised Plan objectives should explicitly include a requirement to meet the specified flow targets and the current Plan provisions should be comprehensively revised based on the new objectives, outcomes and strategies.

DPIE-Water should develop a package of Plan revisions that it can demonstrate will effectively and efficiently meet environmental and basic land holder requirements including native title. The Commission advises that this should include the detailed suite of recommendations in this report, unless DPIE-Water can demonstrate a more efficient method of achieving the outcomes.

To further enhance trust in Government, routine reporting against the flow targets should be required. This must go beyond reporting against the LTAAEL, which is not sufficient for assessing short to medium term outcomes in the highly variable Barwon-Darling. Further, DPIE-Water should be required to outline mitigating actions being taken if monitoring shows that targets are not being met. Real time monitoring of water take is essential, along with better

river flow measurement to improve assessment of outcomes and impacts of Plan rules.[13] Improved monitoring and regular reporting arrangements would increase transparency and accountability, help rebuild stakeholder confidence and support any necessary future Plan adaptation or improvement.

The Commission believes that, due to the relatively unique nature of the Barwon-Darling, the Plan needs to be subject to more regular independent review and potential amendment to ensure all reasonable steps continue to be taken in a timely manner to ensure better outcomes. This is necessary due to the system's complexity, and risks and uncertainties around knowledge gaps and climate change.

The Commission supports any efforts to address external factors that are contributing to the failure to achieve Plan outcomes. In addition to those already discussed, these efforts should include to:

- finalise and implement the *Reasonable Use Guidelines* and enhanced tracking of extraction under basic landholder rights provisions
- improve rules to account for connectivity between plans
- investigate remote telemetry to enforce cease to pump rules
- develop strategies and rules to address potential impacts of climate change
- improve riparian and floodplain management and associated in-channel refuges and improved fish passages.

Given the reliance on inflows from outside the Barwon-Darling, the Commission recognises that to achieve the desired outcomes in the Barwon-Darling will ultimately require a whole of Northern Basin approach. However, the need for an integrated Northern Basin approach should not prevent Government from taking immediate action within the scope of the Plan to address the concerns raised in this report.

Scope of the review

The Commission is tasked with assessing the extent to which the 2012 Plan has contributed to environmental, social and economic outcomes, and advising on whether changes to the Plan provisions are warranted. The Commission has drawn on a range of evidence, including targeted consultation, document review, public submissions and expert technical advice, including input from an expert panel.

Changes since the draft report

Since the draft report there have been several changes made in this the final report, including:

- cease to pump thresholds for A Class licences (recommendation 7b)
- resumption of flows (recommendation 9a)
- annual extraction limit (recommendation 10c)
- *Interim Unregulated Flow Management Plan for the North-West* (recommendation 13 and suggested action F)
- floodplain harvesting (new suggested action A).

[13] The Commission notes that implementation of the metering policy, scheduled for complete roll out in the Barwon-Darling by 1 December 2020 will provide greater transparency of licenced water take.

These changes have been prompted by a review of community submissions, emerging data and new information from government agencies as they advance preparation of the draft *Long Term Water Plan* and the draft Water Resource Plan in parallel to this review. These changes have added to the rigour of the Commission's assessment. No doubt further information will emerge after the Commission's review has ended. This reinforces the need for more frequent and transparent reviews of management decisions impacting the Plan remake and implementation.

There has been significant media attention focused on the work of Professor Sheldon and her hypothesis in the draft public report that extractions pushed the river below Bourke into hydrological drought three years earlier than the upstream section of the river. In Professor Sheldon's final technical report and this final report, the hypothesis has been amended. The hypothesis outlines how extractions from the baseflow band following the introduction of the Plan rules pushed the Barwon-Darling system below Bourke into persistence of very low flow conditions three years earlier than the river upstream.[14] This hypothesis is based upon multiple lines of evidence in the absence of modelled hydrological data for the period 2012 to 2019.[15] The impact of A Class extraction on downstream flows has been previously documented in six publicly available reports, including Professor Vertessy and the Australian Academy of Sciences.[16]

Following release of the draft report, WaterNSW commenced modelling to test this hypothesis which remains in progress at the time of finalising this report. Notwithstanding the modelling run testing one hypothesis of this review, the findings of such a model cannot either validate or discredit the remaining work of this review. Our conclusions and methods are robust, peer reviewed and transparent. The weight of scientific evidence is clear: while reduced inflows due to drought, upstream extraction, and climate change are all impacting the flows in the Barwon-Darling, the Plan provisions that allow increased access to low flows have resulted in poor ecological and social outcomes downstream of Bourke. To address these issues, changes need to be made to the Plan to protect the river's ecosystem and meet the needs of downstream landholders and communities. The task for government is to continue with the commendable reform already commenced and extend it by adopting the Commission's suite of measured recommendations.

We would like to thank all of the stakeholders and agency representatives who provided the Commission with valuable submissions, data and input to assist us in preparation of this report.

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14 Sheldon, F. (2019), *Technical review of the water sharing plan for the Barwon-Darling unregulated and alluvial water sources 2012*, advice to the Natural Resources Commission.

15 Lines of evidence used to derive this assessment includes meteorological data demonstrating the rainfall deficiencies in the three years to 2019, volumes of water extracted within the A Class licence band from 2015, knowledge of stages of drought including the progression to hydrological drought conditions and the responsiveness and catchment characteristics of the Barwon-Darling system – from Sheldon (2019), *Technical review of the water sharing plan for the Barwon-Darling unregulated and alluvial water sources 2012*, advice to the Natural Resources Commission.

16 Vertessy, R., Barma, D., Baumgartner, L., Mitrovic, M., Sheldon, F., Bond, N. (2019), *Independent Assessment of the 2018-19 fish deaths in the lower Darling – Final Report*, for the Australian Government, 29 March 2019; Australian Academy of Science (2019), *Investigation of the causes of mass fish kills in the Menindee region NSW over the summer of 2018–19*, 18 February 2019; Carlile, P. (2017), *Hydrological impacts of water management arrangements on low flows in the Barwon-Darling River system*, advice to the Commonwealth Environmental Water Office; Simpson P. (2017), *Barwon-Darling: low flow environmental watering impediments and opportunities*, report for Commonwealth Environmental Water Office, Canberra; Sheldon, F. (2017), *Characterising the ecological effects of changes in the 'low-flow hydrology' of the Barwon-Darling River*, report to the Commonwealth Environmental Water Office, Canberra; MDBA (2017), *Observed flows in the Barwon-Darling 1990-2017, a hydrological investigation*, available at https://www.mdba.gov.au/sites/default/files/pubs/observed-flows-barwon-darling.pdf.

Recommendations

Table 1: Summary table of the Commission's recommendations for DPIE–Water

	The Commission recommends that DPIE–Water:
	Amend and remake the Plan
1	DPIE-Water should: a) Amend the Plan immediately to address recommendations (2, 4, 5a, 5c, 5d, 7a, 7b, 8a, 9a, 10a, 11, 12a, 12b, 12c, 12d, 13a, 14 a, 14b 14c and 15a). b) Remake the Plan addressing recommendations (2, 3, 4, 5b, 6, 7c, 7d, 8b, 9b, 10b, 10c, 12e, 13b, 14d, 14e, 15b, 16 and 17) as part of an open, evidence based, and independently peer reviewed process to implement the new Plan on 1 July 2023. c) If DPIE-Water can demonstrate that it is not possible to implement any of the recommendations indicated in 1a) as part of the immediate amendments, then they should be implemented as soon as possible in an additional set of amendments, no later than the end of 2020.
2	Ensure that the amended and remade Plan rules, objectives and outcomes fully recognise and are consistent with the prioritisation specified in the *Water Management Act 2000*. This should include ensuring current amendment provisions (such as Part 12, Section 78(b)) are revised so that they do not prioritise avoiding impacts to extractive use over environmental and social outcomes.
3	Include a provision in the 2023 Plan that enables a review of Plan outcomes every five years to ensure all reasonable steps are taken in a timely and evidence based manner.
4	Further enhance proposed Plan revisions to implement clearly linked objectives, outcomes and performance indicators that meet SMART criteria (specific, measurable, achievable, realistic, time-bound) and are tracked to ensure progress, including: a) Identifying key environmental values, outcomes and objectives based on best available evidence, including alignment with the Barwon-Darling *Long Term Water Plan*, and inclusion of water quality targets. b) Identifying key social values, outcomes and objectives for the Plan in consultation with community stakeholders, including assessment of basic landholder rights and utility needs. c) Identifying key economic values, outcomes and objectives in consultation with the full range of industries reliant upon water in the system.
	Strengthen water metering, monitoring and compliance arrangements
5	Take steps to further improve monitoring and compliance, including: a) Implementing the metering requirements in the Barwon-Darling as a matter of urgency, including the requirement for telemetry. b) Exploring options that would allow the river operator to remotely operate pumps, enabling pumps to be switched off when the cease to pump limit has been reached, eliminating concerns around compliance with, and communication of reaching the cease to pump level. c) Strengthening the reporting requirements and accountability of WaterNSW and DPIE-Water for any agency required actions (such as tracking of performance

indicators), as well as tracking of outcomes under the Plan. This should include publicly reporting evidence of progress against outcomes-based performance indicators.

d) Including monitoring, evaluation and reporting requirements in the Plan to provide an evidence basis for performance against outcomes and support adaptive management.

Improve modelling of the Barwon-Darling

6 In remaking the Plan for 2023, DPIE-Water should:

a) Expedite the transition from IQQM to Source modelling to address issues with model capture of cease to flow and low flows.
b) Conduct an updated 'natural' model run to allow for the assessment of Plan rules on natural flow hydrology.
c) Ensure that Plan decision making incorporates observed data and modelled scenarios to deliver the best outcomes based on evidence and assessment of impacts.

Enhance the protection of low flows to improve environmental and social outcomes

7 Implement enhanced flow targets, with a particular focus on protecting low flows, to better deliver environmental and social outcomes, including:

a) Adopting the revised flow targets specified in **Chapter 9.1.1** of this report, or a similar set of targets based on best available information that can be demonstrated to meet riverine ecosystem, water quality and basic landholder needs.
b) Raising the cease to pump level for A Class licences to be consistent with the newly established flow targets.
c) Reviewing and updating the cease to pump thresholds for all access classes for the 2023 remake based on analysis of performance under the amended Plan, and best available information regarding any impacts on flow targets.
d) Assessing the impacts of current water use under B Class licences, considering observed data and information on actual user behaviour, against sustainable flow targets to be established for the new Plan.

8 Implement Individual Daily Extraction Limits (IDELs) based on the allowable extraction rates that existed before removal of restriction on pump sizes for certain licence classes and implement Total Daily Extraction Limits (TDELs) for each river reach:

a) Implement trade rules that limit trade of IDELs to maintain river reach TDEL. As a precaution, initially restrict trade to at least within river reach, with an allowance in the Plan to expand trade if no unacceptable or unintended negative impacts are identified from greater trade of IDELs.
b) In the 2023 remake of the Plan, implement TDELs based on consideration of system connectivity and best available evidence regarding any necessary changes to the TDEL to meet the flow rates that would protect the ecosystems targeted by the Plan.

9 To protect critical environmental and social flows, DPIE-Water should:

a) Develop and implement Plan provisions that protect resumption of flows updated to be consistent with the baseflows defined in the draft *Long Term Water Plan* and as described in **Chapter 9.1.4** of this report. This rule should contribute to prioritising outcomes in line with the *Water Management Act 2000*.
b) Evaluate outcomes before the 2023 remake and revise rules as necessary to achieve Plan objectives.

10 Revise Plan rules to help ensure that the flow targets can be met, considering the highly variable nature of the Barwon-Darling and potential impacts of climate change, including:

a) Eliminating the provision allowing for take of 'imminent flow'.
b) Analysing an appropriate limit on the carryover provision and replacing the unlimited carryover provision with a capped carryover provision in the 2023 remake of the Plan.
c) Analysing an appropriate limit on annual take to replace the 300 percent provision in the 2023 remake of the Plan. As a starting point, the allowable annual take should be reduced to a rolling average of 450 percent over three consecutive years. The potential ecological impacts of this and impacts on water users should be further assessed, and the provision should be consistent with the prioritisation required under the Act.

11 Support the work of the relevant Commonwealth department's efforts to secure A Class licences, including the option of voluntary buybacks, to reduce extraction of low flows.

12 Implement active management as soon as possible, applied to all flow classes and at all times, to achieve the full range of benefits, including:

a) Installing the metering, gauging and information technology (IT) systems necessary for effective active management as soon as possible to allow the transition to active management to proceed quickly and no later than the end of 2020.
b) Ensuring held environmental water within the Plan area and from upstream is protected.
c) Ensuring that the rules sufficiently allow for adaptive management by the river operators to adjust to new information about real time flows, such as loss estimates.
d) Implementing a monitoring, evaluation and reporting program that provides publicly available reporting on water allocated via active management and the estimated and gauged volumes of active environmental water protected and used instream.
e) Evaluating whether active management needs to incorporate consideration of basic landholder rights, domestic and stock, and utility take to ensure protection of held environmental water for the 2023 Plan remake.

13 To enhance connectivity in the Northern Basin to better achieve Plan outcomes:

a) Include, update and implement provisions in the Plan to enable an updated *Interim Unregulated Flow Management Plan for the North-West* to be implemented and protect flows from extraction by all licence classes. These provisions should be clear and transparent and not require a section 324 order under the *Water Management Act 2000*.
b) Revise Plan provisions as necessary to contribute to Plan objectives before the 2023 remake based on best available information.

Improve Aboriginal engagement and outcomes

14 Take steps to improve Aboriginal engagement and outcomes, including:

a) Amending current provisions to include recognition of Barkandji and Malyangapa native title rights.
b) Including a timeframe of three months to undertake initial amendments of the Plan following future determination of any other native title claims and Indigenous Land Use Agreements, and a further 12 months to undertake the detailed engagement, final amendment and allocation process.

c) Providing an interim water allocation for each nation in the Plan area. An interim allocation is required to deliver clear and immediate support for water rights that responds to a long period of inaction. This approach also acknowledges the significant amount of time needed to identify Aboriginal water-related values, objectives and outcomes, and develop final agreed flow allocations in consultation with all relevant Aboriginal organisations, including traditional owners and Aboriginal Land Councils.
d) Simplifying licence categories and processes for Aboriginal water access that can address cultural, environmental, social and economic purposes.
e) Building on the established nation-by-nation engagement already being undertaken to identify Aboriginal values and uses, objectives and outcomes, and flow allocations. This should use relevant guidelines, be well-resourced with Aboriginal staff experienced in water management, include a specific process and clear timeframe for implementation in consultation with all relevant Aboriginal groups.

Engage to improve community outcomes

15 To improve social outcomes, DPIE-Water should:

a) Review the Stakeholder Advisory Panel structure, representation and operation to develop more effective and equitable modes of engagement with local communities in the Plan area. Various forums should be used to gain comprehensive insights and the full spectrum of water users must be represented. This should begin immediately and continue until after the Plan is remade in 2023.
b) Use the revised stakeholder engagement model to identify key water-related community values, objectives and outcomes for the Plan, risks to these, as well as priorities for equitably sharing available water to inform the social objectives, outcomes, and strategies of the Plan. Specify links between flows, water quality measures and their target values to protect stated social values and uses of water.

Enhance consideration of climate change

16 In remaking the Plan for 2023, improve the consideration of climate change by:

a) Transparently modelling the impacts of various climate regimes considering ongoing environmental, basic landholder and utility requirements in and downstream of the Barwon-Darling to ensure the new Plan functions appropriately under a range of scenarios.
b) Reviewing and revising Plan provisions based on the climate modelling, and strengthen provisions to allow for Plan amendments to address longer term water availability based on evidence of changing climatic conditions.

Improve groundwater consideration in the Plan

17 Improve consideration of groundwater in the Plan by:

a) Confirming the presence, classification and extent of high priority groundwater dependent ecosystems across the Plan area through on-ground studies.
b) Clearly defining groundwater related terms in the glossary, including connectivity and terms used to describe groundwater dependent ecosystems – priority, ecological value, potential and type. Connectivity should include both discharge of groundwater to surface water and surface water recharge to shallow groundwater systems.

Table 2: Commission suggested actions for outside the Plan

	The Commission suggests that DPIE–Water:
	Improve environmental outcomes
A	Finalise development, modelling and implementation of floodplain harvesting and storage policy, recognising the importance of overland flows for river health, wetland and floodplain needs and downstream users' water supply entitlements.
B	The Secretary of the Department of Planning Industry and Environment review institutional arrangements for modelling to avoid duplication and provide a single modelling service for government decision making.
C	Revisit the NSW water quality and river flow objectives during community consultation to agree on currency of objectives and develop community understanding to improve participation in plan development and implementation.
D	Clearly state and communicate the link between water quality measurements (for example pH, dissolved oxygen, total nitrogen) and the desired water quality objectives (for example swimmable, fishable) in Plan documents.
E	Develop and apply water quality targets for various flow bands using monitoring data and models incorporating flow, catchment and instream influences to guide sustainable use and management.
F	Address the costs or benefits of varying flows and water quality associated with non-extractive industries in any cost benefit analysis. Low flows and poor water quality should be considered from an economic as well as an environmental and social point of view, including costs of works to secure, deliver and treat water supplies.
G	To enhance connectivity in the Northern Basin to better achieve Plan outcomes: a) Update the *Interim Unregulated Flow Management Plan for the North-West* based on best available information. b) Improve consideration of connectivity across the Northern Basin by updating and implementing provisions of all relevant water sharing plans enabling an updated *Interim Unregulated Flow Management Plan for the North-West*. c) Undertake necessary enhancements including gauging and tools for estimating losses as required to facilitate implementation.
H	Finalise and implement the *Reasonable Use Guidelines* by the end of 2020 so that basic landholder rights can be better enforced and properly estimated for each water sharing plan.
I	Fund and implement integrated catchment actions to improve riverine health objectives drawing on relevant agencies across the cluster of Planning, Industry and Environment. Such complementary actions include but are not limited to investment in fish passageways, refuge restoration, catchment management and private land conservation.

	Improve Aboriginal outcomes
J	Develop a NSW Aboriginal Water Strategy to provide consistent and transparent guidelines for Aboriginal involvement in water planning and management in NSW. At a minimum, the strategy should align with relevant international and national guidelines and consider: a) Aboriginal water and its uses. b) Processes for nation-by-nation engagement for allocating water for Aboriginal interests including cultural, environmental, social and economic purposes. c) Governance and decision making arrangements. d) Initiatives for capability building. e) Accountability and monitoring, evaluation and reporting requirements. f) Resources including dedicated Aboriginal staff and roles in water management and potential innovative funding arrangements such as an Aboriginal Water Trust. g) Tailored social impact management strategies.
	Improve community engagement and social outcomes
K	Develop social impact strategies in consultation with stakeholders, to ensure that key mechanisms and outcomes are implemented (such as complaints and grievance mechanisms, data sharing agreements, community-based monitoring or citizen science programs, early and ongoing engagement in Plan revisions, monitoring and evaluation plans).
	Improve climate change consideration
L	Outline a transparent process that will be initiated to review water sharing arrangements if significant changes in the availability of water in the system occurs as a result of climate change.
	Improve groundwater consideration
M	Improve groundwater understanding and management by reviewing the extent of localised fresh groundwater sources and confining beds in the sequence of aquifers to assess the lateral interconnectivity of groundwater supplies, focusing on connectivity around Wilcannia to better understand risks to freshwater used for supplementary town water.
	Review compensation requirements
N	While the Commission has provided its understanding of compensation requirements, DPIE-Water should seek their own legal advice in regards to any potential compensation implications of implementing the recommendations.

The Commission considers that DPIE-Water should report progress on the implementation of the Government's final response to our recommendations and suggested actions both to the Commission and publicly.

1 The Commission's review

This chapter provides some context for the review, including how public interest has brought the review forward. It explains the Commission's role in reviewing water sharing plans, as well as the review scope and focus, and the multiple lines of evidence that have informed the Commission's findings and recommendations.

1.1 Review context and the Commission's role

Water sharing plans are statutory instruments under the *Water Management Act 2000* (the Act). They prescribe how water is managed to support sustainable environmental, social, and economic outcomes. They are designed to provide certainty for water users over the life of the plan, which is typically ten years unless the plan is extended.

The Natural Resources Commission (the Commission) has a role under section 43A of the Act to review water sharing plans within five years of expiry and report to the Minister on:

- the extent that water sharing provisions of the plan have materially contributed to the achievement of, or the failure to achieve, environmental, social and economic outcomes
- if changes to plan provisions are warranted.[17]

Depending on its review findings, the Commission may recommend extension or replacement with a new water sharing plan. Section 43A(3A) of the Act requires the Commission to consider some potential compensation requirements resulting from recommended changes to a plan.[18] Under the Act, compensation is payable by the state to holders of access licences only in certain circumstances[19] where water allocations under a water sharing plan are reduced.

The *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources 2012* (the Plan) is not due to expire until 1 July 2023. It will, however, be updated as part of the water resource plan process required under the *Murray-Darling Basin Plan* (the *Basin Plan*). In January 2019 the then Minister for Regional Water, with the support of the Premier, requested the Commission to bring forward its independent review of the Plan due to the high public interest in its operation and downstream fish deaths.

It is acknowledged the Commission is undertaking this review during an intense drought that is highlighting many of the poor outcomes and deficiencies in the Plan. The Commission has

17 The *Water Management Act 2000* was amended in 2018. These changes require the Commission to now report on the achievement of environmental, social and economic outcomes. Previously, the Commission has reported against the *Quality Standard for NRM for Catchment Management Authorities* and state priorities for Local Land Services that relate to natural resource management under section 43A. This is no longer part of the Commission's legislated role in reviewing water sharing plans.

18 If a Commission report recommends changes to a plan that will reduce water allocations in relation to which compensation might be payable under section 87AA, the Commission is to state in the report if the purpose of the proposed changes is: (a) to restore water to the environment because of natural reductions in inflow to the relevant water source, including changes from climate change or drought or (b) to provide additional water to the environment because of more accurate scientific knowledge demonstrating the amount previously allocated to the environment is inadequate.

19 As set out in section 87 and section 87AA. Section 87 specifies that compensation applies for certain reductions in water allocations arising during the initial (10-year) period of a water sharing plan, only where amendments are not already contemplated in that plan. Section 87AA makes clear that compensation applies to amendments to the Plan after its 10-year term (30 June 2023). In addition, the Minister has an overriding discretion under section 87 (but not under section 87AA) to determine if compensation should be paid and, if so, the amount of any such compensation and the manner and timing of any payments.

worked with the Department of Planning, Industry and Environment - Water (DPIE-Water) to coordinate this review with its *Barwon-Darling Water Resource Plan* development process.

1.2 Review approach

1.2.1 Scope

The Commission sought to understand how the Plan provisions have contributed to environmental, social and economic outcomes under the Act, the extent to which Plan objectives have been met, and if changes to provisions are warranted.

The Commission identified and examined Plan provisions of particular relevance to these goals. For example, the Commission considered the role of planned environmental water provisions in providing healthy, diverse and connected environments, and trade provisions in supporting productive and sustainable primary industries.

1.2.2 Available evidence

The Commission's review was informed by:

- **Submissions** – the Commission called for initial submissions and submissions on the draft report via:
  - NSW Government's 'Have Your Say' website
  - media release
  - the Commission's website.

  Stakeholders were initially asked five questions to assess the Plan's contribution to environmental, social and economic outcomes (see **Appendix A**). Stakeholders were subsequently invited to provide submissions on the Commission's draft report.

  Overall, 1,231 submissions were received, with 121 unique submissions across the two calls. Non confidential submissions are published on our website www.nrc.nsw.gov.au. Most unique submissions and all form submissions on the draft public report were calling for government to implement the Commission's draft recommendations. Most submissions also highlighted areas in the report which they thought could be amended and we have made changes accordingly where there was sufficient evidence supporting the submission and it was within our scope.
- **Targeted consultation** – with community and industry representatives and individual citizens, Aboriginal traditional owners and Land Councils, and government agencies.
- **Document review** – of both publicly available information, unpublished reports and data from water management agencies including DPIE-Water, WaterNSW, the former Office of Environment and Heritage (OEH), DPI-Fisheries , the Murray-Darling Basin Authority (MDBA) and Commonwealth Environmental Water Office.
- **Technical advice –** from consultants including Professor Fran Sheldon, EcoLogical Australia, Aither, and GHD to provide expert analysis on Plan provisions and opportunities for improvement.
- **Expert panel** – the Commission formed an expert panel of Dr Martin Mallen-Cooper, John Madden and Paul Simpson for advice and review.
- **Peer review –** by Professor Martin Thoms and Associate Professor Simon Mitrovic.

The Commission would like to particularly thank DPIE-Water who have provided a significant amount of data, modelling and reporting for the purpose of this review. The Commission would also like to thank DPIE-EES, WaterNSW, DPI Fisheries, the Natural Resources Access Regulator, Murray Darling Basin Authority and Commonwealth Environmental Water Office for their assistance and cooperation in providing evidence and input to this report.

The review drew on advice from two recent independent reports:

- Independent panel for the Australian Government (2019), *Independent Assessment of the 2018-19 fish deaths in the lower Darling – Final Report* (Vertessy report)
- Australian Academy of Science (2019), *Investigation of the causes of mass fish kills in the Menindee Region NSW over the summer of 2018-2019.*

Additional background information was also sourced from the following:

- Ken Matthews AO (2017), *Independent investigation into NSW water management and compliance – final report*
- Murray–Darling Basin Authority and the Independent Review Panel (2017), *Murray-Darling Basin compliance review*
- Productivity Commission (2017), *National Water Reform, Inquiry Report*
- Bret Walker SC (2019), *Murray-Darling Basin Royal Commission Report*.

For the readers' reference, the roles of the various NSW water management agencies are summarised in **Figure 1**, noting that as of 1 July 2019 the former Department of Industry – Water (DoI-Water) is now DPIE-Water and the former OEH is now the Environment, Energy and Science Group within DPIE (DPIE-EES).

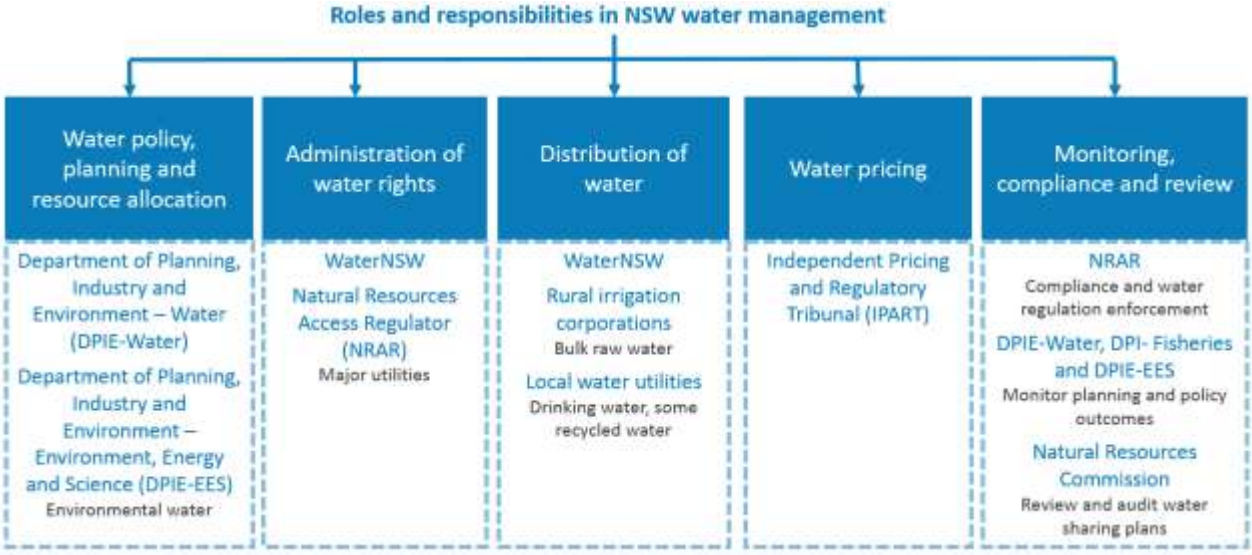

Figure 1: Roles and responsibilities in rural and regional water management[20]

[20] Revised from DoI-Water (2019), *NSW Regional Water Statement*, available at www.industry.nsw.gov.au/__data/assets/pdf_file/0019/218404/NSW-Regional-Water-Statement.pdf

2 The Plan area

This chapter provides background information on the Plan area, which includes the Barwon-Darling from the NSW border at Mungindi to just south of Wilcannia, and the Upper Darling Alluvial groundwater source.

In summary, the Barwon-Darling is a highly variable, unregulated river system, although many of its upstream tributaries are regulated. It is ecologically significant, provides connectivity between the northern and southern Murray Darling Basin, and supports many regional towns and Aboriginal nations. The Aboriginal community has a particularly important connection to the river, including key sites such as the Brewarrina fish traps (Ngunnhu). Land use in the region is dominated by grazing and dryland cropping, with just under three percent of the catchment area used for irrigated agriculture. The Plan area is characterised by extremely variable climatic conditions, with higher temperatures and lower inflows expected in future.

2.1 The Barwon-Darling is a 1,600 km long semi-arid lowland river

The Barwon River originates at the junction of the Weir and Macintyre rivers, which lies 25 km upstream of Mungindi at around 200 metres elevation.[21] The Barwon becomes the Darling River at the Culgoa River north of Bourke, at which point the elevation is around 100 metres, before reaching an elevation of less than 100 metres at the Menindee Lakes.[22] **Figure 2** shows the Plan boundaries and water sources. The Plan consists of 14 management zones across four sections of the river.

The Barwon–Darling catchment covers 13 percent of the Murray-Darling Basin, although it only generates around 3 percent of the total runoff in the basin.[23] The Barwon River flows south-west through a floodplain with a tightly meandering channel and a highly-variable flow pattern. At Mungindi the Barwon River's capacity is about 4,000 ML per day,[24] increasing downstream of Collarenebri after the confluence with Little Weir, Boomi, Moonie, Gwydir and Mehi rivers. By Walgett, the river has a capacity of 50,000 ML per day, and the floodplain widens across alluvial floodplains to Bourke where the capacity is about 80,000 ML per day.[25] The Darling River then continues south-west in a deeply incised channel towards Wilcannia. Below Wilcannia, the Darling reaches the Menindee Lakes at the artificial storage of Lake Wetherell.

21 MDBA (undated), *Barwon-Darling*, available at https://www.mdba.gov.au/discover-basin/catchments/barwon-darling

22 MDBA (2018), *Ecological needs of low flows in the Barwon-Darling, available at* https://www.mdba.gov.au/sites/default/files/pubs/ecological-needs-low-flows-barwon-darling_0.docx

23 CSIRO (2008), *Water Availability in the Barwon-Darling: Summary of a report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project*, available at http://www.clw.csiro.au/publications/waterforahealthycountry/mdbsy/pdf/Barwon-DarlingSnapShot.pdf.

24 DPIE-EES (2019), *Draft Barwon–Darling Long Term Water Plan Parts A and B*.

25 Ibid.

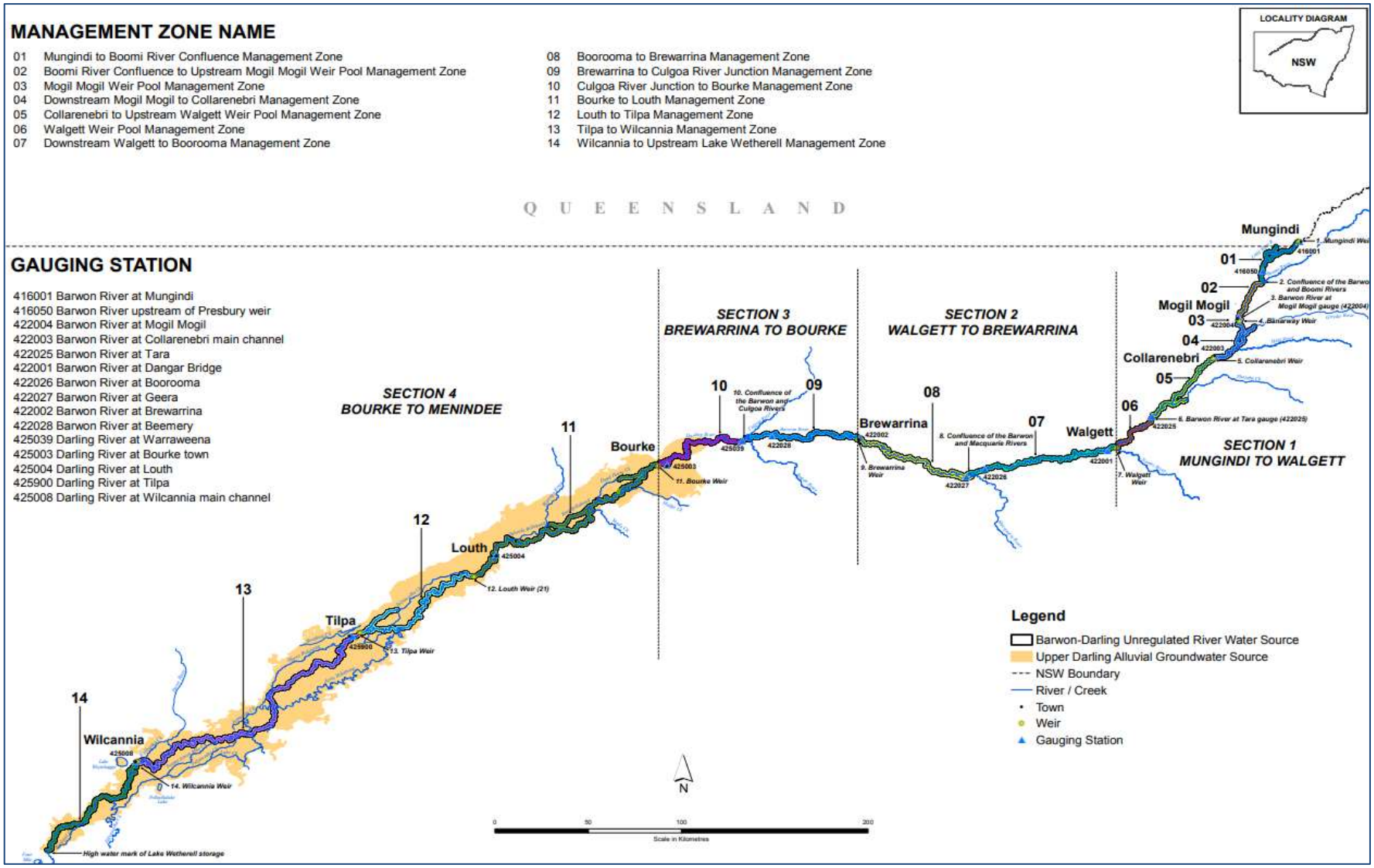

Figure 2: Barwon-Darling showing the Plan and water source boundaries[26]

[26] NSW Office of Water (2012), *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources Background Document*, NSW Government.

The Barwon–Darling is unregulated, except for the low-level weirs near townships, although many of the tributaries of the system are regulated. Major tributaries, their regulated or unregulated status, and modelled long term average contribution to the Barwon-Darling (in brackets) are as follows:

North-west

- Paroo (unregulated, zero percent)
- Warrego (largely unregulated, 3 percent)
- Condamine–Balonne (partially regulated, 12 percent)
- Moonie (unregulated, 4 percent)

South and east

- Border Rivers (regulated, 24 percent)
- Gwydir (regulated, 7 percent)
- Namoi (regulated, 27 percent)
- Macquarie–Castlereagh and Bogan (unregulated and regulated respectively, 23 percent).[27]

The Paroo and Warrego rivers only reach the Barwon-Darling after significant rain events in their catchments, contributing relatively infrequent flows downstream and west of Bourke. They can provide significant volumes in flood events, increasing the duration of high flow events in the Darling River.[28] When flowing after significant rainfall, the Paroo and Warrego Rivers both typically inundate extensive floodplain and wetland systems in their catchments including the Toorale Western Floodplain, the Peery and Poloko Lakes and the Cuttaburra.[29]

Flows in the Darling River generally decrease downstream of Bourke due to the infrequent contributions from the Paroo and Warrego Rivers, the relatively low contributions of local groundwater and the focus of irrigation take at Bourke.[30] Under natural modelled conditions, average annual flows from the Lower Darling into the Murray River represent only 59 percent of the average annual flows in the Darling observed at Bourke.[31]

The Barwon-Darling is recognised as one of Australia's most hydrologically variable river systems,[32] with periods of low flow and small pulses or freshes punctuated by large overbank flows fuelling large scale riverine productivity. The system is characterised by '*unpredictable summer dominated flows, highly intermittent*',[33] which translates to flows in summer months

27 Vertessy, R., Barma, D., Baumgartner, L., Mitrovic, M., Sheldon, F., Bond, N. (2019), *Independent Assessment of the 2018-19 fish deaths in the lower Darling – Final Report*, for the Australian Government, 29 March 2019.

28 Cooney (1994), *Barwon-Darling River Riparian Health Report: Wetland Inundation*, NSW Department of Water Resources, Sydney.

29 Reid and Brooks (2000), *Detecting effects of environmental water allocations in wetlands of the Murray-Darling Basin, Australia,* Regulated Rivers: Research and Management Vol. 16, pp. 479-496.

30 Webb, McKeown and Associates (2007), *State of the Darling – Interim Hydrology Report*, for the Murray Darling Basin Commission, Canberra.

31 Ibid.

32 Puckridge et al (1998), *Flow variability and the ecology of large rivers*, Marine and Freshwater Research, 49(1):55-72.

33 Kennard et al (2010), *Classification of natural flow regimes in Australia to support environmental flow management. Environmental Flows*: Science and Management 55(1) 171-193.

ranging from cease to flow periods through to floods.[34] For example, in 1950 prior to significant development, the maximum recorded flow in the Darling at Bourke was 352,000 ML per day. Conversely, there have also been periods over seven months where the river has stopped flowing. The Federation drought and World War II drought (pre river regulation) had three periods of stillwater[35] conditions of seven to 11 months, while the Millennium drought (post river regulation) had five periods of seven or more months of stillwater conditions.[36]

The variable river flows are reflected in the extreme climatic variability, particularly annual rainfall. Average annual rainfall ranges from about 500 mm at Mungindi in the north-east to 300 mm at Bourke and 265 mm at Wilcannia in the south-west.[37] Rainfall and runoff are typically highest in summer. The semi-arid environment and high summer temperatures result in high evaporation rates across the whole catchment.

The river's low gradient, along with a series of branches and wetlands, make it prone to broad flooding in peak flows. The area's ecosystems are adapted to the natural climatic variability, and rely on the changing flow regime to maintain the presence of pool refuges and provide flooding events that connect the river and surrounding floodplain.[38] However, the variability of the climate presents challenges to water planning and management, particularly under a changing climate (see **Chapter 12**).

2.2 The riverine environment is varied and ecologically significant

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 the Golden Perch.[39] Habitat components in the Barwon-Darling variably can include: deep channels, flowing water, pools, wetlands, instream woody habitats, aquatic plants and floodplains. The river provides habitat for other aquatic species including turtles, mussels, river snails and shrimp. The longitudinal connectivity is particularly important for regional communities of native fish and other aquatic species.[40] There are many billabongs and lagoons

34 Sheldon, F. (2019). *Technical review of the water sharing plan for the Barwon-Darling unregulated and alluvial water sources 2012*, advice to the Natural Resources Commission.

35 Stillwater is a term used to describe the hydraulic characteristics of a river. Stillwater is also referred to 'lentic' conditions and is typically observed in riverine pools and lakes. This is in contrast to flowing water 'lotic' conditions which is visibly moving water, for example riffles, runs or glides. The distribution of still water and flowing water habitats in a river is determined by the interaction of flow and the physical characteristics of the river channel (such as channel dimensions, shape and roughness). Hence, for a given flow rate, the distribution and characteristics of still and flowing water habitats may vary between locations in a river and between rivers. Definition derived from information in Mallen-Cooper, M. (2019*), Barwon-Darling Water Sharing Plan: opportunities to link ecology, river hydraulics, culture, and social values to meet the objectives of the Water Management Act*, discussion paper for the Natural Resources Commission.

36 Mallen-Cooper, M. (2019*), Barwon-Darling Water Sharing Plan: opportunities to link ecology, river hydraulics, culture, and social values to meet the objectives of the Water Management Act*, discussion paper for the Natural Resources Commission.

37 Bureau of Meteorology (2019), *Monthly rainfall statistics at Mungindi Post Office (52020), Bourke Airport (48245) and Wilcannia Reid St (46043)*, available at http://www.bom.gov.au/climate/data/.

38 Vertessy, R., Barma, D., Baumgartner, L., Mitrovic, M., Sheldon, F., Bond, N. (2019), *Independent Assessment of the 2018-19 fish deaths in the lower Darling – Final Report*, for the Australian Government, 29 March 2019.

39 MDBA (2014), *Basin-wide environmental watering strategy*, MDBA, Canberra.

40 DPIE-EES (2019), *Draft Barwon–Darling Long Term Water Plan Parts A and B.*

along the Barwon-Darling, as well as lakes and wetlands on the floodplains, which provide major bird foraging and breeding sites.[41]

The vegetation along the Barwon-Darling is dominated by River Red Gums, which grow along the banks and around lagoons and channels.[42] Coolibah and Black Box woodlands occur on higher areas of the floodplain, with both Coolibah and Black Box in the northern part of the catchment and only Black Box in the south and west – these all have varying levels of water dependence.[43]

Wetlands are a particular feature of the area and include the Wongalara, Woytchugga and Poopelloe lakes, the Acres Billabong and several deflation basin wetlands.[44] There is also the nationally important wetland area Talyawalka Anabranch and Teryawynia Creek, near the southern boundary of the Plan area, between Wilcannia and Menindee on the Darling Riverine Plains. Seven wetland sites have been recorded as having supported breeding for seven waterbird species, including two colonial breeding species – though these records are sparse in the area and likely to under-report what is present.[45]

Table 3 lists a number of threatened species and Endangered Ecological Communities recorded in the Plan area.

The critically endangered Darling River Snail (*Notopala sublineata*) is thought to have significantly reduced from being widely distributed in the natural drainage system in the 1950s-1970s down to a few populations in irrigation pipes near Bourke, Brewarrina and Walgett.[46] They were thought to be extinct in their natural river environment, although field studies in the Barwon-Darling in 2019 found the Darling River Snail in the wild for the first time in 30 years or more.[47]

The aquatic community of the Barwon-Darling is part of an Endangered Ecological Community known as the 'aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River'. Vulnerable or endangered species, such as the Olive Perchlet, Murray Cod, Silver Perch and Freshwater Catfish, have been recorded among the 15 native species of fish known to inhabit the Barwon-Darling. These native fish species are key indicators of the health of the rivers and their catchments.[48] The Endangered Ecological Community listing (under the *NSW Fisheries Management Act 1994*) includes the main Barwon-Darling channel from Mungindi to Wilcannia and further downstream.

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41 NSW Department of Primary Industries (DPI) (2017), *Barwon-Darling Watercourse Water Resource Plan (Surface Water SW12), Status and Issues Paper*.

42 Green and Petrovic (2011), *Water resources and management overview: Barwon-Darling and Intersecting Streams*, NSW Office of Water, Sydney.

43 NSW Office of Water (2012), *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources Background Document*

44 MDBA (2016), *Assessment of environmental water requirements: Barwon-Darling River system*, MDBA, Canberra.

45 Advised by DPIE-EES, via email 5 July 2019.

46 Department of Energy and the Environment, *River Snail (Notopala sublineata),* available at http://www.environment.gov.au/biodiversity/threatened/nominations/ineligible-species/notopala-sublineata; and NSW DPI, *Darling River Snail*, https://www.dpi.nsw.gov.au/fishing/threatened-species/what-current/critically/river-snail

47 Mallen-Cooper, M. (2019*), Barwon-Darling Water Sharing Plan: opportunities to link ecology, river hydraulics, culture, and social values to meet the objectives of the Water Management Act*, discussion paper for the Natural Resources Commission.

48 NSW DPI (2015), *Fish and flows in the Northern Basin - responses of fish to changes in flow in the Northern Murray-Darling Basin, reach scale report*, NSW –DPI-Fisheries, prepared for the MDBA.

Table 3: Important river flow dependent species and ecosystems[49]

Group	Details
Fish	**Critically Endangered:** Silver Perch (Commonwealth) **Endangered:** Southern Purple Spotted Gudgeon (NSW) **Endangered population:** Olive Perchlet (western population) (NSW); Freshwater catfish (Murray-Darling Basin population) (NSW) **Vulnerable:** Silver Perch (NSW); Murray Cod (Commonwealth) **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 (Commonwealth) **Endangered**: Curlew Sandpiper (NSW); Australasian Bittern (NSW; Commonwealth); 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
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

Overall, the fish community of the Barwon-Darling was rated to be in moderate health in 2015, before the recent fish deaths and record cease to flow period.[50] Most of the valley's fish community was in a moderate condition (see **Figure 3** below), providing a strong platform for fish recovery if management actions are developed and implemented appropriately. However, there are still many factors that impact native fish in the Barwon-Darling valley. These include barriers to fish passage, loss of flowing-water habitat in weirpools, changes to water flow, extraction through river off-takes, degradation of instream habitat and riparian vegetation, poor land management, and invasive fish species such as Carp.[51]

49 NSW DPI (2017). *Barwon-Darling water resource plan – surface water resource description*
50 Ibid.
51 Ibid.

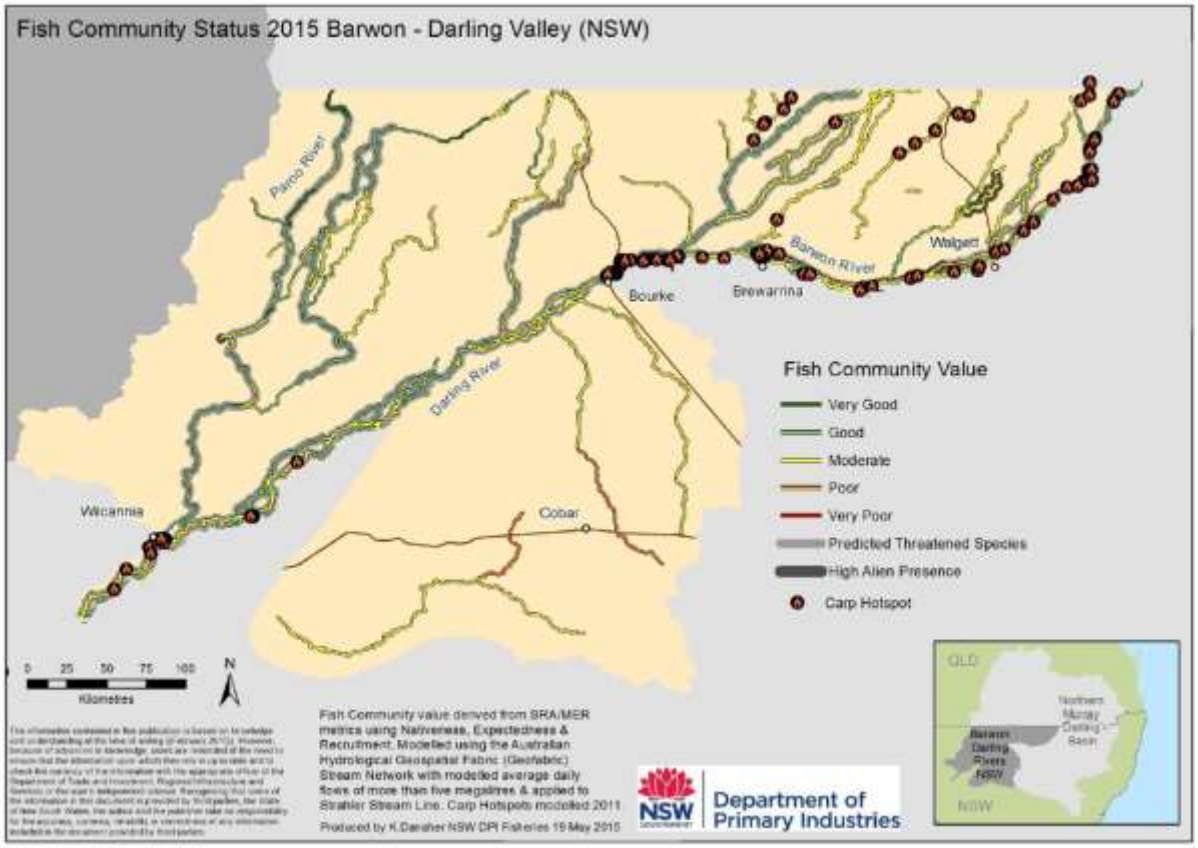

Figure 3: Fish community status for the Barwon-Darling valley in 2015, highlighting condition of fish communities and Carp hotspots[52]

Recent monitoring of the Barwon-Darling indicated a high diversity in terms of the number of fish species, but low overall fish population numbers.[53] Fish sampled in April 2018 were stressed in areas where the Darling River had ceased to flow. The proportion of fish with health conditions was highest immediately downstream of Wilcannia, where the river had ceased to flow for longest and algae levels were high. Around a third of the fish sampled at one site downstream of Wilcannia had a health condition such as raised or discoloured scales, and the presence of parasites such as anchor worm.[54] Recent research work has identified changes in food webs in the Barwon-Darling, including the ratio of fish, mussel and snail populations, which point towards a loss of system resilience.[55]

Downstream of the Plan area, three significant fish death events occurred in the Darling River near Menindee between December 2018 and January 2019 (see **Chapters 3.1** and **6**).[56] The main native fish species involved included Murray Cod, Silver Perch, Golden Perch, and Bony Herring, with mortality estimates in the range of hundreds of thousands to over a million fish. The ongoing lack of significant inflows means that more fish deaths are likely in the coming

52 Taken from DPI Fisheries (2015), *Fish and Flows in the Northern Basin: responses of fish to changes in flow in the Northern Murray-Darling Basin – Reach Scale Report*.

53 Commonwealth Environmental Water Office (2019), *Northern connectivity event update 8*, available at http://www.environment.gov.au/water/cewo/publications/northern-rivers-update-8

54 Commonwealth Environmental Water Office (2018), *Commonwealth Environmental Water Portfolio Management Plan Barwon–Darling 2018–19.*

55 Thoms, M. and Delong, M. (2018), *Ecosystem responses to water resource developments in a large dryland river*, Water Resources Research, 54.

56 Vertessy, R., Barma, D., Baumgartner, L., Mitrovic, M., Sheldon, F., Bond, N. (2019), *Independent Assessment of the 2018-19 fish deaths in the lower Darling – Final Report*, for the Australian Government, 29 March 2019.

warmer months, with the Minister for Agriculture stating that it is a "potential fish Armageddon".[57] State and Commonwealth governments are working to find short and long-term solutions that could mitigate further fish deaths including fish breeding and restocking, and artificial aeration to support water quality.[58] Such long term solutions need to also consider the impacts upon other river dependent species as part of the interconnected ecosystem. For instance, the 2019 widespread death of river mussels (see **Chapter 6.1.3**) appears to have a greater impact on riverine biota than the Menindee fish deaths.

2.3 The Upper Darling Alluvium spans the southern half of the Plan

The Upper Darling Alluvial groundwater source stretches along the Darling River from just upstream of Bourke to Lake Wetherell, downstream of Wilcannia.[59] The Upper Darling Alluvium is conceptualised as having a shallow (sediments of the Narrabri formation) and a deep (Gunnedah and Cubbaroo formations) aquifer system.[60]

The Narrabri formation reaches depths of 25 metres below ground level and salinity varies depending on its connection to the river and the underlying Murray Geologic Basin basement.[61] The fresh water aquifers are generally perched and recharged directly from the rivers. Groundwater level generally follows the elevation of the land surface and the flow of the Darling River.[62] The Gunnedah and Cubbaroo formations reach depths of 120 metres below ground level, with a pre-Cenozoic palaeochannel roughly parallel with the modern Darling River. Deeper aquifers are generally more saline, but are largely confined to sub-confined (except where there are constrictions or faults).[63]

The Upper Darling Alluvium sediment and groundwater flow is continuous from the Upper to Lower Darling Alluvium.[64] It overlies the Great Artesian Basin and Lachlan Fold Belt, but they are generally not hydraulically connected.[65] The southern end of the Upper Darling Alluvium is hydraulically connected to the Murray Geologic Basin basement.[66] Barriers to groundwater flow in this bedrock basement result in saline discharges to the Darling River about 30 kilometres west of Bourke.[67] This discharge is the target of the Salt Interception Scheme licenced under the Plan, which aims to improve water quality for downstream town use.[68]

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57 Minister for Agriculture, Minister for Western NSW Adam Marshall (2019), *Media release: combating horror summer of fish kills*, available at https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/1154650/Combating-horror-summer-of-fish-kills.pdf

58 MDBA (2019), *Fish deaths in the Lower Darling*, available at https://www.mdba.gov.au/managing-water/drought-murray-darling-basin/fish-deaths-lower-darling; Minister for Agriculture, Minister for Western NSW Adam Marshall (2019), *Media release: combating horror summer of fish kills*, available at www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/1154650/ Combating-horror-summer-of-fish-kills.pdf

59 NSW Office of Water (2012), *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources – Background document*, NSW Government, Sydney.

60 Note the Narrabri, Gunnedah and Cubbaroo formations are not recognised as official units in the Australian Stratigraphic Unit Database: http://dbforms.ga.gov.au/www/geodx.strat_units.int.

61 NSW DoI-Water (2019), *Draft Darling Alluvium Water Resource Plan Description*, NSW Government.

62 Ibid.

63 NSW Office of Water (2012), *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources – Background document*, NSW Government, Sydney.

64 NSW DoI-Water (2019), *Draft Darling Alluvium Water Resource Plan Description*, NSW Government.

65 Ibid.

66 Ibid.

67 Cresswell, R for EcoLogical (2019), *Technical advice related to groundwater dependent ecosystems and groundwater as covered by the Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources (2012),* for the Natural Resources Commission 15 May 2019.

68 MDBA (2011), *Upper Darling – salt interception scheme. Murray Darling Basin Authority fact sheet*, available at http://www.mdba.gov.au/publications/brochures-factsheets/upper-darling-salt-interception-scheme.

There are 128 active monitoring bores at 94 sites in the Upper Darling Alluvium. These show how groundwater discharges to the Darling River near Bourke, while further downstream the Darling River recharges the Upper Darling Alluvium.[69] There are no seasonal 'drawdown' patterns in the hydrographs as there is minimal groundwater extraction.[70]

Extended low and cease to flow conditions affect how groundwater interacts with surface water, with the potential to affect surface water quality. Monitoring bores demonstrate that the Upper Darling Alluvium gains water from the Darling River in floods and loses water to the river in low flows in some river sections.[71] Fresh alluvial groundwater is mainly recharged via the Darling River channel floor in high river flow, and the floodplain in overbank events.[72]

There are no high priority groundwater dependent ecosystems identified in the Plan. The following risks to groundwater dependent ecosystems were identified during Plan preparation:

- moderate risk from changing groundwater levels from pumping groundwater
- high risk from short term pumping or changes in timing of groundwater level fluctuations
- moderate risk of changing baseflows due to the river gaining groundwater.[73]

2.4 Aboriginal communities have relied on the river over 40,000 years

Aboriginal language groups in the Plan area include the Ngemba, Wilyali, Nawalgu Ngiyampaa, Gurnu, Barundji, Garanggaba, Baranbinya, Wayilwan, Yuwalari, Murrawari, Wanywalgu, Wadigali, Wangkumara, Malyangaba, Bandjigali, Yawaalaraay, Gomeroi and Barkandji nations and clans.[74] These traditional owners of the land managed and interacted with the landscape for over 40,000 years before European arrival in Australia.[75]

The river has been central to Aboriginal culture in the region. For example, the Barkandji peoples inhabited the Darling River and its surrounding rangelands, exploiting the resource rich area of the river and the rangelands in cooler months. The plants and animals of the region provided Barkandji peoples with a varied high protein and nutrient rich diet.[76] Plants also provided the equipment to support hunting and gathering activities, including bark, reed and grass vessels, nets and baskets, and spear shafts, shields, digging sticks and boomerangs.[77]

For Aboriginal people, the Darling River, lakes and associated wetlands were a central component of their lifeway, providing them with economic resources and supporting trade and ceremony.[78] Creation stories tell of the formation of the Darling River – the Barka – as well as

69 NSW DoI-Water (2019), *Draft Darling Alluvium Water Resource Plan Description*, NSW Government.
70 Ibid.
71 NSW Office of Water (2012), *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources – Background document*, NSW Government, Sydney.
72 DoI-Water (2019), *Draft Darling Alluvium Water Resource Plan Description*, NSW Government.
73 NSW Office of Water (2012), *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources* Background Document.
74 Ibid.
75 Ibid.
76 Balme, J. (1995), *30,000 years of fishery in western New South Wales*. Archaeology in Oceania 30(1), 1-21.
77 Western Local Land Services (2016), *Ecological Cultural Knowledge - Barkindji (north of Pooncarie): Knowledge shared by the Barkindji people,* Local Land Services, NSW Government, available at http://western.lls.nsw.gov.au/resource-hub/video-resource-material.
78 Balme, J. (1995), 30,000 years of fishery in western New South Wales. *Archaeology in Oceania* 30(1), 1-21.

specific sites such as the Brewarrina fish traps (Ngunnhu) (see **Figure 4** showing the traps in use as they were 50 years after European arrival, and dry in early 2019). The fish traps are a long complex of dry-stone walls and holding ponds for fish to be herded and caught during high and low river flows – these are the largest group of traps recorded in Australia. According to Aboriginal tradition, the ancestral creation being, Baiame produced the design by throwing his net over the river and, with his two sons Booma-ooma-nowi and Ghinda-inda-mui, building the fish traps. The Ngemba people are the custodians of the fishery. The place is also extremely significant to the Aboriginal people of western and northern NSW as the fish traps, and the laws governing their use, helped shape the spiritual, political, social, ceremonial and trade relationships between groups as one of the key regional Aboriginal meeting places.[79]

Figure 4: Brewarrina Fish Traps, Darling River; at work in 1887 at top (photo H. King, Sydney, from Brewarrina Shire Council print) and dry in April 2019 at bottom (Natural Resources Commission)

[79] NSW State Heritage Inventory, *Brewarrina Aboriginal Fish Traps / Baiame's Ngunnhu*, available at https://www.environment.nsw.gov.au/heritageapp/ViewHeritageItemDetails.aspx?ID=5051305

2.5 European settlement began around the 1830s

European settlers used the Darling River as a transport corridor and imposed British law to enable expansion of the pastoral frontier. Like many other Aboriginal and Torres Strait Island groups across Australia, Aboriginal nations in the area faced severe disruption to their way of life, having to contend with displacement and relocation into church missions and government reserves.[80] As a consequence, Aboriginal peoples from this area now have low rates of land ownership and experience other forms of socio-economic disadvantage.

One of NSW's earliest reserves was created in 1842 recognising Aboriginal ownership. It covered 640 acres of Crown Land at Brewarrina 'for the use of Aborigines' to protect the Ngunnhu, noted to be of intense significance to Aboriginal owners. The reserve (understood to now be known as Barwon 4) stopped non-Aboriginals from fishing there and was enforced by local Aboriginals and the police until at least 1906.[81] The traps at the time were recognised as providing for the Ngiyampaa, and other language groups including Murrawarri, Kamilaroi and Yuwalaraay, as well as for large ceremonial events. The early status of this reserve recognised Ngunnhu and the river as central to regional Aboriginal economic and social life.[82]

Europeans called the Barka the Darling River in 1829 after the then Governor of NSW, Sir Ralph Darling. Bourke was one of the main European settlement towns from the 1840s.[83] The settlement was based on an agricultural economy owned and controlled by non-Indigenous families. Its location on the Darling River provided the link between the nearby agricultural industries and the east coast trade routes. The town of Bourke flourished, and by the late 19th century, it was deemed the greatest stock centre in Australia. Since the late 1800s, grazing properties such as Toorale (later, part of the world's largest sheep station) in the Warrego River catchment gradually developed onsite water infrastructure and dams as agricultural practices evolved.[84] Despite severe droughts and fluctuations in commodity prices, Bourke and surrounding areas remained part of a strong agricultural economy largely based on wool production and beef, with some support from cotton and citrus fruits.[85]

From the mid-1960s, a combination of falling wool prices, rising wages, drought and the introduction of labour-saving technology resulted in a substantial decline in employment in the agricultural industry. Agricultural trade also moved away from river transport, which meant that Bourke's role in inland trade was not as critical.[86] However from this point, other sectors of the Bourke economy began to increase and Bourke became a key service centre for north-western regions of NSW.

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80 Hartwig *et al.* (2018), *Recognition of Barkandji Water Rights in Australian Settler-Colonial Water Regimes*. Resources, 7: 16-32.

81 Goodall, H. (1996), *Invasion to Embassy: Land in Aboriginal Politics in New South Wales, 1770-1972*, St Leonards: Allen & Unwin in association with Black Books, NSW Government Gazette (1842), p587.

82 Mathews, R.H. in Dargin, P. (1976) *Aboriginal Fisheries of the Darling-Barwon Rivers, Brewarrina*, Brewarrina Historical Society, p37

83 Flowers (1989), *We're the same mob fighting for the same thing: Bourke Aboriginal community development and adult education training strategies*, Paper from a National Research Fellowship Scheme, Sydney College of Advanced Education, Sydney.

84 EcoLogical (2019), *Toorale Water Infrastructure Project – Phase 1 REF*, for OEH.

85 Flowers (1989), *We're the same mob fighting for the same thing: Bourke Aboriginal community development and adult education training strategies*, Paper from a National Research Fellowship Scheme, Sydney College of Advanced Education, Sydney.

86 Ibid.

2.6 Land use is dominated by grazing and dryland cropping

Table 4 summarises agricultural statistics in the Barwon-Darling local government areas (LGAs). Agricultural production covered over seven million hectares in 2006 and 2016, with irrigated production 3.5 and 2.2 percent of this area respectively. In 2006 the gross value of non-irrigated agriculture ($193 million) was over three times greater than irrigated agriculture ($61 million).[87] Similar statistics are not available for 2016.

The agricultural industry remains the largest employer in the Barwon-Darling. Central Darling LGA had the highest proportion of agricultural employed persons in 2016 at 39 percent, followed by Walgett at 27 percent (see **Appendix B** for details). MDBA community profiles indicate that the government services sector is the largest employer in the Bourke and Brewarrina communities (44 percent and 52 percent of all jobs, respectively), and is approximately equal size with the agriculture and agricultures supply sectors in Walgett, based on 2011 data.[88] The profile for Bourke also indicates that, from local peoples' perspectives, an average of about 90 percent of agricultural income comes from grazing and 10 percent from irrigation.[89]

Table 4: Agricultural industry overview, Barwon-Darling 2006 and 2016[90]

	2006[91]	2016[92]
Agricultural production	7,191,547 ha[93]	7,005,693 ha
Gross value of agricultural production	~ $254 million	~ $317 million
Irrigation production area	25,000 ha	17,627 ha[94]
Total volume used for irrigation	171,043 ML	152,889 ML

Land use in the Barwon-Darling catchment[95] is currently dominated by grazing at just over 78 percent of the area (**Table 5**). Dryland cropping is the next major land use and occurs mostly in the north of the Plan area, while irrigated cropping is concentrated between Mungindi and Brewarrina and around Bourke.[96] The main irrigated crop in the Barwon-Darling catchment is cotton, with other irrigated crops including fruit, nuts and grapes (see **Chapter 3.3.1**).[97]

87 Department of Primary Industries (2012). *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources: Background document*, NSW Government

88 MDBA (2016), *Bourke: Understanding community conditions*; MDBA (2016), *Brewarrina: Understanding community conditions*; MDBA (2016), *Walgett: Understanding community conditions*; MDBA (2016), *Walgett: Understanding community conditions*; all available at https://www.mdba.gov.au/publications/mdba-reports/NBreview-social-economic-condition-reports

89 MDBA (2016), *Bourke: Understanding community conditions*, available at https://www.mdba.gov.au/publications/mdba-reports/NBreview-social-economic-condition-reports

90 Barwon-Darling defined as Walgett, Brewarrina and Bourke as relevant LGAs for agriculture statistics.

91 2006 data sourced from the Department of Primary Industries (2012). *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources*.

92 2016 data sourced from Australian Bureau of Statistics *Agricultural Commodities Produced, Australia 2015-16*; Australian Bureau of Statistics *Water use on Australian Farms 2015-16, Total area watered*; Australian Bureau of Statistics Water use on Australian Farms 2015-16, *Total volume applied (ML)*

93 2006 data may be up to 12 million hectares

94 2016 data may be up to 71,400 hectares (MDBA 2016), cotton irrigated area accounts for 17,131 hectares

95 ABARES data report agricultural activity at the Barwon-Darling catchment scale. This reflects the natural river catchment in NSW, which includes the Gwydir, Namoi, Castlereagh, Macquarie, Bogan and Culgoa rivers.

96 Australian Bureau of Agricultural and Resource Economics and Sciences (2016) *National scale land use data*

97 Crown Lands & Water Division (2017) *Barwon-Darling Water Resource Plan: Surface water resource description*

Table 5: Land use (greater than one percent land cover) in the Barwon-Darling catchment[98]

Land use	Area (km²)	Area (%)
Grazing	27,740	78.5
Dryland cropping	3,497	9.0
Irrigated cropping (as part of cropping above)	714	2.9
Conservation areas (inc. National Parks and Forest Reserves)	1,713	4.8
Tree and shrub cover	634	1.8

Cotton production began in Bourke in 1966 with the first crop harvested on family farms in April 1967. The industry grew from there with the various growers setting up Bourke Water Users Association, intended to represent all interests and self-regulate water use conflicts. In 1982, Clyde Agriculture established the first large 20,000 hectare corporate farm, which initially included four properties (including Janbeth and Toorale, south west of Bourke). Current levels of cotton production vary with seasonal conditions. Production covers around 10,000 hectares when there are high levels of water availability. The Commission understands that for the 2018–2019 season no cotton has been planted.[99]

Toorale was purchased by the Commonwealth Government in 2008, with the land provided to the NSW National Parks and Wildlife Services, and the water access licences held by the Commonwealth Environmental Water Holder.[100] The water was purchased to improve benefits from flow delivery to key water-dependent environmental assets on Toorale and downstream to the Darling River.[101] OEH began the Toorale Water Infrastructure Project in 2016 to modify water storages to increase flows through the Warrego River to the Darling River, and improve fish passage conditions.[102] The Commission understands that the approvals and planning process for phase one is almost complete but on ground work has not begun to improve connectivity through to the Darling River. This should be expedited and future phases to remove structures such as floodplain harvesting infrastructure progressed as soon as feasible.

As summarised in **Chapter 2.1**, the Warrego River only reaches the Barwon-Darling after significant rain events in its catchment. Flows from the Warrego River recently (May 2019) reached the Darling River at Louth, reaching Tilpa in June and overtopping the Wilcannia weir pool mid-June, with the river downstream of Wilcannia starting to flow late June and averaging 420 ML per day.[103] These flows extended further down the Barwon-Darling than originally forecast[104] and provided vital town water supply and water quality improvement functions (see **Chapters 6.1** and **7.2**).

98 Australian Bureau of Agricultural and Resource Economics and Sciences, 2016 *National scale land use data*

99 Submission received from Cotton Australia for this review

100 OEH (2013), *Toorale National Park and State Conservation Area: Conservation Management Plan*, Available at https://www.environment.nsw.gov.au.

101 EcoLogical (2019), *Toorale Water Infrastructure Project – Phase 1 REF*, for OEH.

102 Note public submissions on the review of environmental factors for phase one of this project closed 30 April 2019, see EcoLogical (2019), *Toorale Water Infrastructure Project – Phase 1 REF*, for OEH.

103 MDBA (2019), *River Murray Weekly Report for the week ending 26 June 2019*, available at https://www.mdba.gov.au/sites/default/files/weeklyreports/River-Murray-Operations-Weekly-Report-26th-June-2019.pdf; and WaterNSW (2019), *Regional drought update – 25 June 2019*, available at https://www.waternsw.com.au/__data/assets/pdf_file/0016/145060/Regional-NSW-drought-report-25-June-2019.pdf.

104 WaterNSW (2019), *Rain extends Barwon-Darling temporary pump restriction*, available at www.waternsw.com.au/about/newsroom/2019/rain-extends-barwon-darling-temporary-pump-restriction

2.7 The population in the Plan area has declined

2.7.1 The Plan area has a varied population

The Plan area is serviced by regional centres in Bourke (population 1,824), Brewarrina (population 1,546) and Walgett (population 851) (see **Appendix B**). All LGAs[105] in the Plan area have experienced population decline over the census period between 2011 and 2016. Rates of unemployment are also higher than is common for rural areas of NSW and was higher in 2016 than 2011 for all LGAs. The highest rates of unemployment in 2016 were in Brewarrina (16.2 percent), followed by Central Darling (11.2 percent) and Walgett (10.6 percent), compared to the rural NSW average of 4.4 percent. Income levels reflect the trends in other economic indicators, demonstrating below average economic well-being across personal, family and household wealth. The overall personal median weekly income level across all LGAs for 2016 was around $566 compared to the average of $626 for rural NSW).

There are various Aboriginal nations affected by the Plan including the Barkandji, Murrawarri, Ngiyampaa, and Ngemba people. **Figure 5** shows the boundaries of the seven supporting Local Aboriginal Land Councils. Aboriginal and Torres Strait Islander people comprise, on average, over 32 percent of the population of the region covered by the Plan. In Brewarrina LGA, the Aboriginal and Torres Strait Islander population is as high as 61.5 percent of the total population. This is much higher than the state average of 2.9 percent and the average for rural areas of NSW at 3.7 percent.[106]

Aboriginal and Torres Strait Islander populations have significantly higher unemployment rates and lower full-time employment. Unemployment rates were as high as 31.2 percent in Brewarrina in 2016, followed by Walgett (26.4 percent) and Central Darling (25.5 percent). Aboriginal unemployment rates also increased between 2011 and 2016 across the LGAs.[107] The Aboriginal and Torres Strait Islander populations also have significantly lower household and personal incomes than the general population and rural average. Median household weekly incomes are lowest in Brewarrina LGA at $743 compared to $1,253 for rural NSW.[108]

105 Walgett, Brewarrina, Bourke, Central Darling, Moree Plains and Cobar LGAs. Moree Plains and Cobar LGAs are much less prominent in the Barwon-Darling.

106 Australian Bureau of Statistics (2011, 2016) *Census of Population and Housing. General Community Profile*. Catalogue Number 2001.0 Brewarrina (A) (LGA11200); Bourke (A) (LGA11150); Walgett (A) (LGA17900); Moree Plains (A) (LGA15300); Central Darling (A) (LGA11700); Cobar (A) (LGA11750); NSW Rural Balance (Code SOS13)

107 Ibid.

108 Ibid.

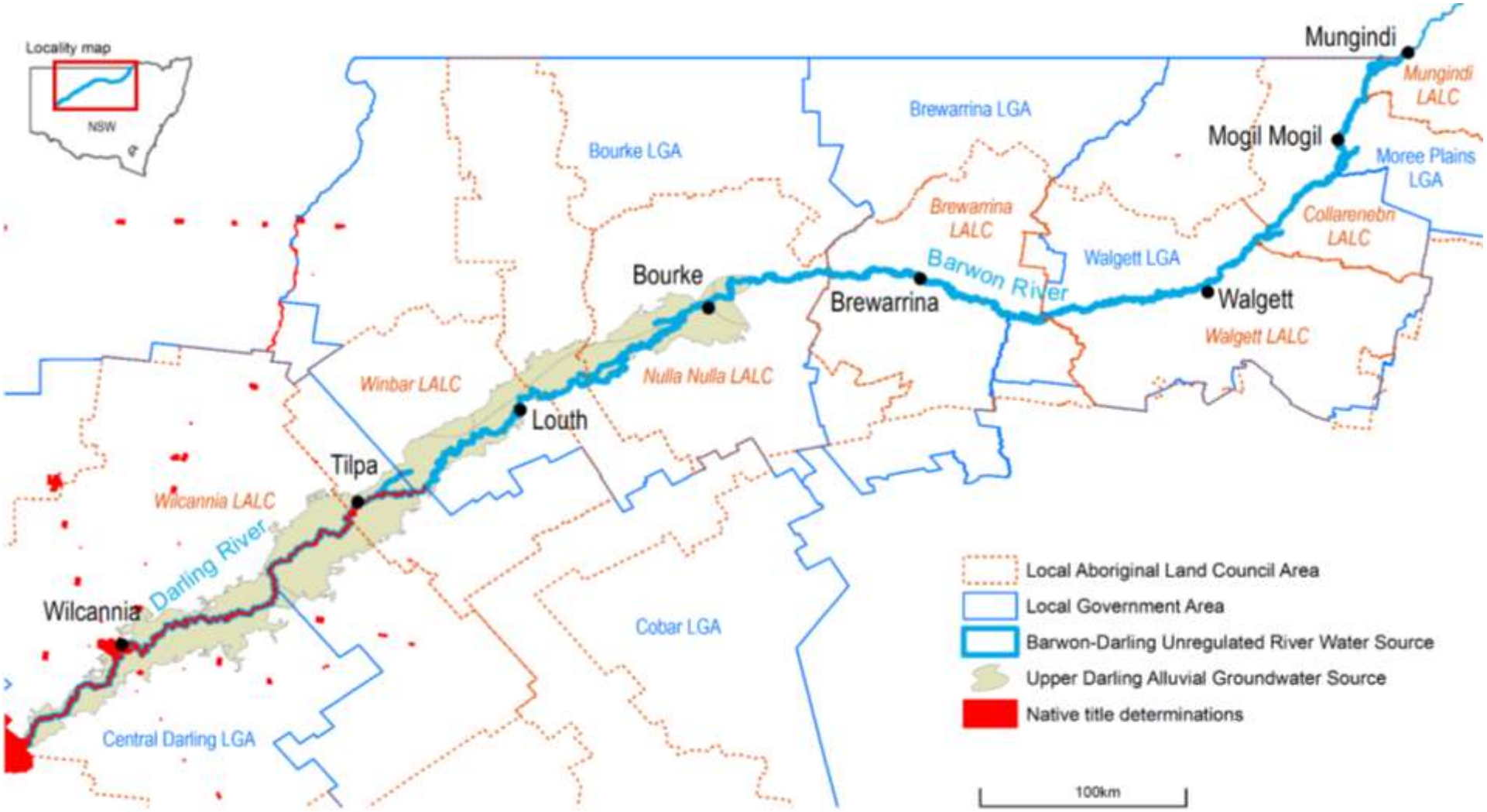

Figure 5: Map of the Barwon-Darling area including Local Government Areas, Local Aboriginal Land Council Areas and native title determinations

2.7.2 The Plan area includes recognised existing and potential native title rights

In 2015, the native title rights of the Barkandji and Malyangapa traditional owners were legally recognised. It is the largest native title claim in NSW covering 128,000 km^2.[109] It extends from the South Australian border to Tilpa in the east, Wentworth in the south, and north almost to Wanaaring. Further native title land and water parcels were added in August 2017.[110] The native title area includes 400 km of the Darling River (from Tilpa to the northern end of the Great Darling Anabranch) partly in the Plan area, and several water courses and lagoons further south.

Barkandji people have a number of recognised, water related native title rights similar to many native title determinations under the provisions of the *Native Title Act 1993 (Commonwealth)* (see overview of native title rights in **Appendix F**). Their water use rights are specified as being for personal, domestic and communal purposes, which includes cultural purposes, watering of native animals, cattle and other stock, and watering of gardens that are less than two hectares. These rights do not extend to a right to control the use and flow of the water in any rivers or lakes that flow through or past or are in the land of two or more occupiers.[111]

The term 'cultural purposes' in this water use right was defined in the determination to include activities of a cultural nature that *'involve the use of insubstantial quantities of water'*; examples given include cleansing ceremonies, the preparation of food or bush medicines, and activities involving the teaching of native title holders about traditional laws, customs and practices.[112]

Ancillary rights and interests that indirectly relate to water were also recognised, including (but not limited to) the rights to:

- hunt, fish, and take and use natural resources (other than water)
- engage in cultural activities
- have access to, maintain and protect from physical harm sites and places of importance or significance under traditional laws and customs.[113]

The Barkandji Native Title Group Aboriginal Corporation hold the determined native title in trust for the common law holders and have negotiated an Indigenous Land Use Agreement with Wentworth Shire Council.[114]

There are also two other current native title claims that include parts of the Plan area. These claims were lodged by the Gomeroi People (NSD2308/2011), and the Ngemba, Ngiyampaa, Wangaaypuwan and Wayilwan Peoples (NSD415/2012). The outcomes of these claims is yet to be determined.

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109 Ashurst (2018), *Native Title Year in Review 2017 - Determination of native title claims*. Native Title Insights: 16 May, available at: https://www.ashurst.com/en/news-and-insights/insights/native-title-year-in-review-2017---editorial/native-title-year-in-review-2017---determination-of-native-title-claims.

110 Wainwright, S. (2017), *Barkandji Native Title claim amended to include more land in far west NSW. ABC News: Broken Hill,* 24 August, available at: https://www.abc.net.au/news/2017-08-24/barkandji-native-title-claim-amended-to-include-more-land/8837912.

111 *Barkandji Traditional Owners #8 v Attorney-General of New South Wales 2015,* para 6.

112 Ibid.

113 Ibid.

114 Australian Institute of Aboriginal and Torres Strait Islander Studies (2018), *Barkandji Traditional Owners #8 (Part B) v Attorney-General of New South Wales [2017] FCA 971*, available at: https://aiatsis.gov.au/ntpd-resource/29171.

2.8 Rainfall variability in the Barwon-Darling is likely to increase

2.8.1 Current trends towards higher temperatures are likely to continue

As outlined in **Chapter 2.1**, the Barwon-Darling climate is highly variable. Climate change and emission scenarios indicate that temperature variation is projected to remain within a similar range,[115] with the whole range shifting upwards accompanied by an increase in heatwaves.[116] Temperatures for the Barwon-Darling are projected to rise by 3.0 to 5.4 degrees Celsius by 2090 under the highest emission scenario.[117] The mean temperature increase projected for 2030 is 0.7 to 1.5 degrees Celsius.[118] This is in the life of the next iteration of the Plan.

2.8.2 Rainfall and runoff projections indicate a more uncertain future

Rainfall variability in the Barwon-Darling is likely to increase, manifesting in both time in drought and intensity of extreme rainfall events. The projections indicate no clear signal for total annual rainfall, but suggest a decrease in winter rainfall.[119]

Rainfall projections are typically less certain than temperature projections, and the high climate variability in the Barwon-Darling makes it difficult to interpret the effect and potential impact of climate change against the natural variability in rainfall. For example, although it is believed that a reduction in rainfall is more likely, some models have indicated a potential increase in rainfall, particularly in summer and in the northern tributaries of the Darling.[120]

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) has dealt with uncertainty in rainfall projections by developing a variety of climate scenarios, with 'wet extreme', 'dry extreme' and 'best estimate' (median) models.[121] These models have the following projections for the Barwon-Darling:

- **best estimate model** – indicates an 8 percent reduction in surface water availability, 10 percent reduction in end-of system flows, and a 2 percent reduction in surface runoff for 2030
- **extreme (dry vs wet) scenario** – estimates for 2030 vary from a 27 percent reduction to a 31 percent increase in surface water availability, and 35 percent reduction to 47 percent increase in end-of-system flows.[122]

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115 Climate change projections and emission scenarios for natural resource management clusters were developed by CSIRO around 2015, and are based on more recent climate science than those modelled for the Barwon-Darling in 2008.The Barwon-Darling sits across two natural resource management 'clusters'. The Central Slopes cluster sits in eastern Australia, slightly removed from the east coast, incorporating Walgett and Mungindi. The Rangelands cluster sits across most of arid central Australia. The western part of the Barwon-Darling sits in the Rangelands cluster, incorporating Bourke and Wilcannia.

116 From the Central Slopes cluster, Representative Concentration Pathway 8.5, as reported in Vertessy, R., Barma, D., Baumgartner, L., Mitrovic, M., Sheldon, F., Bond, N. (2019), *Independent Assessment of the 2018-19 fish deaths in the lower Darling – Final Report*, for the Australian Government, 29 March 2019.

117 Ibid.

118 Ekström, M. et al (2015), *Central Slopes Cluster Report, Climate Change in Australia Projections for Australia's Natural Resource Management Regions: Cluster Reports*, eds. Ekström, M. et al, CSIRO and Bureau of Meteorology.

119 Vertessy, R., Barma, D., Baumgartner, L., Mitrovic, M., Sheldon, F., Bond, N. (2019), *Independent Assessment of the 2018-19 fish deaths in the lower Darling – Final Report*, for the Australian Government, 29 March 2019.

120 Ibid.

121 CSIRO (2008), *Water Availability in the Barwon-Darling,* A report to the Australian Government from the CSIRO Murray-Darling Sustainable Yields Project

122 The CSIRO Sustainable Yields Project was developed using the IPCCs models and emission scenarios from the 2007 Fourth Assessment Report which have since been updated in the 2014 Fifth Assessment Report.

Soil moisture and runoff are projected to decrease, with an increase in potential evapotranspiration. The significant range in annual rainfall projections means planning for future water availability is challenging.[123] As a result of the uncertainty of rainfall projections, the modelled estimates of river flows are also highly uncertain, and further research needs to be conducted to provide more accurate climate change modelling for the management of water systems.

Despite the uncertainty of rainfall and runoff projections, increasing temperatures and increasing evaporation rates means that inflows to the Barwon-Darling are likely to decline in the future.[124]

2.8.3 Groundwater projections indicate recharge may reduce by 2030

Model projections for groundwater recharge rates under climate change are also highly variable. Groundwater recharge in the Barwon-Darling may reduce slightly by 2030 under the best estimate model, but would not significantly change the ratio of extraction to recharge.[125] The modelling indicates that climate change is not a threat to the alluvial groundwater sources due to the very low proportion of extraction. Even in cases of decreased rainfall recharge under climate change (the dry scenario), the extraction to recharge ratio remains low.[126]

Although climate change is not identified as a risk to this water source, CSIRO models indicate that climate change in addition to increases in development could lead to a significant increase in extraction of groundwater (up to 240 GL per year by 2030).[127] The development scenario indicates that behaviour by water users such as the likely increase in farm dams could lead to a 37 GL per year reduction to streamflow.[128] If the dry extreme scenario transpires and surface water is significantly decreased, the desire to extract groundwater may increase, particularly in the freshwater aquifer that is used for the Wilcannia supplementary town water supply.

However, analysis has suggested the scenarios are still valid and representative scenarios in light of the more recent science, although the probability of the dry scenario occurring may have declined slightly. As in Australian Academy of Science (2019), *Investigation of the causes of mass fish kills in the Menindee region NSW over the summer of 2018-2019*

123 Vertessy, R., Barma, D., Baumgartner, L., Mitrovic, M., Sheldon, F., Bond, N. (2019), *Independent Assessment of the 2018-19 fish deaths in the lower Darling – Final Report*, for the Australian Government, 29 March 2019.

124 Ibid.

125 CSIRO (2008), *Water Availability in the Barwon-Darling,* A report to the Australian Government from the CSIRO Murray-Darling Sustainable Yields Project

126 Ibid.

127 Ibid.

128 Ibid.

3 Water management and use

This chapter provides background information on water management and use in the Plan area, including an overview of key historic trends and events since development increased in the 1960s. Water use in the Plan area is currently dominated by irrigated agriculture, particularly cotton production, with town use representing a small but important proportion of licenced extraction. There are also three key basic landholder rights that do not require a licence: domestic and stock rights; native title rights; and harvestable rights. Extraction is mostly from surface water due to groundwater salinity.

Commencement of the Plan in 2012 gave effect to other state-wide changes in water regulation, particularly the conversion of licences created under the *Water Act 1912* to align with the current Act and the removal of restrictions linking water access to land use or title. Among other things, these changes allowed A Class licences to be connected to storages and transferred to larger pump sizes. Stakeholders are concerned that these changes, combined with contentious account rules included in the gazetted Plan, has increased access to low flows under A Class licences. Stakeholders also raised concerns about the impact of off-river harvesting and storage and floodplain harvesting.

3.1 Development has increased and water regulations changed

Water management in the Barwon-Darling has evolved over time, both regarding the specific policies and rules for the Barwon-Darling and more broadly in terms of national legislation and management in the Murray-Darling Basin. Key historic trends and events with implications for water management in the Barwon-Darling are outlined in **Table 6** below. Some dates represent approval or adoption of policies, where there may have been a short lag before these were experienced by water users in the area.

Table 6: History of water management in the Barwon-Darling from the 1960s to the present[129]

Period	Trends and events
1960s	▪ Broad-scale irrigated cotton farming developed on the Barwon-Darling, centred around Bourke. ▪ Water licences provided for both small acreage properties and large acreage broad-scale irrigation. Small acreage licences (for properties under 50 acres or 20.5 hectares) allowed small pumps up to 150 mm with average extraction rates up to 5 ML per day, while large broad-scale licences (for properties over 400 acres or 162 hectares) permitted large pumps such as 610 mm with average extraction rates of 80 ML per day. ▪ Water licences were generally unrestricted, with an ability to pump if the downstream weir was flowing. ▪ Many water licences were issued to landholders next to the river who had no real intention to irrigate (these are commonly referred to as sleeper licences).

[129] Barwon-Darling history based on: NSW Office of Water (2011), *Barwon-Darling Valley – IQQM Cap Implementation Report,* NSW Government; Aither (2019), *Memorandum: Barwon-Darling Water Sharing Plan comparison and concessional conversions*; NSW DPI (2012), *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources Background document*, and stakeholder submissions for this review.

Period	Trends and events
	▪ Floodplain harvesting was an unlicensed and unmonitored implied right, similar to a basic landholder right.
1980-1990	▪ The profitability of irrigated cotton compared to wool led to an increased uptake of irrigation and increased competition for access to water. ▪ The installation of large on farm storages called "ring tanks" became common in the Barwon-Darling and unregulated parts of the Condamine-Balonne.[130] ▪ Concerns grew over declining river health. Increasing objections were made to water licence applications. ▪ In 1982 an embargo was placed on the issue of large-scale irrigation licences, broadened in 1987 to all entitlements. ▪ In 1988 licence pumping conditions were standardised, the river was divided into eight sections, and A, B and C Class licences were created to manage water access. ▪ D Class access licences with no usable conditions were issued as a holding strategy for the backlog of applicants. ▪ In 1990 the embargo of 1987 was relaxed to allow 10 hectare entitlements to be issued per property for small-scale use.
1991	▪ The *Water Licencing Policy for the Barwon-Darling River Mungindi to Menindee (Including Boomi River)* was released in July with proposals including: - formalising the licence class system - removing area-based limitations in favour of volumetric entitlements - increasing freedoms to trade - resuming half unused entitlements, with half reissued as D Class licences and the other half retired. ▪ A major blue-green algal bloom along almost the entire 1,600 km of the Barwon-Darling in November and December prompted significant concern for river health.
1992	▪ The *Interim Unregulated Flow Management Plan for the North-West* (*Interim Flow Plan*) was released in June to reinforce flow targets for river health including fish migration and algal suppression. The *Interim Flow Plan* also committed to the volumetric conversions and metering requirements initiated in 1991.
Early 1990s	▪ Time and event meters were introduced to monitor the take, quota, or Annual Volumetric Limit of all large-scale irrigators on the river.

130 Webb, McKeown and Associates (2007). *State of the Darling – Interim Hydrology Report*, for the Murray Darling Basin Commission, Canberra

Period	Trends and events
1994	▪ Broad-scale water policies were developed and implemented in the mid-90s including 1994 Council of Australian Governments Water Reforms.
1995	▪ The Barwon-Darling Cap was established by the Murray-Darling Basin Ministerial Council, and introduced long-term limits on the volume of water that could be taken from the river. The Cap aimed to '*protect and enhance the riverine environment and protect the rights of water users*'.[131] The Cap is the estimated long-term annual diversion at 1993-1994 levels of development based on river basin modelling. ▪ The (then) Department of Water Resources engaged a panel of five scientists known as 'Scientists on Safari' to asses instream environmental flow needs of the Barwon-Darling.
1997	▪ The Barwon-Darling River Management Committee was established, agreeing on environmental flow rules for the river in 1998 to increase the cease to pump thresholds for licences. ▪ A permanent Cap on Murray-Darling Basin diversions was adopted, with associated reporting starting in 1997-98.
2000	▪ The *Water Management Act 2000 (NSW)* was created to provide for the sustainable and integrated management of the state's water resources for present and future generations. Water Sharing Plans are made under the Act. Provisions under the Act have been enabled progressively.
2000-2001	▪ New stream monitoring gauges installed and calibrated (MACE meters). ▪ There was a modelled 10 percent growth in water use to 2000-01 since the Cap benchmark of 1993-94. ▪ 'No Further Development' conditions were issued on all irrigation entitlements to limit extractions and on-farm development. ▪ River reach delineations were rearranged from eight to 13 reaches in 2000.
2005	▪ The Barwon-Darling and Lower-Darling valleys are combined for Murray-Darling Basin Cap compliance reporting. Cap compliance was breached five times from 2003-04 to 2010-11.[132] In 2005 after the 2003-04 reported breach, the NSW Government developed a *Cap Management Strategy*.
2006	▪ The *Cap Management Strategy* was approved (and implemented in 2007) to convert 525 GL of Annual Volumetric Limits to 173 GL of Cap shares (favouring entitlements historically used) and allocate this amount between water accounts.[133] This strategy also introduced unlimited carryover of account water with an annual limit on use equal to the

131 MDBA. *Transitioning from the Cap to sustainable diversion limits*, available at https://www.mdba.gov.au/basin-plan-roll-out/sustainable-diversion-limits/transitioning-cap-sustainable-diversion-limits

132 Water audit monitoring reports are available on the MDBA website for the period 1994-1995 to 2011-2012. Cap register data is available for the period 2012-2013 to 2016-2017. Transitional reporting of SDL water accounting data began in 2012-2013.

133 Aither (2019). *Memorandum – The proposed purchase of A-class licences in the Barwon-Darling*, for the Natural Resources Commission.

Period	Trends and events
	previous annual entitlement volume. This was a substantial reduction (around two thirds) when compared to the previous annual entitlement. It also provided additional trading rules and removed the 'No Further Development' condition from licences. The 173 GL limit was the long-term average annual extraction volume when the Plan commenced in 2012.
2006-2017	▪ Concessional conversions[134] were introduced through the *Heads of Agreement for the Barwon-Darling River System Cap*. They were permitted from 2006 through to the first five years of the Plan.
2007	▪ The *Water Act 2007 (Commonwealth)* was passed, requiring formation of the MDBA to develop the *Basin Plan* and limit how much water could be used by Basin industries and communities.
2007-2008	▪ New Cap share volumes were put in place, with the first year allowing a 200 percent allocation and some water distributed by valley to active users to ease irrigators into the new volumes. ▪ Licence holders were issued with notice of Concessional Conversion Allowance. ▪ The NSW Government attempted to incorporate floodplain harvesting into the water management framework via a *Draft Floodplain Harvesting Policy Framework*. A number of issues delayed implementation and a Floodplain Harvesting Anomalies Committee was established, and later dissolved. An embargo was placed on works that facilitate harvesting of water from a floodplain.[135]
2011	▪ The draft *Barwon-Darling Unregulated River Water Sharing Plan* was released for public exhibition. Public information sessions were held in November during the exhibition period at Walgett, Bourke and Wilcannia. ▪ D Class licences were cancelled.
2012	▪ Barwon-Darling Unregulated River Water Transfer Rules were published in January. ▪ The final *Barwon-Darling Unregulated River Water Sharing Plan 2012* was published in October including a number of changes to the Plan which were not part of the draft version for public comment (see **Chapter 3.1.1** and **Appendix C**). Examples that are likely to have had a substantial impact on the Plan include changes in the share component of A, B and C

134 As some licence holders had insufficient Cap share to pursue their pre-Cap conversion average history of extraction, concessional conversion rules enabled licence holders to transfer Cap share from one licence class to another (e.g. convert shares in C Class to B Class) reinstate their previous extraction at specified access conditions.

135 DPIE-Water (2019), *Managing floodplain harvesting in NSW: fact sheet*, available at https://www.industry.nsw.gov.au/__data/assets/pdf_file/0015/217023/managing-floodplain-harvesting-in-NSW-fact-sheet.pdf

Period	Trends and events
	Class licences, changes in annual extraction limit to 300 percent, and replacement of the notwithstanding clause.[136] ▪ Plan implementation gave effect to separation of land and water entitlements under the Act, licencing and approval rules, and share and extraction components.[137] This removed the limit on pump sizes enabling A Class licences to be assigned to larger pumps, and enabled A Class extraction to be stored (see **Chapters 3.1.2** and **3.1.3**). ▪ The *Basin Plan* was adopted by the Commonwealth Government in November.
2013	▪ The *Floodplain Harvesting Policy* was introduced to address unconstrained growth in harvesting and bring it into the Act's regulatory framework.
2013-2018	▪ A number of minor amendments were made to the Plan between 2013 and 2018
2014	▪ The Cap was revised up to 189 GL following internal modelling reviews, as it was determined that modelled diversions did not represent actual diversions in 1993-1994.[138] The MDBA provisionally accredited the revised Cap model.[139] Due to the new Cap model and the increased Cap limit, the combined Barwon-Darling and Lower Darling valleys moved from reported breaches to cumulative credit in the Cap register.[140]
2015	▪ The Cap adjustment process increased existing share allocations for A, B and C Class licences by nine percent (15,572 ML) based on updated modelling (see **Chapter 8.5**).
2016	▪ The *Northern Basin Review* report was released in November. The four year review aimed to assess the Northern Basin catchment water recovery targets to determine impacts on both communities and river health. It reviewed the *Basin Plan* recovery target of 390 GL for the Northern Basin river systems and complementary water recovery management activities. It proposed a reduction in the water recovery target to 320 GL provided there were commitments from Commonwealth, NSW and Queensland Governments on 'toolkit measures'. Barwon-Darling water recovery targets were increased as a result of the *Northern Basin Review* from 28 GL (6 GL local recovery, 22 GL shared recovery) under the *Basin Plan* to 32 GL of local recovery.
2017	▪ In August the Australian Broadcasting Corporation's Four Corners episode 'Pumped' was aired with allegations of illegal water take from the Barwon-Darling. It raised issues with government transparency and

136 The notwithstanding clause describes a rule in Schedule 2 where holders of specific licences can apply to DPIE-Water when flow at the Bourke town gauge is between 1,250 ML/day and 1,610 ML/day (cease to pump) to seek written permission to extract and irrigate an area of 1,000 hectares or less on specific properties.

137 NSW DPI (2015). *Guide to the conversion of water licences to water access licences and approvals*

138 Advised by DPIE-Water, via email.

139 Advised by MDBA, via email.

140 MDBA (various), *Cap compliance reports*. https://www.mdba.gov.au/publications/mdba-reports/cap-compliance-reports

Period	Trends and events
	accountability, alleged that changes were introduced to the 2012 Plan on the basis of representation by interest groups, and instigated a series of parliamentary inquiries, investigations, reports and reviews including Ken Matthews' independent investigation. ▪ Ken Matthews AO released an interim (September) and final report (November) into water management and compliance to the NSW Government. Significant progress was made between the reports but it highlighted the significant risks and challenges to implementing water management and compliance reforms unless government remained committed and focused on the total reform package.
2018	▪ The Natural Resources Access Regulator began work, having been established under the *Natural Resource Access Regulator Act 2017 (NSW)*. Their legislated role is to ensure effective, efficient, transparent and accountable compliance and enforcement measures for natural resources management legislation, and to maintain public confidence in the enforcement of that legislation. ▪ NSW Government formed the Water Renewal Taskforce and IWG to respond to the Ken Matthews reports. ▪ The *Water Management Amendment Act 2018 (Amending Act)* complemented by the *Water Management (General) Amendment (Metering) Regulation 2018* brought in more rigorous monitoring and metering requirements, rules and standards for metering equipment, and stronger enforcement measures. It also amended the individual annual take limit, including for the Barwon-Darling Plan. ▪ The 2013 *Floodplain Harvesting Policy* was significantly redrafted and finalised after public consultation on the NSW Water Reform Action Plan. DPIE-Water contracted an independent review of the policy implementation and put a draft *Monitoring and Auditing Strategy* on public exhibition. Progress is being made on the activities required for implementation.
2018-2019	▪ A series of fish deaths downstream of the Plan area occurred due to factors including low flows, poor water quality and a sudden change in temperature.[141] The fish deaths sparked significant community concerns and prompted two reports: one to Government (the Vertessy report) and the other to the Opposition (Australian Academy of Sciences Report). ▪ Recent fish death events include:[142] - 15 December 2018 – about 30 km of the Darling River from downstream of Menindee Lakes main weir to upstream of Weir 32. Tens of thousands of fish were estimated to have died, mostly Bony

141 Vertessy, R., Barma, D., Baumgartner, L., Mitrovic, M., Sheldon, F., Bond, N. (2019), *Independent Assessment of the 2018-19 fish deaths in the lower Darling – Final Report*, for the Australian Government, 29 March 2019.

142 NSW DPI (2019), *Identified fish kills in 2019 due to environmental conditions*, available at https://www.dpi.nsw.gov.au/fishing/habitat/threats/fish-kills; NSW DPI (2019), *Lower Darling River Fish Death Event, Menindee 2018/19,* available at https://www.dpi.nsw.gov.au/fishing/habitat/threats/fish-kills/Fish-death-interim-investigation-report.pdf

Period	Trends and events
	Herring (Bream), also Golden and Silver Perch, Murray Cod and small numbers of Carp. - 6-7 January 2019 – about 45 km of the Darling River below the Menindee main weir including Menindee town. Hundreds of thousands of fish estimated to have died including significant numbers of Bony Herring, Golden and Silver Perch, Murray Cod and small numbers of Carp. - 28 January 2019 – about 30 km of the Darling River from Weir 32 to upstream Menindee main weir. Over a million fish are estimated to have died including hundreds of thousands of Bony Herring, as well as Golden and Silver Perch, Murray Cod and Carp. - 26 March 2019 – Barwon River, 40 km from Walgett, hundreds of fish (mostly Golden Perch and Murray Cod) estimated to have died. - 24 April 2019 – Darling River, near Bourke, hundreds of fish (mostly Bony Herring) estimated to have died.
2019	▪ Water resource plans implement the *Basin Plan* and ensure sustainable diversion limits are met from 2019. The water sharing plans will remain the primary legal framework and the water resource plans will build on these arrangements to deliver *Basin Plan* requirements (see **Chapter 3.1.4**). ▪ In future, water resource plans will be audited by the MDBA[143] and water sharing plans will be audited by the Commission within the first five years of implementation under section 44 of the *Water Management Act 2000*.

3.1.1 Post public exhibition Plan changes were contentious

Over half (37) of the submissions made to the Commission referenced the significant changes between the version of the Plan published for public comment in 2011 and the version gazetted in 2012. These changes are described in **Table 6** above and detailed in **Appendix C**. These submissions expressed significant concern about the lack of transparency about the changes and the process involved. Further, these submissions expressed that while the exhibited draft had some public agreement, the final Plan was not supported. The most contentious aspect was the changes to rules that increased opportunities to legally extract water at low flows.[144]

There have also been poorly communicated changes to the Plan since implementation, such as the increase in the long term average annual extraction volume,[145] that have led to community concerns around government transparency and management of water extraction in the Barwon-

143 MDBA (n.d.) *Basin-wide compliance and enforcement,* available at https://www.mdba.gov.au/basin-plan-roll-out/basin-wide-compliance-enforcement.

144 MDBA (2018), *Ecological needs of low flows in the Barwon-Darling*, available at https://www.mdba.gov.au/sites/default/files/pubs/ecological-needs-low-flows-barwon-darling_0.docx

145 The increase in the long term average annual extraction occurred due to updates to modelled estimates by DPIE-Water. As discussed in **Chapter 3.1.4**, the Cap is equivalent with the long term average annual extraction volume. The Murray-Darling Basin Ministerial Council set Cap at 1993-1994 diversions; however, earlier modelled estimates did not appropriately capture this level of take. DPIE-Water updated modelling to include best available information including crop and rainfall harvesting efficiencies, on farm storage seepage rates, irrigation entitlements and access conditions as at 1993-1994.

Darling. Issues around community distrust and social licence are explored further in **Chapter 7.5**.

3.1.2 Pump size restrictions were removed, increasing A Class extraction rates

Conversion from licences created under the *Water Act 1912* to licences under the current Act allowed a significant increase in pump sizes for A Class licences, which access the lowest flows. Rather than requiring three different sized pumps for different licence types, a pragmatic decision allowed a licence's associated water supply works to be changed using an s71W dealing.[146] This let A Class licences, which previously had a maximum 150 mm (5.9 inch) pipe to be assigned to 610 mm (24 inch) pipes, allowing significantly higher extraction rate for users accessing low flow. Increased rates of extraction result in faster rate in drawdown of river levels and may also impact bank erosion.[147]

Plan provisions such as individual daily extraction limits (IDELs) would have helped mitigate the impacts from pump size increases; however, these were not implemented. IDELs are discussed in more detail in **Chapter 8.6.1**.

3.1.3 A Class licences are now connected to storages

A Class licences were traditionally used to directly irrigate permanent plantings, and were not attached to storages. The conversion of licences described in **Chapter 3.1.2** removed the restrictions linking water access to land use and title. This meant water extracted under A Class licences could be stored, changing user behaviour as licence holders can extract above immediate requirements to meet future watering needs. The ability to store water gives licence holders more options to strategically maximise their take using various access provisions designed to enhance user flexibility, including the carryover and 300 percent annual take rules discussed in **Chapter 8.4**. While this supports increased productivity, it also leads to greater demand on water resources in low flow periods.

3.1.4 Long-term average annual extraction volume concerns

One of the key Plan provisions to manage diversions is the long-term average annual extraction limit (LTAAEL). Stakeholder submissions demonstrated a general lack of understanding about the LTAAEL (and within this, the long term annual extraction volume and its equivalence with the Cap) and the *Basin Plan's* sustainable diversion limit.

There are also concerns around LTAAEL compliance and reporting. Some stakeholders called for a review of the LTAAEL (and consequently the sustainable diversion limit). The Commission notes the conclusion of the Vertessy report that, while the sustainable diversion limit may need adjustment, there is currently insufficient data to justify a change. The appropriate timing for such an adjustment would be as part of the 2026 *Basin Plan* review. There should be sufficient evidence available at that time to assess the sustainable diversion limit and adjust as necessary. This review should consider the seasonality of flows over time and impacts on water availability.

146 Stakeholder interview and submission for this review.

147 Thoms, M., Sheldon, F., Roberts, J., Harris, J., Hillman, T. (1996), *Scientific panel assessment of environmental flows for the Barwon-Darling river system*, a report to the technical services division of the NSW Department of Land and Water Conservation.

The LTAAEL for the Barwon-Darling is 240 GL per year of extraction under Cap baseline conditions, consisting of 223 GL per year surface water and 17 GL per year from the Upper Darling Alluvium. The annual surface water component is comprised of the following:

- domestic and stock rights (0.8 GL surface water see **Chapter 3.3.3**)
- native title rights (0 GL, see **Chapter 10.1**)
- harvestable rights (11 GL, see **Chapter 3.2.1**)
- licence holders (189 GL of A, B and C Class (see **Table 7**), 5.4 GL utility, 2.66 GL domestic and stock licences)
- floodplain harvesting (14 GL, see **Chapter 3.2.2**).[148]

Irrigation and industry take is referred to as the long term average annual extraction volume and aligns with the Cap. It is 214 GL per year, with 189 GL (the 2014 Cap allowance) extracted 'within channel' (see **Table 7** for breakdown).

Table 7: Break down of long term average annual extraction volume for the Barwon-Darling surface water[149]

Category of take	Average annual figures
Metered river by 'major' irrigators	181.6 GL
Unmetered river 'reach' irrigators	7.3 GL
Irrigation take sub total	189 GL[150]
Floodplain harvesting by 'major' irrigators	14 GL
Rainfall runoff harvesting	11 GL
Total	214 GL

When *Basin Plan* arrangements start, states will report on sustainable diversion limit compliance instead of Cap compliance. The *Basin Plan* sets sustainable diversion limits that restrict the average volume of water used by communities and industries while maintaining environmental health.[151] Sustainable diversion limit compliance will begin with water resource plan accreditation, with enforcement starting in 2019.[152] The Commission understands that DPIE-Water is currently targeting accreditation of the *Barwon-Darling Water Resource Plan* in December 2019.

148 LTAAEL is established under Plan Part 6, Div 1, 33 (2-3)

149 NSW Office of Water (2013), *Technical Report on the Impacts of Restricting Diversions on the Barwon-Darling River (v3)*, NSW Government. The Commission notes that utility take and domestic and stock licences are not included in the breakdown of the long-term annual extraction volume. This is due to utility take not being captured in the IQQM model developed by DPIE-Water. The Commission has assumed that domestic and stock licenced access is included within DPIE-Water volumes provided for *unmetered river 'reach'* irrigators.

150 The Commission understands that the Commonwealth Environmental Water Holder currently holds 30.1 GL of the 189 GL licenced entitlement in the Plan area

151 MDBA, *Sustainable diversion limit reporting and compliance framework*, available at https://www.mdba.gov.au/basin-plan-roll-out/basin-wide-compliance-review/sustainable-diversion-limit-reporting-compliance.

152 MDBA, *Sustainable diversion limit reporting and compliance documents*, available at https://www.mdba.gov.au/publications/policies-guidelines/sustainable-diversion-limit-reporting-compliance-documents.

The sustainable diversion limit is established for each valley, accounting for the baseline diversion limit (an estimate of extraction before the *Basin Plan*)[153] and water recovery targets (specified in the *Basin Plan*). Estimates provided by the MDBA for the Barwon-Darling are a sustainable diversion limit of 166 GL per year, a baseline diversion limit of 198 GL per year, and a local reduction water recovery target of 32 GL per year (as of December 2018). The Commission understands that 30.1 GL has been recovered to date with 1.9 GL still required.[154] The *Northern Basin Review* indicates that some of the remaining volume may be recovered through funding new infrastructure.

3.2 Off-river harvesting and storage is significant

While the Barwon-Darling is unregulated, significant volumes of water are held off-river by irrigators and other landholders (utilities do not have off-river storage in the Plan area).

In 2007, the estimated volume in ring tanks in the Barwon-Darling itself was 289 GL, with another 4,039 GL in ring tanks and hillside dams in the upstream catchments.[155] These ring tanks store water to meet future irrigation requirements.

A greater proportion of river flows are taken in dry periods compared to wet periods, resulting in higher levels of extraction in summer to meet crop demands.[156] The water held in on-farm storages can be a mix of licenced extraction from the river, entitlements under basic landholder rights and floodplain harvesting.

3.2.1 Harvestable rights take is a poorly quantified volume

Unlike in the rest of the state, properties in the Western Division are able to capture almost all rainwater runoff from their property[157] and store it for use in "*one or more dams on non-permanent minor streams, hillsides and gullies without a water licence, water supply work approval, or water use approval*".[158] This is their harvestable right and is included in the basic landholder rights (see **Chapter 3.3.3**).

The Commission understands that the volume of harvestable rights was modelled to be 11 GL per year in Plan development, although the calculations behind this figure are unclear.[159]

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153 The Baseline diversion limit estimates the volume of water that was used in the Basin, with initial limits established under the *Basin Plan* in 2012.

154 Aither (2019). *The proposed purchase of A class licences in the Barwon-Darling*, for the Natural Resources Commission

155 Webb, McKeown and Associates (2007). *State of the Darling – Interim Hydrology Report*, for the Murray Darling Basin Commission, Canberra.

156 Ibid.

157 Excluding from floodplains or on land of special environmental or cultural significance.

158 NSW Government (2006), *Government Gazette of the State of NSW Number 40 - Water Management Act 2000: Order Under Section 54*, available at https://gazette.legislation.nsw.gov.au/so/download.w3p?id=Gaz_Gazette%20Split%202006_2006-40.pdf; and NSW Department of Industry (2019), *Harvestable rights – Dams*, available at https://www.industry.nsw.gov.au/water/licensing-trade/landholder-rights/harvestable-rights-dams.

159 Assumption based on part 6, division 2, section 33 of the Plan, where modelled long-term annual extraction volume taken by irrigation and industry was 214 GL per year, of which 189 GL per year was extracted from the river channel. It is understood the remaining 25 GL must be harvestable rights and/or floodplain harvesting, this is further broken down in NSW Office of Water (2013), *Technical Report on the Impacts of Restricting Diversions on the Barwon-Darling River (v3)*, NSW Government to 11 GL of rainfall runoff harvesting and 14 GL of floodplain harvesting by 'major' irrigators.

Without peer reviewed and publicly available information on the measurement and modelling of harvestable rights take and floodplain harvesting (discussed below), reporting on the actual take from the system versus the LTAAEL does not meet public expectations of adequacy or transparency.

The volume of rainfall captured under harvestable rights will be limited by practical storage constraints. The Commission assumes that as water becomes more valuable, the cost benefit of capturing higher proportions of rainfall will improve. In a hypothetical situation where harvestable rights in the Western Division were fully taken up, there would be minimal rainfall runoff reaching the river from the immediate Barwon-Darling catchment or Western Division tributaries. However, the impact of increased Western Division harvesting on flows in the Barwon-Darling may not be as extreme as expected. For example, the Border, Gwydir, Namoi and Macquarie-Bogan River catchments have contributed on average two thirds of tributary inflows over the last 20 years and their harvestable rights are limited to about 10 percent of average annual rainfall runoff.[160]

3.2.2 Floodplain harvesting regulation is a work in progress

Floodplain harvesting is the collection, extraction or impoundment of water flowing across floodplains.[161] Flows can originate from local runoff that has not yet entered the main channel of a river, or water overflowing from a main channel in a flood. Floodplain harvesting is most prominent in northern valleys such as the Barwon-Darling, Border Rivers, Gwydir, Namoi and Macquarie. The regulation and licencing of floodplain harvesting is initially focused on these valleys.[162]

Floodplain harvesting reduces water volumes reaching or returning to rivers, and can seriously affect connectivity between the local floodplain, wetlands and the river.[163] The variable climate in the Barwon-Darling area means that periodic large rainfall events can be captured in on-farm storages and used over the intervening dry periods. This decreases the amount of water available to meet downstream river health, wetland and floodplain needs and the water supply entitlements of other users. The impact of floodplain harvesting on flows in the Barwon-Darling was raised as a significant concern during stakeholder consultation for this review.

Like harvestable rights, floodplain harvesting should be accurately and transparently accounted for and managed within the LTAAEL. The long term average annual extraction volume for floodplain harvesting under the Plan is understood to be 14 GL for 'major' irrigators only.[164] The NSW Government has reported 11.49 GL per year of modelled floodplain harvesting in the Barwon-Darling since 2012, from about 210 GL in the Northern Basin.[165] Section 34 of the Plan provides the method for calculating annual extraction, by reference to hydrological computer modelling. However, through the *Floodplain Harvesting Policy*:

160 Webb, McKeown and Associates (2007). *State of the Darling – Interim Hydrology Report*, for the Murray Darling Basin Commission, Canberra

161 DoI-Water (2018), *NSW Floodplain Harvesting Policy*, available at https://www.industry.nsw.gov.au/__data/assets/pdf_file/0017/143441/NSW-Floodplain-harvesting-policy.pdf.

162 DPIE-Water (2019), *Floodplain Harvesting Action Plan*, available at https://www.industry.nsw.gov.au/__data/assets/pdf_file/0015/272301/floodplain-harvesting-action-plan.pdf.

163 Appendix 3 of the *Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016*

164 NSW Office of Water (2013), *Technical Report on the Impacts of Restricting Diversions on the Barwon-Darling River (v3)*, NSW Government.

165 MDBA (2017), *Transition Period Water Take Report 2012–13 to 2015–16*; and MDBA (2018), *Transition Period Water Take Report 2016–17*, available at https://www.mdba.gov.au.

- these limits are intended to be re-calculated based on the capacity of the various floodplain works that exist under the Plan-specified level of development; and
- floodplain harvesting long-term extraction limits will be separated from the extraction limit for other licences.

DPIE-Water has recently made significant advances in understanding and regulating floodplain harvesting. In collaboration with MDBA and GeoScience Australia they are collecting and analysing data on historic and current floodplain harvesting through farm surveys, on-ground mapping, satellite imagery, remote sensing and flood management models.[166] Evidence suggests that the volume of water harvested from floodplains is above the legal limits specified in water sharing plans and the *Basin Plan*.[167]

DPIE-Water's *Action Plan for Floodplain Harvesting* outlines the significant amount of work to be completed in the near future. While progress is being made, data and modelling of floodplain harvesting is not yet available to be integrated into the Plan or water resource plan process. DPIE-Water has advised that an interim estimate of floodplain harvesting based on best available information will initially be used for water resource plan accreditation and water sharing plans amended as a priority once estimates are finalised. The Commission supports this approach. Alluvium's independent review highlighted the lack of transparency in the models and methods to date, but highlighted the recent progress in rectifying this significant issue.[168] The Commission reiterates the need for transparent, peer reviewed policy development and implementation and notes the recent release of supporting documents on DPIE-Water's website.

Floodplain harvesting licences and approvals for the northern valleys are scheduled to be in place by early 2020.[169] DPIE-Water has stated they will amend water sharing and water resource plans with entitlements in the second half of 2020.[170] This should improve transparency around calculated extraction. DPIE-Water also released a *Draft Floodplain Harvesting Monitoring and Auditing Strategy* (November 2018) for consultation. Review of DPIE-Water's strategy and the broader policy changes around floodplain harvesting are outside the Commission's scope for this review. Submissions to this review clearly indicated a broad community concern around the scale of floodplain harvesting, lack of compliance of existing water storage structures, historic lack of effective regulation and fears around policies which may further entrench excessive floodplain harvesting. The Commission encourages DPIE-Water to finalise the work already underway, addressing community concerns. The Commission further recommends the government adequately supports the Natural Resources Access Regulator to implement the necessary auditing, compliance and enforcement measures to support improved outcomes for the environment and downstream water users.

166 DPIE-Water (2019), *Floodplain Harvesting Action Plan*, available at https://www.industry.nsw.gov.au/__data/assets/pdf_file/0015/272301/floodplain-harvesting-action-plan.pdf.

167 DPIE-Water (2019), *Floodplain harvesting program video*, available at https://www.industry.nsw.gov.au/water/plans-programs/healthy-floodplains-project/harvesting.

168 Alluvium (2019), *Independent Review of the NSW Floodplain Harvesting Policy – Final Report*, available at https://www.industry.nsw.gov.au/__data/assets/pdf_file/0004/272146/Final-floodplain-harvesting-independent-review.pdf.

169 DoI-Water (2019), *NSW Floodplain Harvesting Policy*, available at https://www.industry.nsw.gov.au/water/plans-programs/healthy-floodplains-project/harvesting.

170 Advised by DPIE-Water, via email 11 June 2019.

The Commission suggests that DPIE-Water:

A Finalise development, modelling and implementation of floodplain harvesting policy, recognising the importance of out of channel flows for river health, wetland and floodplain needs and downstream users' water supply entitlements.

3.3 Water use is dominated by irrigated agriculture

3.3.1 Cotton is the main irrigated crop in the Plan area

Cotton is the major irrigated agricultural crop produced in the Barwon-Darling catchment (**Figure 6**). The next largest irrigated production systems are categorised by ABARES as 'other cereals' and 'other broadacre' (**Figure 6**). As cotton production is the major use of irrigated extraction, total water use for the catchment reflects water use for cotton production (**Figure 7**).

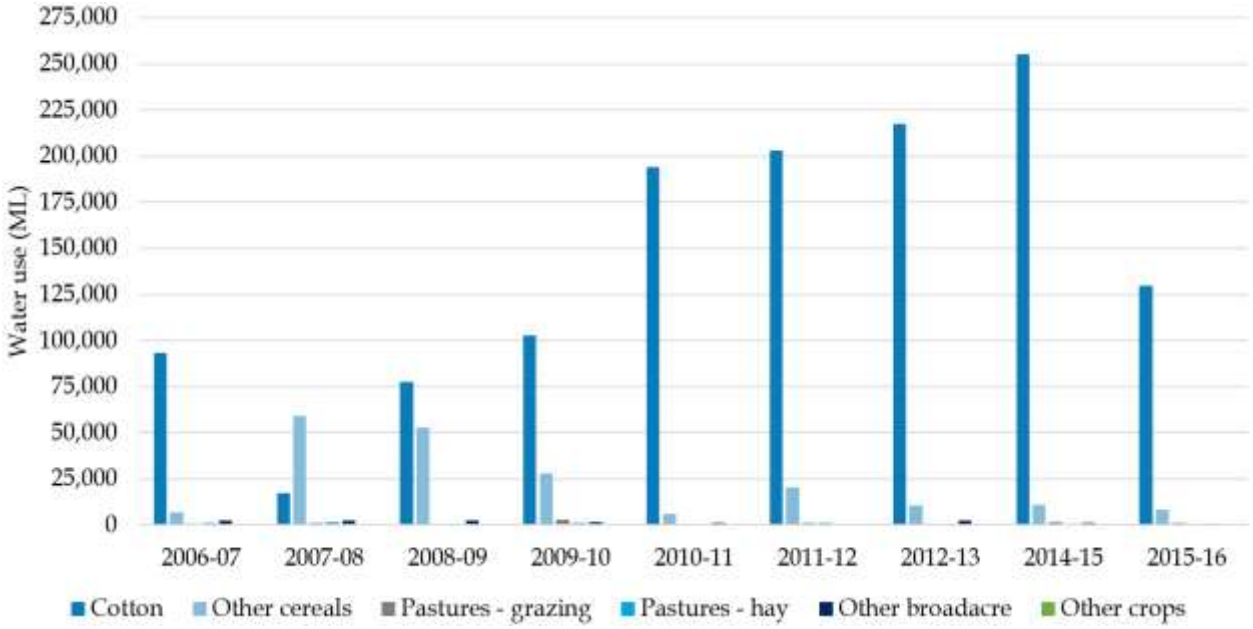

Figure 6: Irrigated agricultural water use by industry in the Barwon-Darling region 2006-2016[171]

171 Note that the chart is based on data from the following source and should be used as a guide only. Tableau Public (2018). *Australian Water Markets Dashboard 2016-17, based on ABARES data*, available at https://public.tableau.com/profile/australian.bureau.of.agricultural.and.resource.economics.and.sci#!/vizhome/AustralianWaterMarketsDashboard2016-17/AWMR2016-17

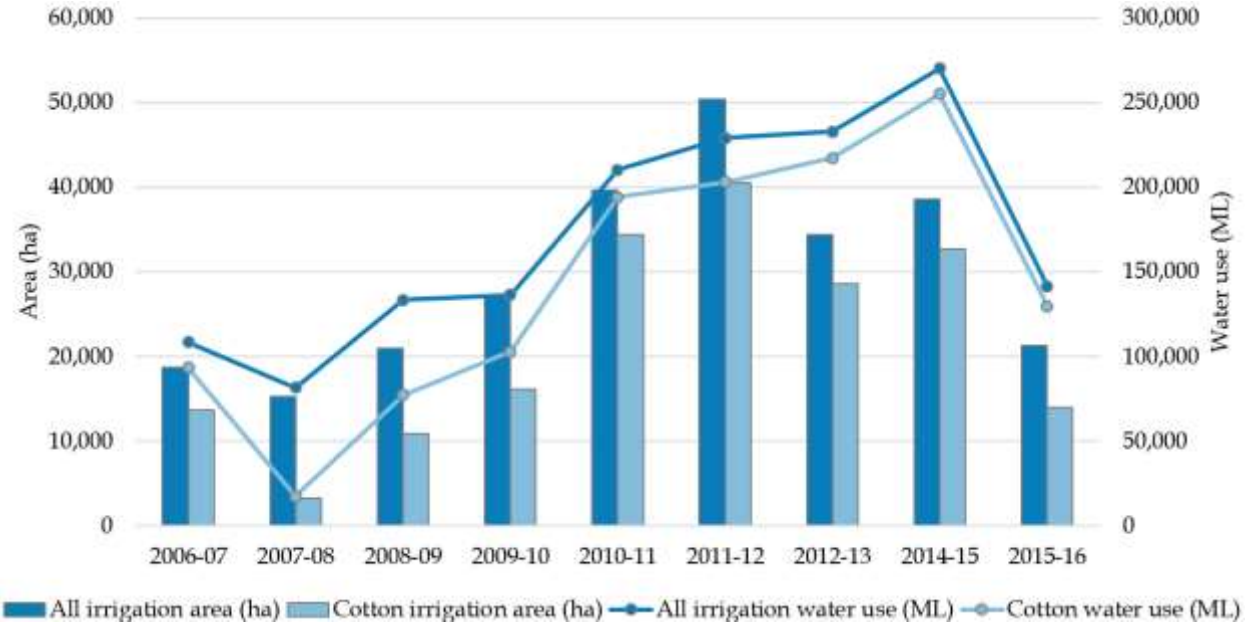

Figure 7: Total irrigation activity and cotton irrigation in the Barwon-Darling region 2006-2016[172]

3.3.2 Towns use a small but important volume of water

While only a small volume of water is required for household water use (towns have about 5,700 ML per year licenced utility take), the high level of quality and security required may impact other parts of the water supply system.[173]

The average typical residential water bill for regional NSW residences is $601. However, the Brewarrina and Central Darling LGA's were much higher than regional averages at $2,022 and $1,381 respectively.[174] The key drivers identified for the high cost were the lack of economies of scale, availability and proximity of water resources, and the relatively high cost per property due to the low population density. Issues around town water supply and utility licences are discussed further in **Chapter 7.2**.

3.3.3 There are three categories of water take under basic landholder rights

Under the Act basic landholder rights are to have priority over other extractive uses. The Act outlines three types of basic landholder right, which do not require a licence:

- **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

172 Note that the chart is based on data from the following source and should be used as a guide only. Tableau Public (2018). *Australian Water Markets Dashboard 2016-17, based on ABARES data*, available at https://public.tableau.com/profile/australian.bureau.of.agricultural.and.resource.economics.and.sci#!/vizhome/AustralianWaterMarketsDashboard2016-17/AWMR2016-17

173 Australian Bureau of Statistics (ABS), *Australian Bureau of Agricultural and Resource Economics (ABARE), and Bureau of Rural Sciences (BRS) (2009) Socio-economic context for the Murray–Darling Basin – Descriptive report*. Report to the Murray–Darling Basin Authority, Canberra, September.

174 NSW DPI-Water (2017) *2015-16 NSW Water Supply and Sewerage Performance Monitoring Report*. NSW Government.

- **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
- **harvestable rights – dams** - allows landholders to collect a proportion of rainfall runoff on their property and store it in one or more farm dams.

The share of basic landholder rights used for stock and domestic purposes was estimated to total 825.5 ML per year of river water and 2,283 ML per year alluvial water at the start of the Plan.[175] Harvestable rights were not directly defined (see **Chapter 3.2.1**) and native title rights were assigned a zero allocation (see **Chapter 10.1**). It is noted that carryover provisions do not apply to basic landholder rights.

Water is not always available to fulfil basic landholder rights along the length of the Barwon-Darling, a highly variable, unregulated system with natural cease to flow periods (see **Chapter 7.1**). The riparian flow targets in the *Interim Flow Plan* were calculated to provide the minimum water necessary to meet basic landholder rights (understood to be domestic and stock only). In the absence of inflows from tributaries downstream of Mungindi, the targets listed below indicate the flows required to meet the 1992 basic landholder rights requirements:[176]

- 850 ML per day at Mungindi
- 760 ML per day at Collarenebri
- 700 ML per day at Walgett
- 550 ML per day at Brewarrina
- 390 ML per day at Bourke
- 280 ML per day at Louth
- 150 ML per day at Wilcannia.[177]

These targets are included in the access provisions relating to supplementary water events in the major tributary water sharing plans (NSW Border Rivers, Gwydir Valley and Namoi Valley) and as a note in the Barwon-Darling Plan, These provide for temporary water restrictions to be used to meet target requirements, if it is in the public interest to do so, by restricting or prohibiting access under unregulated river (B or C Class) access licences. It is not certain whether these targets are currently applicable and these targets should be revisited and revised if necessary based on best available information.

3.3.4 Groundwater take is low but a vital additional supply

Groundwater is relied upon for supplementary town and domestic and stock use. There was no metered groundwater use before the Plan, and minimal metered groundwater use under the Plan. Groundwater development is limited due to the generally saline water quality, with the exception of narrow shallow lenses of freshwater along the Darling River. The electrical conductivity (a measure of salinity) ranges from about 300 µS/cm to 52,000 µS/cm.[178]

175 Part 5, Division 2, Clause 19 *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources 2012*

176 As per clause 46 note 5 in the Plan, the intention of the riparian flow targets set out in the *Interim Flow Plan* presented in Clause 46 Note 2 c) is to meet basic landholder rights requirements along the Barwon-Darling.

177 NSW Government, (1992), *Interim Unregulated Flow Management Plan for the North-West*

178 DoI-Water (2019), *Draft Darling Alluvium Water Resource Plan Description*, NSW Government

Table 8 summarises the estimated extraction under licenced share components and basic landholder rights from the Upper Darling Alluvium. Total estimated and allocated extraction is 6,281 ML per year while the LTAAEL is 17,120 ML per year. There are about 101 un-metered basic landholder rights bores.[179] Stock and domestic bores are usually shallow, small diameter bores with limited extraction capacity that can be susceptible to climatic fluctuations in water levels.[180]

Table 8: Basic landholder rights and licenced share components for the Upper Darling Alluvium

Basic landholder right estimate	Wilcannia town utility supply	Salt interception scheme	*Total*	LTAAEL
2,761 ML/year	220 ML/year	3,300 ML/year	*6,281 ML/year*	17,120 ML/year

The Salt Interception Scheme is licenced to take 3,300 ML per year. The water is evaporated and the salt disposed of to prevent the saline groundwater reaching the Darling River below Bourke. Extraction has been much lower than licenced share, with average extraction (to 2018) of around 1,000 ML per year and a maximum take in 2015-16 of about 1,440 ML.

179 Department of Primary Industries (2017). *Darling Alluvium Water Resource Plan Groundwater (GW7), Status and Issues Paper,* https://www.industry.nsw.gov.au/__data/assets/pdf_file/0010/157348/Darling-GW-SIP.pdf

180 DoI-Water (2019), *Draft Darling Alluvium Water Resource Plan Description*, NSW Government

4 Meeting the Act's priorities for water sharing is an ongoing challenge

This chapter introduces and provides a rationale for the Commission's key recommendation that the Plan needs to be amended and subsequently remade to meet the water sharing principles outlined in the Act.

In summary, the water sharing principles in the Act explicitly prioritise the protection of the environment and basic landholder rights over extractive use in the making of the Plan. The Act further emphasises that it is the duty of all persons exercising functions under the Act to act in accordance with them. The Act principles are clear - the needs of the river must come first. The Plan needs to be amended and then remade to achieve the priorities in the Act.

4.1 Priorities under the Act are clear

The Act makes it clear that water sharing is not about balancing uses and values, it is about firstly providing for the environment and secondly recognising basic landholder rights above other uses. The relevant water sharing principles are found in section 5(3) of the Act (**water sharing principles**), and are part of a broader set of water management principles.[181] The Act specifies that:

a) "sharing of water from a water source must protect the water source and its dependent ecosystems, and

b) sharing of water from a water source must protect basic landholder rights, and

c) **sharing or extraction of water under any other right must not prejudice the principles set out in paragraphs (a) and (b)**."[182]

Further, section 9(1) of the Act provides that "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**."[183]

Persons exercising functions under the Act, as contemplated by section 9(1), would extend to the Ministers, in making a new water sharing plan,[184] amending a plan[185] or extending it.[186]

Although the drought and upstream diversions have significantly impacted the availability of water in the Barwon-Darling, evidence indicates that the Plan provisions are exacerbating the negative impacts of water shortages on both environmental and social outcomes (see **Chapter 6.3**). As a result, the Plan does not provide adequate protection for the river and its dependent ecosystems or basic landholder rights. Based on the water sharing principles, it is therefore unreasonable, for example, to continue to allow extraction of water in low flows when the

181 *NSW Water Management Act 2000* Section 5.
182 The Commission has highlighted particular sections of the Act in bold type for emphasis.
183 The Commission has highlighted particular sections of the Act in bold type for emphasis.
184 *NSW Water Management Act 2000* Under section 50.
185 *NSW Water Management Act 2000* Under section 45.
186 *NSW Water Management Act 2000* Under section 43A.

science is clear that this take is detrimental to threatened species. DPIE-Water must ensure the required prioritisation is achieved through both immediate amendments to the Plan and when remaking the Plan.

4.2 Amending and adapting the Plan to meet the Act priorities

The Commission recognises that the legal requirement under the Act is for the Minister for Water, with concurrence from the Minister for Energy and Environment to take all reasonable steps to ensure that the process followed in developing the Plan ensures the prioritisation specified in the Act. The Ministers' duties are focused on the making and amending of the Plan, rather than the ongoing delivery of outcomes. It is beyond the Commission's scope to analyse in depth if the development of the current Plan in 2012 met those requirements. However, with the benefit of hindsight, it is clear that much more should be done to put the needs of the river and dependent ecosystems first within the Plan rules.

The Commission's primary legal responsibility is to provide advice on whether a Plan has achieved its environmental, social and economic outcomes and if the Plan needs to be remade or extended. The Commission is of the view that this Plan needs a series of urgent amendments before being remade to clearly demonstrate that all reasonable steps are being taken by the Ministers to achieve the required prioritisation of environment and basic landholder rights.

The Commission acknowledges that the former Minister for Regional Water requested the Commission to bring forward its current statutory review. The Commission suggests that formal provision for a more open approach to reviews is needed to allow for timely oversight and advice when it is apparent that a plan is inherently complex and has significant risks. In particular, the Plan should provide for reviews that may be required outside of the existing window of the final five years. The Plan should also allow for adaptive management of rules to address actual outcomes and significant risks in a timely manner, while maintaining as much certainty as possible for industry within the requirements of the Act priorities.

The Commission believes that due to the unique nature of the Barwon-Darling – including its complexity, risks, uncertainty of knowledge and potential climate change – the Plan needs to be subject to more regular independent review.

4.3 Current environmental provisions are limited

The main provision for protecting the environment is the volumetric limit on water extraction under the LTAAEL. The Planned Environmental Water provisions (part 4, section 17(1)) highlight that environmental water is the water that is present in the river after the extraction of water under Plan access rules by licenced entitlement holders and basic landholder rights users.

The Plan includes a note indicating that 94 percent of water is allocated to environment. Use of this statistic as an indicator of environmental outcomes is highly misleading, as this figure is based on the long-term average annual extraction and flows in the system. The Commission recognises that the LTAAEL and associated 94 percent figure included in the Plan is based on a very long term average (reliant on the historic record; typically around 120 years of data). This analysis includes years of major flooding that skew the average flow in the system significantly. Meeting the LTAAEL is insufficient to meet environmental objectives, particularly in a system characterised by droughts and floods like the Barwon-Darling where flows are highly variable. This approach also ignores the needs of environmental values, and does not protect ecologically important events such as resumption of flows. Data obtained indicates that the actual average

annual percentage extraction, between 2012-13 and 2018-19, compared to Barwon-Darling inflow volumes has been not six percent but about 13 percent. The rules in the Plan must sufficiently protect dependent ecosystems during the Plan period.

While the Plan includes cease to pump thresholds to protect flows below a certain level, these are based on outdated environmental flow targets (see **Chapter 8.1**). Information gaps regarding endangered species and their flow needs were recognised during Plan development. As a result, the Plan rightfully includes an amendment provision allowing the Minister to adjust the pumping thresholds based on demonstrated impacts to threatened species, but this has not yet been enacted.

Further, independent reports have found that the Plan rules fail to protect low flow events, and that these are critical to environmental and social outcomes.[187] Current provisions allow for increased access to the lowest flow bands, directly impacting these low flows despite their ecological importance. Examples include provisions that allow access to low flows when flows are imminent (refer to **Chapter 8**). Evidence indicates that these rules contribute to an increase in frequency and length of low and cease to flow events, as highlighted in the Vertessy report.[188] This change in the flow regime is significantly impacting critical ecosystems, basic human needs, and social and cultural outcomes.

Some critical environmental provisions were included as discretionary amendments rather than requirements. In particular, the implementation of IDELs and TDELs (Part 8, Div 2, section 51, 52) and protection (or 'shepherding') of held environmental water. These amendment provisions were not acted upon, and the Plan includes no requirement to activate them, for instance based on evidence of failure to achieve environmental outcomes. As discussed further in **Chapter 9.1.2**, the Commission recognises that DPIE-Water are now actively seeking to implement IDELs and TDELs.

There are other Plan provisions and elements of the Plan's Background Document that explicitly prioritise the delivery of economic outcomes over the protection of the ecosystems. For example, Part 12, Section 78(b) of the Plan allows for rules to be changed if current rules are determined to be having an adverse impact on an endangered aquatic ecological community or an individual listed threatened fish species. However, these amendments cannot be made if they substantially alter the long-term average annual extractions under unregulated river (A, B or C Class) access licences. This in effect reverses the priorities specified in the Act.

The Plan fails to protect held environmental water releases as they flow through the system. Its rules effectively allow for the legal extraction of environmental flows before they can fully deliver the intended environmental outcomes. Protection is afforded only by ad hoc Ministerial or voluntary water restrictions, instead of routine active or event-based management to shepherd flows (discussed in **Chapter 9.2**). The Commission notes that over the last year, Ministers have approved a series of section 324 environmental water protections, but this is administratively complex and leaves the protection of environmental water as a discretionary decision. Section 324 orders are issued by the Minister on an ad hoc basis and do not offer certainty for licensees, including environmental licence holders or other water users in the system. DPIE-Water has indicated that new active management rules have been drafted to protect held environmental water so that section 324 orders will no longer need to be

187 Carlile, P. (2017), *Hydrological impacts of water management arrangements on low flows in the Barwon-Darling River system*, Advice to the Commonwealth Environmental Water Office

188 Vertessy, R., Barma, D., Baumgartner, L., Mitrovic, M., Sheldon, F., Bond, N. (2019), *Independent Assessment of the 2018-19 fish deaths in the lower Darling – Final Report*, for the Australian Government, 29 March 2019.

extensively relied on. These rules will protect held environmental water both within the Plan and from upstream.

Finally, the government has not prioritised the delivery of basic landholder rights along the full length of the river (refer to **Chapter 3.3.3** for definition). In particular, effective access to water as part of native title rights has not been provided. As discussed further in **Chapter 10.1**, the Plan was not amended and entitlements not provided following the 2015 determination of the Barkandji and Malyangapa people's native title rights. Water is also not sufficiently available or of adequate quality for domestic and stock rights, with downstream users inequitably impacted.

The Background Document is also clear that town drinking water (utility licences) is meant to have priority over irrigation uses, but the Plan does not adequately provide for this. Provisions including IDELs were not implemented, resulting in spatial inequity and reduced water availability and quality downstream (see **Chapter 6.2** and **7.2**). Prioritisation of water for critical human needs (including drinking water) over other extractive uses is consistent with the *Basin Plan*, and the prioritisation in the Act.

The Commission recognises that there is no cease to pump limit for town utilities, so if there is water utilities can access it while irrigators cannot. However, the current rules and their implementation does not adequately ensure that water is not extracted upstream if needed for downstream town supply. Further, the Commission notes that allowing town water supply to pump below the cease to pump limits is likely to have a detrimental impact on the environment. New rules should ensure that both the environment and town supplies are adequately protected before irrigation extraction can occur.

4.4 Steps to achieve prioritisation in accordance with the Act

To ensure that the Act requirements are met in amending and remaking the Plan, the Commission advises that steps need to be taken to ensure proper prioritisation of the environment and basic land holder rights.

The current Plan does not clearly articulate environmental or social outcomes, nor does it specify what flows would be required to meet those outcomes based on best available evidence. The Plan should be revised to ensure that objectives and outcomes are clear (see **Chapter 5.1**). DPIE-Water should clearly identify flow targets and actions needed to ensure that those outcomes are likely to be met. Proposed rules should first be analysed to assess the potential environmental outcomes. This means moving away from reliance on assessment of impact on LTAAEL, and making better use of both modelled and observed data in decision making (see **Chapter 8.2**). Analysis of existing and proposed amendments needs to demonstrate that rule changes are not prejudicing the health of the river and its dependent threatened species.

The Plan should be independently reviewed if there is material new knowledge or emerging risks. Further, it should include requirements to amend the rules at specified review points if environmental and basic landholder outcomes are not being met. Amendment provisions that currently exist for improving environmental outcomes, such as the provision that allows for pumping thresholds to be amended based on impacts to threatened species, should be revised to make them mandatory under specified conditions and remove discretion in implementation.

The Commission has also outlined in this report several specific rules that must be changed to improve environmental protection. These changes, discussed in detail in **Chapter 9**, include:

- identifying new flow targets and adjusting the A Class cease to pump thresholds accordingly
- implementing IDELs and TDELs
- implementing the resumption of flows rule
- eliminating 'imminent flows' provisions
- restricting A Class extraction, including through amended take rules
- implementing active management at all times and for all flow classes
- protecting upstream held environmental water and flows by including, updating and implementing provisions enabling the *Interim Flow Plan*.

	The Commission recommends that DPIE–Water:
1	DPIE-Water should: a) Amend the Plan immediately to address recommendations (2, 4, 5a, 5c, 5d, 7a, 7b, 8a, 9a, 10a, 11, 12a, 12b, 12c, 12d, 13a, 14 a, 14b 14c and 15a). b) Remake the Plan addressing recommendations (2, 3, 4, 5b, 6, 7c, 7d, 8b, 9b, 10b, 10c, 12e, 13b, 14d, 14e, 15b, 16 and 17) as part of an open, evidence based, and independently peer reviewed process to implement the new Plan on 1 July 2023. c) If DPIE-Water can demonstrate that it is not possible to implement any of the recommendations indicated in 1a) as part of the immediate amendments, then they should be implemented as soon as possible in an additional set of amendments, no later than the end of 2020.
2	Ensure that the amended and remade Plan rules, objectives and outcomes fully recognise and are consistent with the prioritisation specified in the *Water Management Act 2000*. This should include ensuring current amendment provisions (such as Part 12, Section 78(b)) are revised so that they do not prioritise avoiding impacts to extractive use over environmental and social outcomes.

5 Issues affecting evaluation of Plan performance

This chapter discusses how the Commission's review has been constrained by the Plan's limited evaluation framework. Firstly, the Plan does not include clear outcomes, and the objectives and performance indicators lack specificity and measurability. DPIE-Water have taken a significant step towards addressing these issues through their proposed new objectives; however, more can be done to enhance the objectives and ensure they can actually be met by the Plan rules, including:

- addressing the prioritisation of environmental, social and economic outcomes
- developing flow targets and water quality objectives
- identifying social values and objectives, including Aboriginal values and objectives
- expanding the scope of economic objectives, and consideration of costs and benefits.

Secondly, there has been limited accountability in terms of both compliance and evaluation. Implementation and monitoring of metering and gauging in the region has been poor, leading to concerns about non-compliance and an overall lack of knowledge about inflows and extraction. Monitoring, evaluation and reporting has also been limited for the Plan, and a required audit of implementation in the first five years was missed.

There is work underway to improve metering by 2020, to better understand gauging issues across the state, and to address issues regarding outstanding audits. However, an even greater shift towards transparency, accountability and adaptive management is needed to restore community confidence in water management. Additional measures are needed to ensure that agencies responsible for implementing the Plan are accountable for its delivery.

5.1 Plan has poorly defined outcomes, objectives and performance indicators

Due to a lack of clear environmental, social and economic outcomes, the Commission used the Plan objectives and other relevant targets (including flow targets, utility water restrictions, and water quality targets) to assess Plan performance.

Overall, the Plan's objectives and performance indicators are too high level, poorly defined and lack specific, measurable indicators. As discussed further in following chapters, objectives relating to environmental flows, basic landholder rights and Aboriginal values were lacking.

The Commission recognises that DPIE-Water is aware of these limitations and has proposed new objectives, strategies and indicators that are much more detailed and measurable than in the current Plan. Recent revisions focusing on the addition of active management strategies, as well as stronger wording around maintaining water quality and access to water up to the extraction limit are welcomed by the Commission.

However, there is room for further improvement regarding the proposed objectives, strategies and indicators. In addition to the specific recommendations described in the following chapters, DPIE-Water's proposals need further revision to address the following overarching issues:

- **Prioritisation –** clearly address the relative prioritisation of environmental, social (including native title) and economic outcomes and objectives as per the Act (refer to

Chapter 4 for further details), as there remains no explicit recognition of a hierarchy in the revisions

- **Climate change** – address the current lack of objectives, strategies or indicators related to climate change, including how to prepare or respond to predicted impacts and improve resiliency (see **Chapter 12**).

5.1.1 Plan environmental objectives are non-specific and lack flow targets

Current environmental objectives do not specify the environmental values that the Plan rules are aiming to protect, such as endangered fish species, nor does the Plan clearly articulate a full suite of flow targets that can be used to assess performance. For example, current performance indicators are related to changes in flow regime, rather than specifying the flow targets that Plan rules are aiming to achieve, or even the type of change (positive or negative) being sought. Without specific objectives and performance indicators it is hard to monitor Plan performance and assess how Plan rules are impacting on the key species in the Barwon-Darling.

DPIE-Water's revised objectives, strategies and indicators focus on environmental objectives. For example, they identify populations of key species that the Plan aims to support, as defined in the draft Barwon-Darling *Long Term Water Plan* and the *Barwon-Darling Surface Water Resource Plan*. The strategies included to meet the needs of these target populations focus on:

- reserving water in excess of the LTAAEL
- restricting water take and protecting additional licenced water that has been provided for environmental purposes through active management
- restricting take from in-river and off-river pools when the pools are at less than full capacity.

Current notes in the objectives highlight that low flows will be protected from extraction via cease to pump provisions (Division 2, Part 8). However, as discussed further in **Chapter 8.1,** the cease to pump rules do not meet the flow needs of target species populations identified in the objectives. It is essential that in amending and remaking the Plan that analysis demonstrates rules are likely to achieve these objectives. There also needs to be an adaptive management loop to allow for amendment of the rules where objectives are not being achieved.

DPIE-Water should first ensure the revised objectives fully align with the objectives of the Barwon-Darling *Long Term Water Plan*, including objectives and outcomes related to species abundance. The revised outcomes and objectives should then be used to finalise flow targets, based on best available evidence that would enable objectives to be met. The DPIE-Water process should acknowledge the targets established in the *Basin Plan* and developed in peer-reviewed literature. The Commission has identified critical low flow requirements for the Barwon-Darling in **Chapter 9.1.1** that may assist DPIE-Water in finalising flow targets.

5.1.2 Proposed objectives around water quality need to be revised further

While one of the Plan objectives is to '*contribute to the maintenance of water quality*',[189] there are no indicators relating to the objective and no directly linked provisions beyond those generally catering for environmental requirements. The Commission has assessed water quality as a

[189] *P*art 2, section 10, objective (g).

component of intended environmental and social outcomes in our review of the Plan as flow cannot be isolated from water quality when considering outcomes.[190]

DPIE-Water's draft revised Plan objectives, strategies and indicators explicitly address water quality, though the alignment of objectives and indicators needs improvement. The Commission notes there are no indicators considering the water quality costs or benefits associated with non-extractive industries. DPIE-Water should identify and develop more specific objectives focused on the water quality needs of the environment and community (further discussion in **Chapter 6.1.2**) Water quality outcomes should be considered from an economic perspective as well as from an environmental and social point of view.

5.1.3 Social and Aboriginal objectives are poorly defined

The Commission found that social values and objectives, including Aboriginal values and objectives, in the current Plan are poorly defined. In addition, the Plan and its background documents do not define the non-environmental beneficiaries of the Barwon-Darling water resources and therefore cannot consider the full range of potential impacts of the Plan's provisions.

Major (non-environmental) river and alluvial water users that should be considered include:

- riverside landholders' domestic and stock supply
- native title users
- Aboriginal nations and organisations[191]
- town water users (including houses, hospitals, schools, ovals, parks, shops, hotels, abattoirs)
- irrigators
- graziers.

Other non-extractive (non-environmental) uses for the broader community include:

- fishing and aquaculture for food supply and recreation
- swimming and physical recreation
- boating and watersports
- cultural and spiritual activities, practices and knowledge transfer
- amenity and relaxation
- property boundary and stock fence.

The Commission recognises that the social objectives relate to the riverine environment – consisting of the river channel, riparian zone and the floodplain – which is influenced by the Plan and its contributions to the health and resilience of the Barwon-Darling. The Commission

190 Managing flows can mitigate water quality issues including salinity, turbidity, fluctuating water temperature and dissolved oxygen shortages. For example, see MDBA (2019), *Managing water quality*, available at https://www.mdba.gov.au/basin-plan-roll-out/water-quality-and-salinity.

191 Example organisations include NSW Aboriginal Land Council and Local Aboriginal Land Councils

notes the recent efforts to undertake socio-economic impact assessment across the Basin[192] and the work of DPIE-Water in integrating more detailed social objectives in water resource plans. However, despite DPIE-Water's revisions, the proposed new social objectives remain vague. More specific objectives that fully reflect the Act requirements are needed to better protect basic landholder rights and ensure equitable sharing between users. These need to be developed through effective and equitable stakeholder engagement, as outlined in **Chapter 12**.

In contrast, the revised objectives and indicators for Aboriginal outcomes are improved, with updated wording around the provision of access under native title and indicators relating to water quality. These efforts need to be continued to better identify Aboriginal values, objectives, outcomes and measures and ensure these are met through monitoring, evaluation and reporting requirements, in line with the discussion in **Chapter 9.4**.

5.1.4 Economic objectives are too narrow

Economic objectives identify benefits to irrigation and other water-dependent industries, but indicators focus on benefits of extractive use and trade only, not on benefits or impacts to non-extractive water dependent industries like tourism or fishing. 'Third party' impacts considered by DPIE-Water in ancillary reports and Stakeholder Advisory Panel meetings also focus on irrigators, the only beneficiary specifically mentioned in the Plan. Further, there is a lack of indicators that consider costs associated with lack of water or poor water quality – for example, costs to communities and businesses of extra water treatment or switching to bore or bottled water.

	The Commission recommends that DPIE–Water:
3	Include a provision in the 2023 Plan that enables a review of Plan outcomes every five years to ensure all reasonable steps are taken in a timely and evidence based manner.
4	Further enhance proposed Plan revisions to implement clearly linked objectives, outcomes and performance indicators that meet SMART criteria (specific, measurable, achievable, realistic, time-bound) and are tracked to ensure progress, including: a) Identifying key environmental values, outcomes and objectives based on best available evidence, including alignment with the Barwon-Darling *Long Term Water Plan*, and inclusion of water quality targets. b) Identifying key social values, outcomes and objectives for the Plan in consultation with community stakeholders, including assessment of basic landholder rights and utility needs. c) Identifying key economic values, outcomes and objectives in consultation with the full range of industries reliant upon water in the system.

192 At the basin level, the MDBA has requested an independent panel undertake an assessment of social and economic conditions in irrigated communities across the Basin. The assessment will be completed by the end of December 2019 (see: https://www.mdba.gov.au/publications/independent-reports/independent-assessment-social-economic-conditions-basin). This project will be an important part of the longer term efforts to monitor social and economic conditions in the Basin, and to evaluate the outcomes of the *Basin Plan*.

5.2 There is limited monitoring, compliance and accountability

The Commission found there to be variable compliance and monitoring data available to support our analysis, along with a lack of accountability and audit regarding Plan implementation. These findings align with those presented in the recent Ken Matthews report that:

- the overall standard of compliance and enforcement work in NSW has been poor
- metering, monitoring and measurement arrangements for water extractions, especially in the Barwon-Darling, do not support sound water management or meet community expectations
- cases of alleged non-compliance have been unresolved for over 18 months, which is unacceptable to the community
- there is little public transparency around water regulation arrangements in NSW, including the compliance and enforcement arrangements, which should underpin public confidence.[193]

This has limited the Commission's ability to assess the extent to which the Plan has delivered against the desired objectives. It has also contributed to the lack of public trust in water management in the region, discussed further in **Chapter 12**.

The Commission also recognises the findings of the Ken Matthews report that the overwhelming majority of NSW irrigators take compliance seriously and are in favour of action against the small minority who may not always adhere to the rules.

5.2.1 There have been inadequacies in metering data collection and flow gauging

Historically, monitoring of metering and flow gauging data has been inconsistent. Some meters were read only once per year and others were broken for significant periods of time. Stakeholders also indicated that some of the extraction data was self-reported and unverified during the Plan period. Further, overall water use data is only available on an annual, not daily or hourly basis, and not for individual pumping or rainfall events. Accordingly, the water use datasets to date are limited for monitoring, compliance and decision making purposes.

DPIE-Water has developed robust metering rules and associated metering policy for non-urban take in response to the Ken Matthews report that should improve available data, decision-making and reporting. It will allow meaningful analysis based on actual use rather than modelling. The new metering rules will require:

- users with surface water pumps 500 mm and larger to have compliant meters and telemetry installed by 1 December 2019
- all users in the Barwon-Darling who meet the metering thresholds to be compliant by 1 December 2020.

Around 216 (90 percent) surface water works and three (65 percent) groundwater works in the Barwon-Darling will be metered.[194] Under the new rules, 192 (around 80 percent) surface water works in the Barwon-Darling must be fitted with telemetry, and all other meters must enable

193 NSW Department of Industry (2017), *Independent investigation into NSW water management and compliance – final report*

194 Advised by DPIE-Water, via email 27 May 2019.

telemetry to be retrofitted if needed.[195] All meters must have data loggers with tamper resistant seals to ensure water take data is auditable. DPIE-Water estimates the metering rules will cover 98-99 percent of licensed water take in the Plan. This will minimise risks associated with self-reporting of meters and will assist with compliance.

In addition to improved metering, the Commission is of the view that the ability for the river operator to remotely turn off pumps during 'no pump' periods would effectively restore public confidence in compliance. The Commission recognises there may be challenges with implementing this, including legal implications for the NSW Government. This option should, however, be investigated to determine how it might be made feasible in the future.

Management of the Barwon–Darling system is further impacted by an overall lack of gauging. Improved gauging, particularly for tributary inflows, is needed to better understand how much water is available and where to support analysis of outcomes and implementation of the Commission's recommendations, including active management. Submissions to the Commission for this review also demonstrated broad demand for improvements in technology, monitoring and data availability including valley level satellite flow monitoring. Improved gauging would not only benefit transparency and public confidence, it would also assist with meeting any established flow targets. The Commission understands that WaterNSW is undertaking a study to better understand current flow gauging across NSW.

5.2.2 There has been limited Plan evaluation, accountability and transparency

Under section 44 of the Act, each water sharing plan must be audited within the first five years of implementation to determine if its provisions are being given effect. These were not completed for several years. The historic lack of audits is being addressed. An Audit Panel is currently convened to complete audits that were required back to 2015, and the recent Act amendments transfer future responsibility for implementation audits to the Commission. The draft of the current audit for the Barwon-Darling Plan shows significant issues, including the failure to track progress against the performance indicators.

The Commission notes that DPIE-Water has developed a revised *Surface Water Monitoring, Evaluation and Reporting Plan* (MER Plan) for the Barwon-Darling. This MER Plan is primarily focused on environmental indicators – including fish, vegetation, waterbirds, and frogs – along with water quality and connectivity indicators. It states that supply of critical water needs will be monitored and evaluated under DPIE-Water's *Extreme Events Policy*, but monitoring and evaluation arrangements for other social, Aboriginal and economic objectives remain unclear.

Given the current poor outcomes and lack of stakeholder confidence, there is a need for a different approach to water management under a new Plan. As with any new approach, it will be necessary to evaluate the new arrangements over time to ensure that they are effective, and adapt them if there is scope for further improvement. Adaptive management is therefore necessary, informed by real-time metering and monitoring and subject to independent review. The results of the adaptive management, including evidence of progress against objectives and performance indicators, should be made public to provide transparency, accountability and assurance to stakeholders.

Reporting should go beyond indicating if the LTAAEL has been met and provide meaningful insight into how the Plan is operating, such as if flow targets are being met, and how the Plan rules are contributing if they are not being met. Future sustainable diversion limit reporting will

195 Ibid.

include the Commonwealth Environmental Water Holder's 32 GL of environmental water obtained to meet local recovery water targets. It will therefore be critical that data provided to the MDBA is actual extracted volumes rather than the volume licenced under the LTAAEL or baseline diversion limit. The Commonwealth Environmental Water Holder currently does not extract its licenced allocation in the Barwon-Darling. DPIE-Water's reporting must be structured to enable the MDBA to assess if extraction has impacted on the Commonwealth Environmental Water Holder's ability to use water, and where required carry out compliance measures.

The Commission recommends that DPIE–Water:

5 Take steps to further improve monitoring and compliance, including:

a) Implementing the metering requirements in the Barwon-Darling as a matter of urgency, including the requirement for telemetry.
b) Exploring options that would allow the river operator to remotely operate pumps, enabling pumps to be switched off when the cease to pump limit has been reached, eliminating concerns around compliance with, and communication of reaching the cease to pump level.
c) Strengthen the reporting requirements and accountability of WaterNSW and DPIE-Water for any agency required actions (such as such as tracking of performance indicators), as well as tracking of outcomes under the Plan. This should include publicly reporting evidence of progress against outcomes-based performance indicators.
d) Including monitoring, evaluation and reporting requirements in the Plan to provide an evidence basis for performance against outcomes and support adaptive management.

6 Changing flow patterns are impacting environmental outcomes

This chapter focuses on the impact of changing flow patterns, particularly on environmental and water quality outcomes, and how the Plan is contributing to these changes.

The Commission found there is evidence that flow patterns in the Plan area are changing. Importantly, there has been a shift towards increased duration and frequency of low and cease to flow periods.[196] The Commission notes that reduced inflows due to drought, upstream extraction, and climate change are all impacting the flows that are evident in the Barwon-Darling. However, evidence indicates that Plan rules that allow increased access to ecologically significant flows are contributing to the increased duration and frequency of low and cease to flow periods.

Although low flow and cease to flow periods form an essential part of the natural flow regime, changes in the timing and magnitude of these flow bands are having a significant effect on ecosystem resilience and environmental outcomes. Extended low and cease to flow periods have a negative impact on connectivity, water quality, habitat and refugia, especially when combined with dry climatic conditions. Species that rely on regularly flowing water are being impacted by this shift, including fish such as the Golden Perch, Silver Perch and Murray Cod, and large invertebrates like the river mussel and river snail.

6.1 Low flows are vital for ecosystem function and water quality

6.1.1 Low flows support critical environmental functions

Variability in the magnitude, frequency, timing, and duration of flow pulses underpins how river ecosystems function and their integrity. Flow pulses and their recurrence patterns impact a river's physical structure and ecological responses, and play an important role in meeting the various ecological requirements of the Barwon-Darling's environmental values.[197]

To understand the impact of flow pulses in a river system, they can be grouped into flow bands. These flow bands are identified based on their influence on: habitat availability and connectivity; impact on reproduction and recruitment of flora and fauna; their influence on key ecosystem functions; and effect on water quality targets.

DPIE-EES is currently developing the Barwon-Darling *Long Term Water Plan*.[198] It is a *Basin Plan* requirement and a component of the water resource plan package. It includes objectives, targets and environmental flow requirements for key water dependent species and river functions and provides a mechanism by which river and floodplain health can be assessed over time. In developing the *Long Term Water Plan*, DPIE-EES has defined a series of ecologically significant flow bands for the Barwon-Darling (**Figure 8**).

196 For this report, cease to flow periods refer to a time when there is no flow in the channel. As defined in MDBA (2014), *Basin-wide environmental watering strategy*, available at https://www.mdba.gov.au/sites/default/files/pubs/Basin-wide-e-watering-strategy-Nov14.pdf

197 Sheldon, F. (2019), *Technical review of the water sharing plan for the Barwon-Darling unregulated and alluvial water sources 2012*, advice to the Natural Resources Commission.

198 DPIE-EES (2019), *Draft Barwon-Darling Long Term Water Plan Parts A and B*

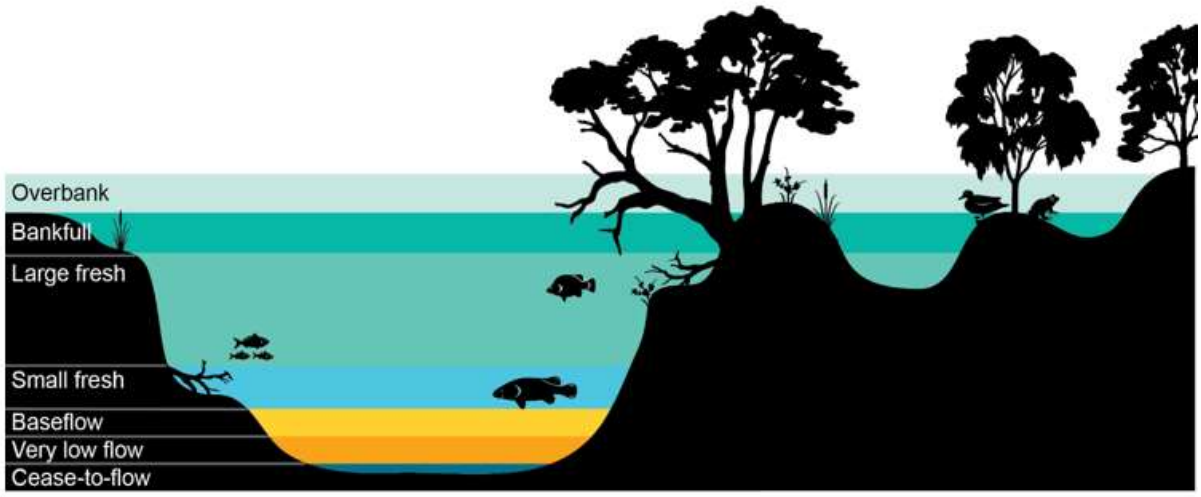

Figure 8: Conceptual model of ecologically important flow bands in the Barwon-Darling[199]

Each of the flow bands provides for different environmental outcomes. For example, overbank flows drive large scale geomorphic processes and reconnection of billabongs, anabranches and floodplain wetlands of the larger Darling floodplain.[200] On the other hand, the intermittent connection and disconnection of aquatic habitats provided during lower flows and cease to flow periods is important for periodic decomposition, microbial activity and nutrient release.[201] **Table 9** lists a more detailed description of the ecological outcomes achieved across flow bands.

Table 9: Flow bands as described in the draft *Long Term Water Plan* and their ecosystem functions[202]

Flow component	Essential environmental outcomes	Role in ecosystem function
Overbank or wetland inundation flow	Overbank flows provide maximum connectivity both longitudinally along the river but also laterally across the floodplain, connecting the river with its floodplain and wetlands. These flows 'reset' water quality, supporting nutrient, carbon and sediment cycling between floodplain and river channel environments. They provide opportunities for large scale breeding events of many fish species as well as invertebrates and associated predatory fauna (riparian birds). These flows promote large-scale productivity of the riverine ecosystem.	'Productivity' flow events – drive large scale connectivity longitudinally and laterally, fuelling high levels of production, reproduction and recruitment across a broad range of flora and fauna
Bankfull flow	Bankfull flows provide maximum longitudinal connectivity along the river channel and may inundate low-lying wetlands and anabranch channels. As these flows drown out of most small in-channel barriers (e.g. small weirs) they provide periods of maximum connectivity for fish moving throughout the	

199 DPIE-EES (2019). *Draft Barwon-Darling Long Term Water Plan Part A and B*.
200 Sheldon and Thoms (2004). *The Darling River corridors*.in R. Breckwoldt, R. Boden, and J. Andrew, editors. The Darling. Murray-Darling Basin Commission, Canberra.
201 Woodward et al. (2015). *Patterns and bioavailability of soil nutrients and carbon across a gradient of inundation frequencies in a lowland river channel, Murray–Darling Basin, Australia*. Agriculture, Ecosystems and Environment 205:1-8; Larned et al. (2010). Emerging concepts in temporary-river ecology. Freshwater Biology 55:717-738.
202 Sheldon, F. (2019), *Technical review of the water sharing plan for the Barwon-Darling unregulated and alluvial water sources 2012,* advice to the Natural Resources Commission.

Flow component		Essential environmental outcomes	Role in ecosystem function
		channel network and are therefore periods of maximum dispersal. Many fish species may take advantage of these flows for breeding events. Without these large connection flows populations can become isolated.	
Large fresh (pulse)		Large flow pulses longitudinally connect sections of the river channel providing opportunities for regional dispersal of fauna. They will inundate vital in-channel habitat, such as benches, snags and inundation-tolerant vegetation higher in the channel – which increases the complexity of habitat available for spawning and recruitment of juvenile fish.	'Maintenance' flow events, provide connectivity along channels, allow movement and some reproduction and recruitment of aquatic fauna. They moderate and reset water quality parameters by preventing thermal stratification, flushing algal blooms and reducing salinity.[203]
Small fresh (pulse)		Small freshes can improve longitudinal connectivity regionally, inundate within channel habitats including lower banks, bars, snags and in-channel vegetation. They can moderate water quality by flushing algal blooms, reducing conductivity and breaking down thermal stratification. Small freshes may trigger some aquatic animal movement and breeding.	
Low flows	Baseflow	Baseflows connect pools and riffles, and reaches along channels. These flows provide sufficient depth for fish movement between pools along reaches. In the Barwon-Darling, the baseflow is a long slow event, rather than a permanent baseflow.	
	Very low flow	Minimum flow in a channel that prevents a cease-to-flow. Provides hydrological connectivity between some pools.	
Cease-to-flow		Partial or total drying of the channel. Stream contracts to a series of disconnected pools. No surface flows.	

All flow bands play a role in determining the structure and function of river ecosystems. However, as shown in **Table 9,** the flow bands can be broadly classified as either productivity or maintenance flows depending on the extent to which they support connectivity, production, reproduction and recruitment.

Productivity flows are important as they stimulate mass reproduction and recruitment of biota and drive nutrient cycling between the river and the floodplain.[204] Overbank flows, which form a flow component of productivity flows, recharge groundwater in the region via palaeochannels meandering across the landscape.[205]

The lower maintenance flows must be protected to ensure that the river system can benefit from larger flows that provide for ecosystem productivity. The ecological benefits achieved at

203 Sheldon, F. (2017), *Characterising the ecological effects of changes in the 'low-flow hydrology' of the Barwon-Darling River*, advice to the Commonwealth Environmental Water Holder Office.

204 Ibid.

205 Cresswell, R for EcoLogical (2019), *Technical advice related to groundwater dependent ecosystems and groundwater as covered by the Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources (2012),* for the Natural Resources Commission 15 May 2019.

various flows depends on the interplay between the current flow pulse, recent flow conditions and longer term climatic cycles. For example, a flow pulse after an extended cease to flow period will deliver a different ecological response to pulses in the same band that occur after a series of similar flow pulses.[206]

Maintenance flows are essential to keep a system in a resilient state with healthy flora and fauna populations, and enable it to respond to overbank flows when they occur. Specific benefits provided by maintenance flows include:

- longitudinal connectivity at varying scales along river channels
- some opportunity for small scale breeding and recruitment events
- moderation of water quality by preventing thermal stratification in river reaches, flushing algal blooms and reducing conductivity.[207]

As highlighted in **Table 9**, maintenance flows include low flows (baseflows and very low flows), small freshes and large freshes. Small, relatively frequent flow pulses are vital to refresh water quality in pools and isolated reaches, while less-frequent moderate flow pulses are important in maintaining water quality by reconnecting river reaches.[208] Small fresh pulses are needed to prevent stratification, suppress algal blooms in weir pools and avoid anoxia which is a main cause of fish deaths.[209] Weirpool stratification is estimated to occur below baseflow, after 12 days below the small fresh pulse flow threshold.[210]

Within the broader category of maintenance flows, very low and cease to flow periods are a normal component of the Barwon-Darling flow regime. Likewise, due to the intermittency of the Barwon-Darling, a constant baseflow is not consistent with the natural flow regime. However, as periods of cease to flow or very low flows increase, conditions decline as water quality decreases and aquatic biota are forced into contracting refugia.[211] There are 1,116 refuge pools below Walgett in the Plan area.[212] For most of the Barwon-Darling, these waterholes naturally persist for over 1,000 days – significantly longer than cease to flow periods experienced in the river.[213] However, an exception is the reach roughly between Louth and Tilpa, which has run dry twice after cease to flow periods at Tilpa of 176 and 182 days.[214] In times of water shortage, regular maintenance flows are critical to refresh water quality and

206 Sheldon, F. (2019), *Technical review of the water sharing plan for the Barwon-Darling unregulated and alluvial water sources 2012*, advice to the Natural Resources Commission.

207 Ibid.

208 Donnelly, M.R., Grace, B.T. Hart, B.T. (1997) *Algal blooms in the Darling -Barwon River - Australia*, Water, Air and Soil Pollution, 99: 1-4, pp487-496.

209 Mitrovic, S.M., Chessman, B.C., Bowling, L.C., Cooke, R.H. (2006), *Modelling suppression of cyanobacterial blooms by flow management in a lowland river*, River Research and Applications, 22 109-114; and Australian Academy of Science (2019), *Investigation of the causes of mass fish kills in the Menindee region NSW over the summer of 2018-2019*, Australian Academy of Science.

210 MDBA (2018), *Ecological needs of low flows in the Barwon-Darling*, available at https://www.mdba.gov.au/sites/default/files/pubs/ecological-needs-low-flows-barwon-darling_0.docx.

211 Rolls, R.J., Leigh, C., Sheldon, F. (2012), *Mechanistic effects of low-flow hydrology on riverine ecosystems: ecological principles and consequences of alteration*, Freshwater Science, 31(4), 1163-1186

212 NSW DPI (2015), *Fish and flows in the Northern Basin - responses of fish to changes in flow in the Northern Murray-Darling Basin, reach scale report*, NSW DPI - Fisheries, as described in MDBA (2018), *Ecological needs of low flows in the Barwon-Darling*, available at https://www.mdba.gov.au/sites/default/files/pubs/ecological-needs-low-flows-barwon-darling_0.docx.

213 Department of Science, Information Technology and Innovation (2015). *Waterhole refuge mapping and persistence analysis in the Lower Balonne and Barwon–Darling Rivers*, available at https://www.mdba.gov.au/publications/independent-reports/waterhole-refuge-mapping-persistence-analysis-lower-balonne-barwon.

214 MDBA (2018), *Ecological needs of low flows in the Barwon-Darling*, available at https://www.mdba.gov.au/sites/default/files/pubs/ecological-needs-low-flows-barwon-darling_0.docx.

periodically reconnect these waterholes. In the absence of these flows, there is significant potential for impacts on both environmental outcomes and community objectives.

In river hydrology there is variation in what is defined as a 'very low flow' or 'small fresh'. Given this variation, the Commission has relied on data from the draft *Long Term Water Plan* to establish the flow rates for each of the flow bands at various points along the Barwon-Darling. These flow rates establish a definition for 'low flow' throughout this review. As shown in **Table 10** the low flow is comprised of very low flows and baseflows throughout the Barwon-Darling. At Bourke this equates to very low flows below 500 ML per day and baseflows from 500 to 1,550 ML per day.

The Commission recommends the protection of 'critical low flows' to target minimum environmental flows to maintain species and ecosystem health (**Chapter 9.1.1**). This will protect very low flows and 10 percent of the baseflow range. The Commission views that these critical low flows must be protected at a minimum.

After the introduction of Plan rule changes, metering and additional monitoring by DPIE-Water, the approach to protecting flows may need to be adjusted in the 2023 Plan remake. Further discussion of critical environmental flow requirements and Plan measures to achieve this are set out in **Chapter 9**.

Table 10 summarises similar flow rates determined against flow bands at Walgett, Brewarrina, Bourke and Wilcannia. The current Plan identifies a 'low flow band that is not broken down into a very low flow and baseflow component but defined as a single daily flow rate. There is a discrepancy between the 'low flow class' as defined in the Plan compared to the flow classes in the draft *Long Term Water Plan*. As the *Long Term Water Plan* will be used as the guide to assess river and floodplain health over time, the Commission has adopted its flow classes as opposed to those defined in the Plan.

Table 10: Flow bands and their equivalent flow (ML per day) from the draft *Long Term Water Plan* for Walgett (gauge 422001), Brewarrina (422002), Bourke (425003) and Wilcannia (425008)[215]

Long Term Water Plan flow bands		Walgett (ML/day)	Brewarrina (ML/day)	Bourke (ML/day)	Wilcannia (ML/day)
Cease to flow		<1	<1	<1	<1
Low flows	Very low flows	95-320	100-500	105-500	30-350
	Baseflows	320-700	500-1,000	500-1,550	350-1,400
Low flow class (as defined in the Plan)		*≤600*	*≤460*	*≤350*	*≤123*
Freshes	Small	700-6,500	1,000-9,000	1,550-15,000	1,400-14,000
	Large	6,500-22,000	9,000-26,000	15,000-30,000	14,000-25,000
	Bankfull	22,000—-27,000	26,000-32,000	30,000-35,000	25,000-29,000

215 The draft *Long Term Water Plan* has been provided to the Commission for this review. Numbers presented in the table represent the minimum flow for each of the flow band ranges. Flow bands are in draft and may change prior to public exhibition of the *Long Term Water Plan* for water resource plan development. The *Long Term Water Plans* represent best available evidence and may be subject to future change with updates in scientific literature.

Long Term Water Plan flow bands		Walgett (ML/day)	Brewarrina (ML/day)	Bourke (ML/day)	Wilcannia (ML/day)
Over-bank	Small	>35,000	>35,000	>50,000	>30,000
	Medium	>60,000	-	>75,000	-
	Large	>100,000	>70,000	>150,000	>35,000

6.1.2 Water quality decreases under extended low and cease to flow conditions

Water quality across the catchment degrades as a result of multiple factors, including altered flow regimes, variation in catchment conditions, and land use activities. In extended low flow periods, water quality decreases in the remaining stretches and pools. Water quality changes in very low and cease to flow periods are driven by factors such as evaporation, groundwater influence and concentration or precipitation of compounds. Water quality can decrease due to low dissolved oxygen levels, high temperatures, increasing salinity, hardness, alkalinity and cations concentrations.[216]

Long periods of decline damages the long-term viability of native fish and invertebrate populations.[217] In the lower Darling, immediate causes of a series of fish death events in 2018 were identified by Vertessy and others as low flows, poor water quality and sudden temperature changes, with contributing factors being climate, water management and barriers to fish passage. **Figure 9** shows examples of links between various water quality indicators, flows and effects on aquatic species.

Surface and groundwater connectivity changes under different flow regimes, affecting water quality. For example, the fresh groundwater used for Wilcannia town supplementary supply and domestic and stock water depends on alluvial recharge from high river flows.[218] In low flow periods the hydraulic gradient downstream of Bourke reverses and saline groundwater seeps into the river, increasing river salinity and impacting surface water quality.[219] The Upper Darling Salt Interception Scheme constructed in 2013 intercepts some of this saline groundwater before reaching the Darling River to reduce river salinity.[220] It operates when river flows are below 4,000 ML per day, as above this flow level groundwater inflow is supressed.[221] Further discussion about the importance of groundwater connectivity and its relationship with salinity and water quality impacts is provided in **Chapter 14.4**.

216 Sinclair Knight Merz (2013), *Characterising the relationship between water quality and water quantity*, Department of Agriculture and Water Resources, Canberra

217 MDBA (2018), *Ecological needs of low flows in the Barwon-Darling*, available at https://www.mdba.gov.au/sites/default/files/pubs/ecological-needs-low-flows-barwon-darling_0.docx.

218 Cresswell, R for EcoLogical (2019), *Technical advice related to groundwater dependent ecosystems and groundwater as covered by the Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources (2012),* for the Natural Resources Commission 15 May 2019.

219 Generally, in periods of low flow groundwater levels also depress and do not impact surface water. However, faults near Bourke allow deeper saline water to reach the river bed and pool when it is in low flow, increasing river salinity. Department of Primary Industries (2017). *Darling Alluvium Water Resource Plan Groundwater (GW7), Status and Issues Paper*

220 NSW Office of Water (2012), *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources – Background document*, NSW Government, Sydney.

221 MDBA (2017), *Observed flows in the Barwon-Darling 1990-2017: a hydrological investigation*, available at https://www.mdba.gov.au/sites/default/files/pubs/observed-flows-barwon-darling.pdf

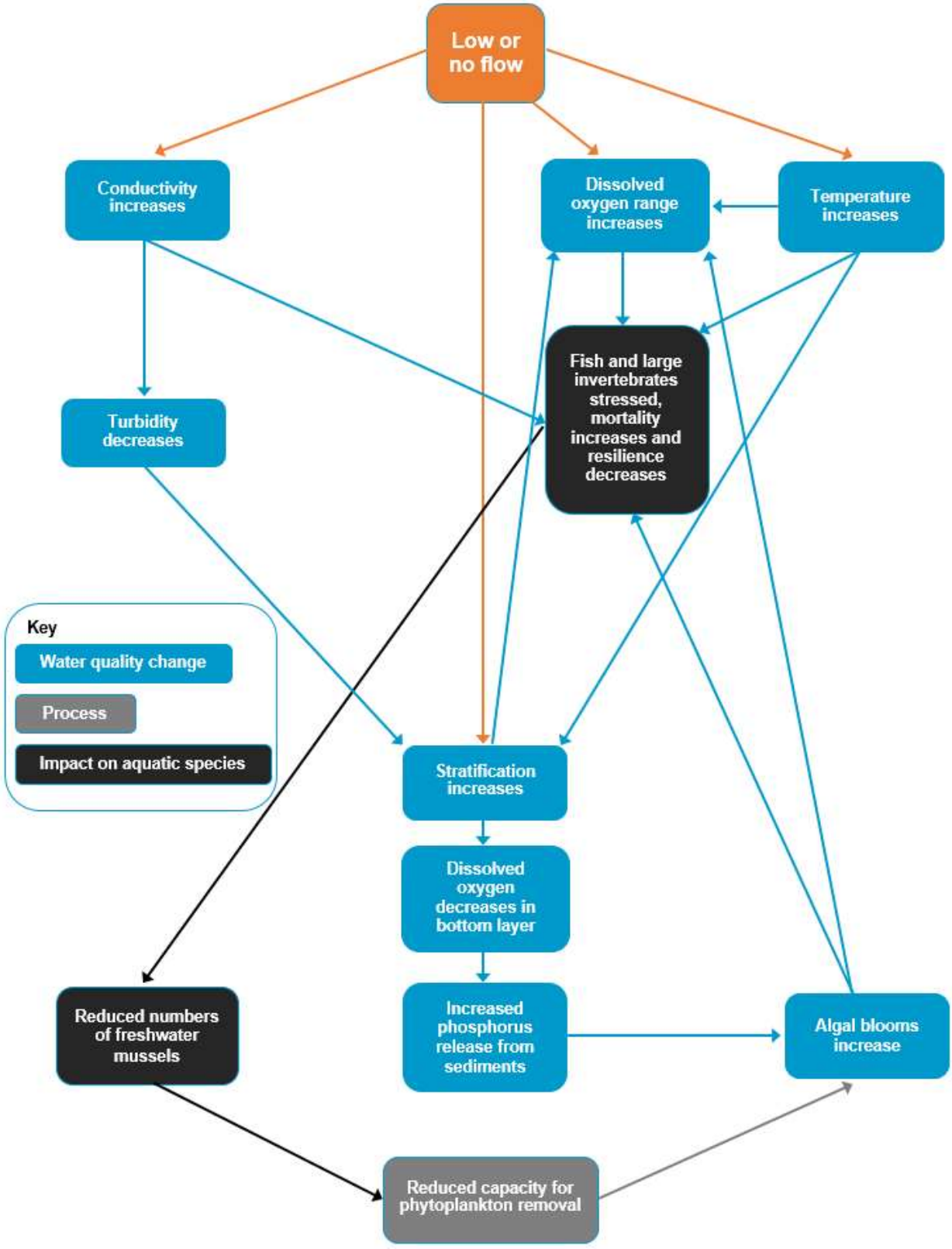

Figure 9: Conceptual model showing potential impacts of no and low flow periods on water quality indicators and effects on aquatic species.[222]

222 Adapted from Rolls, R.J., Leigh, C., Sheldon, F. (2012), *Mechanistic effects of low-flow hydrology on riverine ecosystems: ecological principles and consequences of alteration*, Freshwater Science, 31(4), 1163-1186; and Sheldon, F. (2017), *Characterising the ecological effects of changes in the 'low-flow hydrology' of the Barwon-Darling River*, advice to the CEWH.

Water quality surveys show that salinity in the Darling River increases immediately downstream of Weir 19A due to groundwater seepage.[223] In prolonged very low flow or cease to flow periods a high proportion of flow between Weir 19A and Tilpa can come from saline groundwater.[224] The effect of this seep was observed in data from 2014 showing that salinity rose to 17 mS/cm after 40 days of low flow – a level of salinity that is lethal to native freshwater fish eggs and larvae and highly stressful for adult fish (see **Table 11**).[225] A Commonwealth environmental water release in the Gwydir River increased flows to about 200 ML per day and refreshed the water quality, reducing salinity to about 3.0 mS/cm. After a second cease to flow period, an in-channel event meant flow in February 2015 reached 3,000 ML per day and reduced salinity from a high of 20 mS/cm to below 1.0 mS/cm, fully refreshing the river.[226]

As shown in **Figure 9**, interrelationships between various factors can exacerbate declining water quality, particularly in low or cease to flow periods. The seep downstream of Weir 19A tends to reduce turbidity and phosphorus concentrations in low flow conditions as it settles out sediments in the water column. Clearer water allows more sunlight to penetrate, which in turn leads to a higher risk of algal blooms, followed by a reduction in oxygen levels.[227] Small in-channel flow events are therefore vital below Weir 19A to manage water quality impacts.[228]

Table 11: Comparison of various salinity impacts relevant to the Barwon-Darling[229]

Key indicator variable	Conductivity
Drinking water – fair quality	0.9 mS/cm
Drinking water – unacceptably salty taste	1.2 mS/cm
Freshwater species – show stress	1.5 mS/cm
Freshwater species – severe impacts	5 mS/cm
Unacceptable drinking water for livestock	7.3 mS/cm
Cotton production – yield reduction of 10 percent	11.6 mS/cm
Freshwater fish species – mortality of eggs and larvae, stress of adults	15 mS/cm
Average salinity of groundwater from the Salt Interception Scheme south of Bourke	35 mS/cm
Sea water quality	54 mS/cm

223 MDBA (2011), *Upper Darling Salt Interception Scheme – fact sheet*, available at https://www.mdba.gov.au/publications/brochures-factsheets/upper-darling-salt-interception-scheme.

224 MDBA (2018), *Ecological needs of low flows in the Barwon-Darling*, available at https://www.mdba.gov.au/sites/default/files/pubs/ecological-needs-low-flows-barwon-darling_0.docx.

225 Note that some species have higher tolerances as adults. MDBA (2018), *Ecological needs of low flows in the Barwon-Darling*, available at https://www.mdba.gov.au/sites/default/files/pubs/ecological-needs-low-flows-barwon-darling_0.docx.

226 MDBA (2018), *Ecological needs of low flows in the Barwon-Darling*, available at https://www.mdba.gov.au/sites/default/files/pubs/ecological-needs-low-flows-barwon-darling_0.docx

227 Sheldon, F. (2017), *Characterising the ecological effects of changes in the 'low-flow hydrology' of the Barwon-Darling River*, advice to the Commonwealth Environmental Water Holder Office.

228 OEH (2006), *Barwon-Darling and Far Western Water Quality and River Flow Objectives*, available at https://www.environment.nsw.gov.au/ieo/farwest/report-02.htm.

229 MDBA (2011), *Upper Darling Salt Interception Scheme – fact sheet*; EPA South Australia (2019), *Salinity – drinking water and livestock*, available at https://www.epa.sa.gov.au/environmental_info/water_quality/threats/salinity; NSW Department of Primary Industries (2016), *Salinity tolerance in irrigated crops*, available at https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/523643/Salinity-tolerance-in-irrigated-crops.pdf; Sheldon, F. (2017), *Characterising the ecological effects of changes in the 'low-flow hydrology' of the Barwon-Darling River*, advice to the Commonwealth Environmental Water Office.

Protection of these flows are discussed in **Chapter 9.1,** including the need for resumption of flow rules outlined in **Chapter 9.1.4**. When flows return after cease to flow periods, salinity rises quickly at the start of the flow but is then diluted almost immediately by the next flow event. This demonstrates the importance of regular flows to prevent salinity from having sub-lethal and lethal impacts on aquatic species, and affecting other social and economic uses.[230]

6.1.3 Changed flow patterns are impacting key species

The Barwon-Darling flowed 94 percent of the time at Wilcannia before flow regulation across the northern basin,[231] enabling the development and maintenance of a flowing water ecology. The flow characteristics of the Barwon-Darling have resulted in populations of iconic species such as the Murray Cod, river mussels and river snail, in contrast to the Paroo, Warrego or Culgoa rivers where these species are not found due to the intermittent nature of these rivers.[232] A hydrograph in **Figure 10** demonstrates the variation in flows in the Barwon-Darling over a five year period.

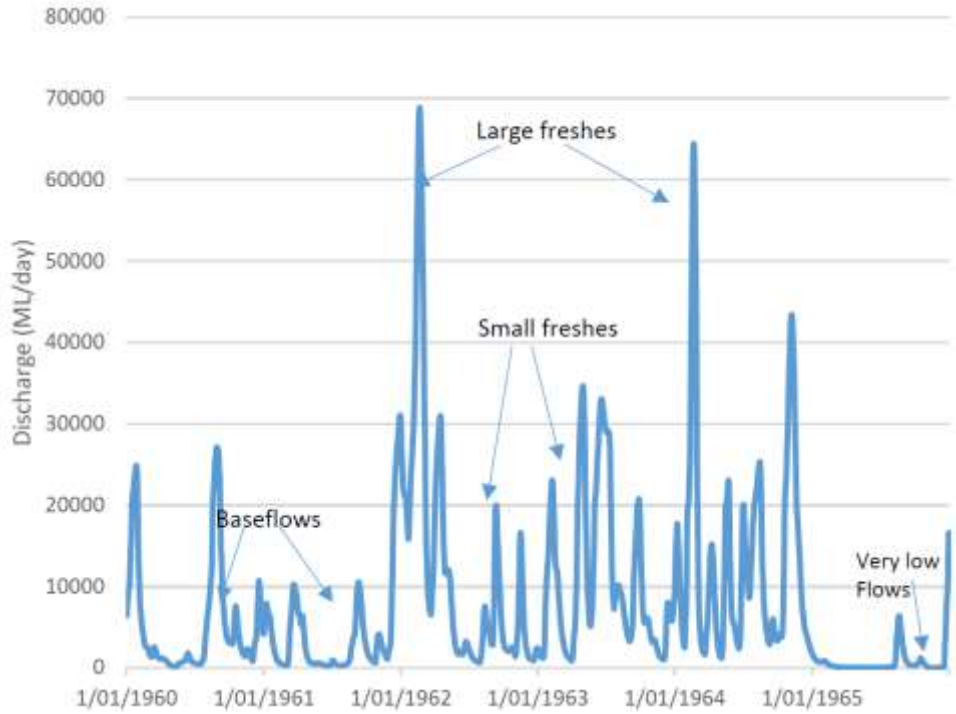

Figure 10: Identification of ecologically important flow bands as identified in the draft *Long Term Water Plan* over a five year pre-development period at Bourke

The Barwon-Darling is currently in a 25 month period of extended stillwater conditions, unprecedented in 134 years of flow records.[233] The Barwon-Darling in drought has changed from an ecosystem dominated by flowing-water to one dominated by stillwater.[234]
While the Barwon-Darling's natural flow variation leads many to assume that biota can adapt to both flowing and stillwater conditions, this does not apply across all species. River mussels and

230 MDBA (2018), Ecological needs of low flows in the Barwon-Darling, available at https://www.mdba.gov.au/sites/default/files/pubs/ecological-needs-low-flows-barwon-darling_0.docx.
231 Mallen-Cooper, M. (2019), *Barwon-Darling Water Sharing Plan: opportunities to link ecology, river hydraulics, culture, and social values to meet the objectives of the Water Management Act*, discussion paper for the Natural Resources Commission.
232 Ibid.
233 Ibid.
234 Ibid.

river snails need almost consistent flow, and can only tolerate short cease to flow periods. Further, while stillwater environments such as refugia pools can be critical for maintaining mature Golden Perch, they also need flow pulses to migrate and spawn, and during their larval drift life cycle phase.[235] The stillwater conditions significantly disadvantage native species that need flowing-water, including Golden Perch, Silver Perch, Murray Cod, river mussels and river snail.[236] Furthermore these conditions advantage carp and, combined with more nutrients from runoff, is one of the most significant factors that increases the risk of blue-green algae.[237]

The different species in the Barwon-Darling respond differently to the system's 'boom and bust' cycles. For example, bony herring spawn in a range of conditions and are able to quickly respond to periodic bankfull and overbank flows with large, and often multiple, breeding events. In contrast, Murray Cod reproduce in response to temperature at a similar time each spring. Survival of larvae and young fish is dependent on flowing water habitats (typically generated by baseflow or higher) and their numbers decline if these conditions do not occur. The life cycle of Murray Cod is further impacted by flow diversions because it is a 'nesting' species where the male guards the eggs. Any sudden drop in water level, which can happen with pumping, will cause the male to abandon the nest and the eggs die. Extensions of periods of low flow or cease to flow periods can therefore impact individual species lifecycles, species mix and the ecosystem as a whole.

A review of flow events between 1990 and 2017 shows that most of the MDBA's Environmental Low Flow Indicators (known environmental water requirements at particular sites) for the Barwon-Darling are not being achieved, particularly for events required once or twice a year.[238] Further, the number of days per year that flow levels at Bourke are high enough to deliver connectivity and aquatic habitat access between Walgett to Menindee has halved under current conditions (from 88 to 44 days per year).[239] Modelling also shows that post-development impacts on ecological flows has been most significant downstream of Bourke, with low flow events that support environmental outcomes becoming less frequent and shorter.[240]
The changes observed in cease to flow and low flow periods as outlined in **Chapter 6.2** have caused ecological impacts. While the fish deaths downstream of the Plan area were highly publicised, the combination of high temperatures and prolonged cease to flow conditions also resulted in mortality of large invertebrates at several locations along the Barwon-Darling.

Site visits conducted by Mallen-Cooper in 2019 found dead river mussels, varying in number from a few to thousands (**Figure 11**). Live river mussels were only found in one location in Tilpa, which was next to a non-saline groundwater seepage point. These surveys appeared to

235 Mallen-Cooper, M. (2019*), Barwon-Darling Water Sharing Plan: opportunities to link ecology, river hydraulics, culture, and social values to meet the objectives of the Water Management Act*, discussion paper for the Natural Resources Commission.

236 Ibid.

237 Ibid.

238 Carlile, P. (2017), *Hydrological impacts of water management arrangements on low flows in the Barwon-Darling River system*, Advice to the Commonwealth Environmental Water Office.

239 NSW Department of Primary Industries (2015). *Fish and Flows in the Northern Basin: responses of fish to changes in flow in the Northern Murray-Darling Basin – Reach Scale Report: Final report prepared for the Murray-Darling Basin Authority,* NSW Department of Primary Industries, Tamworth.

240 NSW Department of Primary Industries (2015). *Fish and Flows in the Northern Basin: responses of fish to changes in flow in the Northern Murray-Darling Basin – Reach Scale Report*: *Final report prepared for the MDBA,* NSW Department of Primary Industries, Tamworth; Sheldon, F. (2017), *Characterising the ecological effects of changes in the 'low-flow hydrology' of the Barwon-Darling River*, Advice to the Commonwealth Environmental Water Holder Office, Australian Rivers Institute, Griffith University; Carlile, P. (2017), *Hydrological impacts of water management arrangements on low flows in the Barwon-Darling River system,* advice to the Commonwealth Environmental Water Office.

encompass most of the river mussel population of the Barwon-Darling, therefore representing a far greater impact on riverine biota than the recent fish deaths. The size of the dead river mussels indicates that these were likely 20 to 40 years old, and while able to survive cease to flow periods in the Millennium drought were not able to tolerate recent conditions.[241] As highlighted in **Chapter 6.2,** the combination of high temperatures and extended cease to flow periods due to extraction in the very low flow band contributed to extensive river mussel mortality.

Figure 11: Dead river mussels at Tilpa, Darling River[242]

The same site visit identified populations of dead river snails in the Barwon-Darling, a significant ecological finding as these snails have been previously considered extinct since the 1980s (**Figure 12**). While previous studies have reported populations of river snails in irrigation pipes in the Riverina areas of South Australia,[243] this represents the first recorded population in the Barwon-Darling in over 30 years. Although the ability of the river snail to survive cease to flow periods is unknown, their recorded presence in the Barwon-Darling historically and their presence in 15,000 year old Aboriginal middens[244] indicates that these invertebrates have some tolerance to zero flow.[245] The recent cease to flow period combined with high temperatures appears too prolonged to prevent extensive mortality.

The causes of the recent fish deaths have been documented through independent reports. However, the impact of changed river flows and the resulting effects on Barwon-Darling fish populations is not new knowledge, with the impacts of flow regimes on native fish populations well understood.

241 Mallen-Cooper, M. (2019), *Barwon-Darling Water Sharing Plan: opportunities to link ecology, river hydraulics, culture, and social values to meet the objectives of the Water Management Act*, discussion paper for the Natural Resources Commission.

242 Ibid.

243 River snail (*Notopala sublineata*), Department of the Environment and Energy. http://www.environment.gov.au/biodiversity/threatened/nominations/ineligible-species/notopala-sublineata.

244 Balme, J. (1990), *A Pleistocene tradition: Aboriginal fishery on the Lower Darling River, western NSW*.

245 Mallen-Cooper, M. (2019), *Barwon-Darling Water Sharing Plan: opportunities to link ecology, river hydraulics, culture, and social values to meet the objectives of the Water Management Act*, discussion paper for the Natural Resources Commission.

Figure 12: Dead river snails in rocky habitat immediately below Tilpa weir[246]

Compared with historic droughts, the Millennium and present (2013–19) droughts have such reduced low flows and greater cease to flow conditions, that the ecosystem has changed from one dominated by flowing to still water. This significantly disadvantages species that require flowing water (Golden Perch, Silver Perch, Murray Cod, river mussels, river snail). Populations of Silver Perch,[247] a previously abundant species, have declined since flow regulation.[248] As spawning and recruitment of Silver Perch is reliant on a flowing river habitat,[249] restoration of baseflows will be critical in their recovery. The requirement for flowing water habitat is likewise critical for spawning of the Olive Perchlet[250] and survival of young Murray Cod as discussed earlier. The Commission has recommended steps that can be taken to improve the Plan to better protect critical low flows required to achieve flowing water habitat for spawning and migration of these key native fish species. These are discussed fully in **Chapter 9**.

6.2 Drought, inflows and the Plan have contributed to increased low flow and cease to flow events

While drought and upstream extraction have impacted flows in the Barwon-Darling, elements of the Plan have also played a role. In particular, the design and implementation of the Plan's access and account rules have contributed to an increase in the frequency and duration of cease to flow and low flow periods leading to negative impacts on environmental and social outcomes. These trends and their resultant impacts are discussed further in the remainder of this chapter and **Chapter 7**, while the Plan elements contributing to these changes are outlined in **Chapter 8**.

246 Mallen-Cooper, M. (2019*), Barwon-Darling Water Sharing Plan: opportunities to link ecology, river hydraulics, culture, and social values to meet the objectives of the Water Management Act*, discussion paper for the Natural Resources Commission.

247 Listed as vulnerable under the *Fisheries Management Act 1994 and critically endangered under the Environment Protection and Biodiversity Conservation Act 1999.*

248 MDBA (2012). *Sustainable Rivers Audit 2: The ecological health of rivers in the Murray–Darling Basin at the end of the Millennium Drought (2008–2010).*

249 NSW DPI (2018). Protecting silver perch – a guide for fishers and land managers. https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/802697/ProtectingSilverPerch.pdf.

250 Listed as endangered under the *Fisheries Management Act 1994.*

6.2.1 Comparison of drought periods highlights the Plan is contributing to the reduced frequency of low flows and small freshes

Drought has been identified as a key factor contributing to reduced flows in the Barwon-Darling; however, analysis undertaken by the Commission indicates that the Plan is contributing to these reduced flows. A comparison of previous severe droughts illustrates:

- the historic drought patterns in the Barwon-Darling
- the impact of river regulation, development and Plan rules on changes to flow in the Barwon-Darling.

The historic flow record indicates that the most severe droughts before the present drought were the:

- Federation drought (1895–1903) (pre river regulation/development)
- World War II drought (1939–1945) (pre river regulation/development)
- Millennium drought (2001–2009) (post river regulation/development).

For this review the current drought has been defined as the period 2013–19, which occurred post river regulation and development, and under current Plan rules. The above droughts are considered to have rainfall comparable to the current drought, providing comparative insights on natural system flow patterns, impacts resulting from regulation, development and current Plan rules.

Cease to flow periods occur in the Barwon-Darling during drought conditions and are a natural part of the flow regime. The current cease to flow period is the longest since records began. It is similar to the Federation drought and is much longer than any cease to flow period in the Millennium drought. Based on mean monthly flows from 1885 to 1950, before any significant flow regulation and including severe droughts, the Darling River at Walgett and Wilcannia flowed for 95 and 94 percent of the time respectively.[251] Continuous cease to flow periods over six months have occurred three times previously: in 1888 (10 months), 1902 (11 months) and 1919–20 (seven months).[252] The present cease to flow period is over a year at Bourke and is projected to continue, at least in the short term.[253]

Gauging data analysis also shows cease to flow periods have recently become longer at the downstream gauges, with cease to flow periods over 80 days occurring each year since 2013 at Wilcannia.[254]

Figure 13 highlights the relationship between temperature and flows. It indicates that the combined impact of high temperatures (over 40 degrees Celsius) and low flow periods at Bourke has been much more concentrated during the Plan period (2013–19). This includes comparing the current drought with the Millennium drought, which was similarly impacted by regulation and development. While all previous severe droughts experienced similar

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251 Mallen-Cooper, M. (2019), *Barwon-Darling Water Sharing Plan: opportunities to link ecology, river hydraulics, culture, and social values to meet the objectives of the Water Management Act*, discussion paper for the Natural Resources Commission.

252 Ibid.

253 Based off Mallen-Cooper, M. (2019), *Barwon-Darling Water Sharing Plan: opportunities to link ecology, river hydraulics, culture, and social values to meet the objectives of the Water Management Act*, discussion paper for the Natural Resources Commission; Bureau of Meteorology (2019), *Climate outlook – rainfall summary*, available at http://www.bom.gov.au/climate/outlooks/#/rainfall/summary

254 MDBA (2017). *Observed flows in the Barwon-Darling 1990-2017: a hydrological investigation*.

continuous high temperatures, there were also significantly more adequate flow events during these periods (over 500 ML per day). It is acknowledged that tributary inflows have been reduced over the life of the Plan (see **Chapter 6.2.2**).

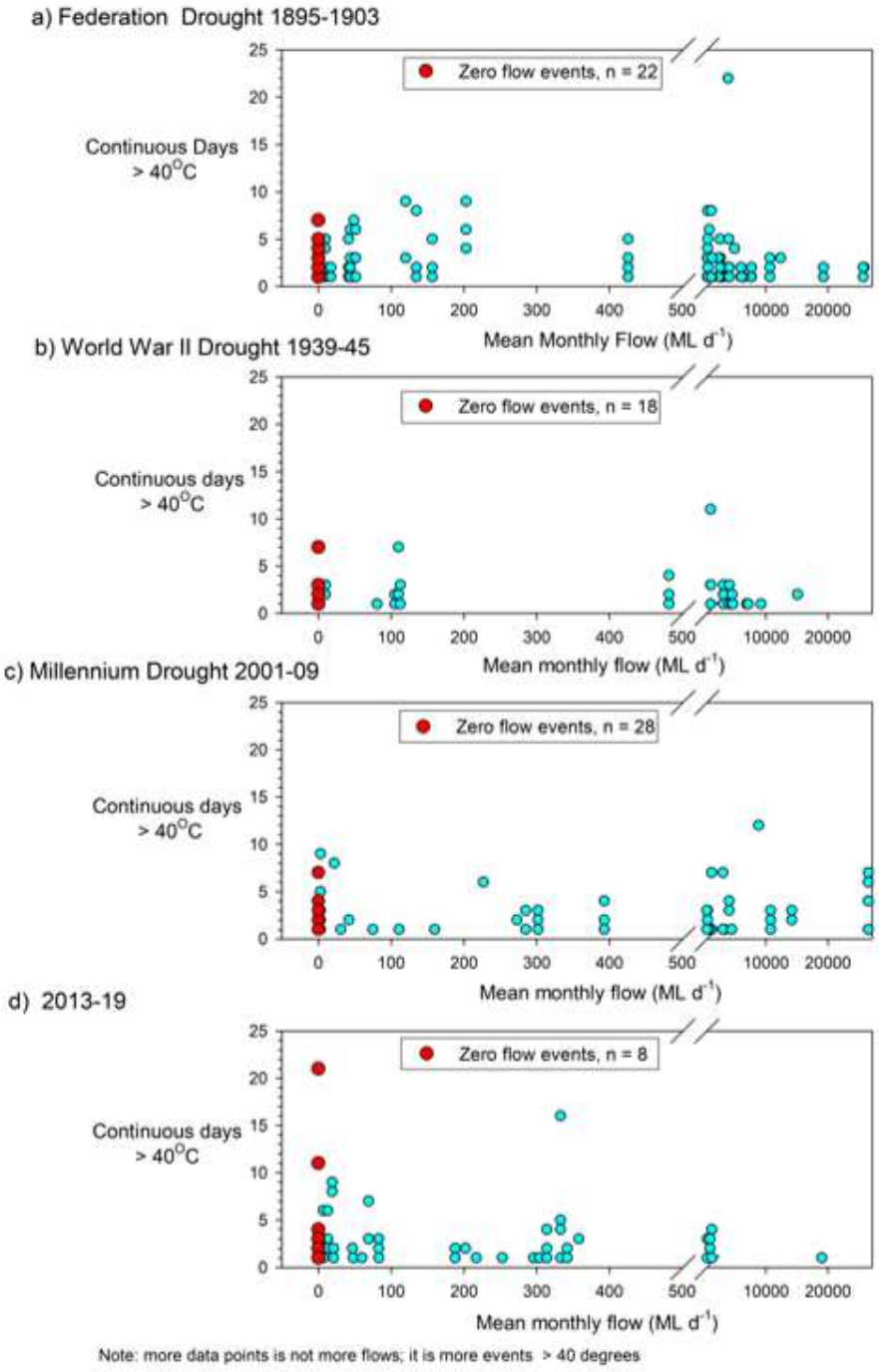

Figure 13: Continuous days > 40°C at Bourke plotted against flow for historic and current droughts[255]

There has been substantial commentary following the release of the Commission's draft report on the impact of A Class extractions bringing forward persistent low flow conditions, or

255 Mallen-Cooper, M. (2019), *Barwon-Darling Water Sharing Plan: opportunities to link ecology, river hydraulics, culture, and social values to meet the objectives of the Water Management Act*, discussion paper for the Natural Resources Commission.

hydrological drought. For this report, the Commission has sought to clarify the multiple lines of evidence underpinning the expert analysis and terminology.

Table 12 summarises definitions of the different stages of drought. The northern Murray-Darling Basin has been in a rainfall deficit, or meteorological drought, throughout the Plan period.[256] It is also currently experiencing extreme low flow, cease to flow and channel drying, which is defined as hydrological drought. The discussion of historically low levels of inflows are outlined in **Chapter 6.2.2**.

Table 12: Definitions of drought[257]

Term	Definition
Meteorological drought	A period of months to years when atmospheric conditions result in low rainfall. This can be exacerbated by high temperatures and high evaporation, low humidity and drying winds.
Hydrological drought	Prolonged moisture deficits that affect surface or subsurface water supply, thereby reducing streamflow, groundwater, dam and lake levels. This may persist long after a meteorological drought has ended.
Agricultural drought	Short-term dryness in the surface soil layers (root-zone) at a critical time in the growing season. The start and end may lag that of a meteorological drought, depending on the preceding soil moisture status.
Socioeconomic drought	The effect of elements of the above droughts on supply and demand of economic goods and human wellbeing.

Hydrological drought conditions generally lag meteorological drought, with the 'lag-time' reflective of the characteristics of the catchment.[258] In a large catchment such as the Barwon-Darling, in the absence of extraction it is anticipated that baseflows would be retained after meteorological drought conditions are experienced in upstream catchments.[259] Based on a multiple lines of evidence approach,[260] expert hypothesis is that extractions from the baseflow band following the introduction of the Plan rules pushed the Barwon-Darling system below Bourke into persistence of very low flow conditions three years earlier than the river upstream.[261]

256 Bureau of Meteorology, *Drought archive 2012-2016 map*, issued 4 August 2016, http://www.bom.gov.au/climate/drought/archive/20160804.shtml; and Sheldon, F. (2019), *Technical review of the water sharing plan for the Barwon-Darling unregulated and alluvial water sources 2012*, advice to the Natural Resources Commission.

257 Definitions of drought taken from the Productivity Commission (2009), *Drought Support Report No. 46, Final Inquiry Report*, in which the definition was based off Hennessy, K., Fawcett, R., Kirono, D., Mpelasoka, F., Jones, D., Bathois, J., Stafford Smith, M., Mitchell, C. and Plummer, N. (2008). *An assessment of the impact of climate change on the nature and frequency of exceptional climatic event*. Bureau of Meteorology and CSIRO.

258 Lake (2011). *Drought and aquatic ecosystems: effects and responses*. Wiley-Blackwell as referenced in Sheldon, F. (2019), *Technical review of the water sharing plan for the Barwon-Darling unregulated and alluvial water sources 2012*, advice to the Natural Resources Commission.

259 Sheldon, F. (2019), *Technical review of the water sharing plan for the Barwon-Darling unregulated and alluvial water sources 2012*, advice to the Natural Resources Commission.

260 Lines of evidence used to derive this assessment includes meteorological data demonstrating the rainfall deficiencies in the three years to 2019, volumes of water extracted within the A Class licence band from 2015, knowledge of stages of drought including the progression to hydrological drought conditions and the responsiveness and catchment characteristics of the Barwon-Darling system – from Sheldon (2019). *Technical review of the water sharing plan for the Barwon-Darling unregulated and alluvial water sources 2012*, advice to the Natural Resources Commission.

261 Sheldon, F. (2019), *Technical review of the water sharing plan for the Barwon-Darling unregulated and alluvial water sources 2012*, advice to the Natural Resources Commission.

Following the release of the draft report, the Commission was approached by WaterNSW who volunteered to undertake modelling relevant to the current expert hypothesis. The Commission welcomes working with WaterNSW and updating any relevant findings based on best available knowledge. As noted in our draft report (and **Chapter 8.2** of this report) the lack of a 'natural' model run after 2009 has meant that current findings have been based on a multiple lines of evidence approach. At the time of finalising this report, the Commission has been provided with modelled 'diversion' and modelled 'no diversion' flow estimates for upstream gauges covering the period July 2016 to June 2019. This information for the Bourke gauge shows a substantial difference between the 'observed' flows and the modelled 'diversion' flows. Therefore, the full impact of diversions under the Plan can only be sensibly made with a calibrated model run that:

- accounts for the natural transmission loss through river pools and weirs
- contains a daily measurement of diversions
- includes both upstream and downstream gauges
- covers the period 2012-19.

The Commission looks forward to reviewing the model's inputs, assumptions and results in collaboration with WaterNSW and encourages WaterNSW to initiate an independent and transparent peer review of its modelling.[262] Following the outcomes of this review, the Commission will, if needed, publish an addendum to this report.

The impact of extractions on flows cannot be fully tested in the absence of a calibrated hydrological model that covers the period 2012-19. However, the impact of A Class extraction on downstream flows has been previously documented in several publicly available reports including, but not limited to:

- two independent reports investigating causes of 2018–19 fish kills in the lower Darling – Vertessy and Australian Academy of Science[263]
- four technical reports prepared for the Commonwealth Environmental Water Office and MDBA.[264]

Figure 14 shows trends in the average time between low flow periods (as specifically related to baseflow), which is the threshold for stratification of weirpools.[265] Observed data from 1990–99, 2000–10 (corresponding to the start of cease to pump rules), and 2011–17 (corresponding with the Plan) show that for Brewarrina, Bourke and Wilcannia the intervals after 2000 had longer

262 Further discussion of modelling is outlined in **Chapter 8.2** of this report

263 Vertessy, R., Barma, D., Baumgartner, L., Mitrovic, M., Sheldon, F., Bond, N. (2019). *Independent Assessment of the 2018-19 fish deaths in the lower Darling – Final Report*, for the Australian Government, 29 March 2019.; Australian Academy of Science (2019). *Investigation of the causes of mass fish kills in the Menindee region NSW over the summer of 2018–19*, 18 February 2019.

264 Carlile (2017), *Hydrological impacts of water management arrangements on low flows in the Barwon-Darling River system*, advice to the Commonwealth Environmental Water Office; Simpson P. (2017) *Barwon-Darling: low flow environmental watering impediments and opportunities*. Report for Commonwealth Environmental Water Office, Canberra., Sheldon, F. 2017. *Characterising the ecological effects of changes in the 'low-flow hydrology' of the Barwon-Darling River*. Report to the Commonwealth Environmental Water Office. Canberra., MDBA (2017), *Observed flows in the Barwon-Darling 1990-2017, a hydrological investigation*, available at https://www.mdba.gov.au/sites/default/files/pubs/observed-flows-barwon-darling.pdf.

265 Note that this analysis does not specifically identify the contribution of tributary inflows in each of these periods. The flows identified relate to the destratification of weirpools rather than the destratification of natural, shallower, pools.

periods below baseflow compared to 1990–99.[266] This is likely due to drought and increased extraction.[267]

Importantly, there were also longer periods between flows, particularly at Wilcannia, under the Plan compared to during the Millennium drought in 2000–10, meaning the risk of decreasing water quality and algal blooms has increased under the Plan rules. The risk of stratification and algal blooms increased more at Wilcannia than at Brewarrina and Bourke, showing that impacts are greater further downstream.

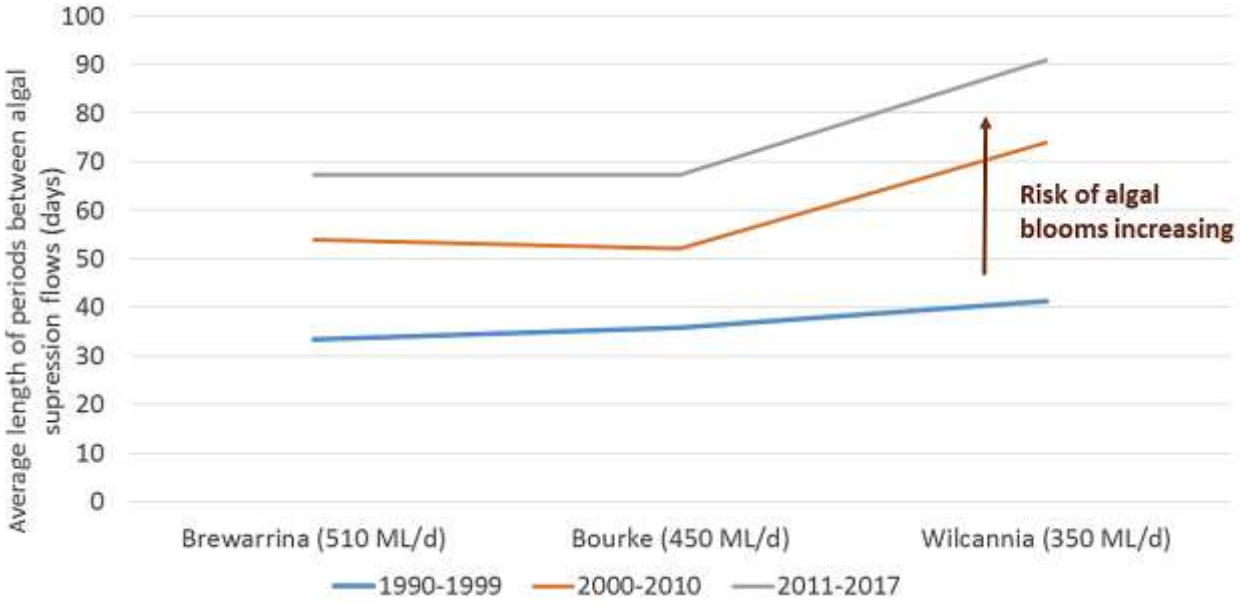

Figure 14: Change in length of periods between algal suppression flows (baseflows) for Brewarrina, Bourke and Wilcannia[268]

The relationship between extraction and impacts on flows, particularly demonstrating the flows that can be achieved at Wilcannia, was further highlighted during the recent northern connectivity event. The northern connectivity event was a highly monitored environmental flow event when no licenced extraction was permitted. It is worth noting that extraction of flows for the purpose of basic landholder rights continued in this event.

Figure 15 shows the observed flows at both Bourke and Wilcannia, with dashed lines showing modelled changes to flow patterns that could have resulted if licenced extraction had occurred.[269] Flow in **Figure 15** represents the impact of extraction in the Barwon-Darling between Mungindi and Walgett. No pumping would have occurred downstream of Walgett during the northern connectivity event due to flows falling below cease to pump thresholds beyond this point. The northern connectivity event provided baseflow levels at Bourke that would have been reduced to the very low flow range if extraction had been permitted between Walgett and Mungindi. Similarly, the event provided flows in the small freshes range at Wilcannia, which would have fallen to very low flow levels if there had been licenced extraction.

266 MDBA (2018), *Ecological needs of low flows in the Barwon-Darling*, available at https://www.mdba.gov.au/sites/default/files/pubs/ecological-needs-low-flows-barwon-darling_0.docx.
267 Ibid.
268 Taken from MDBA (2017), *Observed flows in the Barwon-Darling 1990-2017, a hydrological investigation*, available at https://www.mdba.gov.au/sites/default/files/pubs/observed-flows-barwon-darling.pdf.
269 MDBA (2019), *Active Management Case Studies Summary*, May 2019.

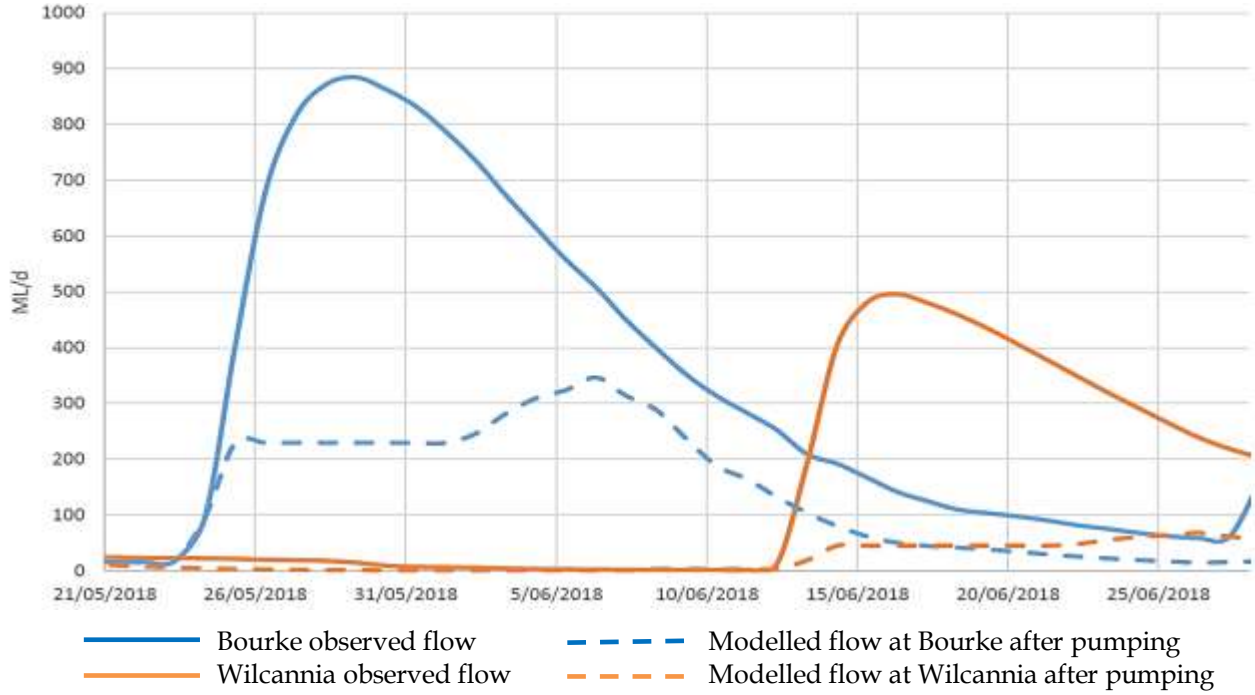

Figure 15: Northern connectivity event as observed (solid lines) and modelled (dashed lines)[270]

The changes that occur to the hydrograph and flow patterns as a result of licenced extraction between Walgett and Mungindi are significant as maintaining baseflows are critical to:

- maintain water quality and reduce thermal stratification
- maintain habitat for endangered fish species (spawning of Olive Perchlet) and larger invertebrates.

Extraction of flows that moves the hydrograph into the very low flow band impacts the river's ecological functions. The absence of baseflows, longer and more frequent very low flow and cease to flow periods, and consecutive high temperatures, is a clear pattern that has been linked to observed impacts on aquatic biota in both the Barwon-Darling and lower Darling systems. In particular, this pattern aligns with the recent Vertessy report findings that A Class extraction in the low flow range is effectively extending low and cease to flow periods downstream, thus also prolonging the associated environmental and social impacts.[271]

An overview of the Plan elements that are contributing to this change in cease to flow and low flows patterns is provided in **Chapter 8**.

6.2.2 Historically low inflows not solely responsible for low flows

The Commission acknowledges that while tributary inflows are at historically low levels, there is evidence that the Plan rules need to change so low flows are available for ecosystem and community needs.

The reductions in tributary inflows place the Barwon-Darling under pressure, reducing the volumes of flow available to meet environmental and social needs. In addition, they have a significant impact on outcomes downstream of the Plan area. The Vertessy report recognises

270 MDBA (2019), *Active Management Case Studies Summary*, May 2019.

271 Vertessy, R., Barma, D., Baumgartner, L., Mitrovic, M., Sheldon, F., Bond, N. (2019), *Independent Assessment of the 2018-19 fish deaths in the lower Darling – Final Report*, for the Australian Government, 29 March 2019.

that extractions in the Barwon-Darling itself have limited impacts on downstream inflows to Menindee compared with the impact of extraction in upstream tributaries:

> *"Extractions in the Barwon-Darling have been found to represent a small proportion of tributary system inflows, even when inflows are small such as in 2017–18. The analysis of extractions, mid-system flows, and tributary inflows into the Barwon-Darling suggests that the majority of impacts from extractions on Menindee inflows, and therefore Menindee Lake volumes, are from tributaries above the Barwon-Darling and not the Barwon-Darling itself".*[272]

Despite this, the report also recognised that tributary inflows are not solely responsible for changes in the pattern of low flows currently being experienced in the Barwon-Darling:

> *"in recent times, one of the main impacts on the frequency, magnitude and duration of low flows in the Barwon-Darling River, which have high ecological importance, is the change in the behaviour and use of A Class diversion licences"*[273]

Significant upstream development, such as in the tributaries upstream of the Barwon-Darling since the 1960s, has a major cumulative impact on downstream flows. **Table 13** compares short and medium term gauged annual tributary inflows to long term modelled annual inflows. The comparison shows how the gauged medium term average is 72 percent of the long term modelled average and the gauged short term average is 40 percent of the modelled long term average yearly tributary inflow.

Table 13: Modelled long and gauged medium and short term yearly tributary inflow average

	Modelled developed long term average yearly tributary inflow[274]	Gauged medium term average yearly tributary inflow[275]	Gauged short term average yearly tributary inflows[276]
Time period	1900-2012	1999-2018	2012-13 - 2018-19
Tributary inflows	2,204 GL	1,589 GL	871 GL

This has been particularly exacerbated in the last two dry years (January 2017 to December 2018), where the average tributary inflow has dropped further to only 248 GL per year.[277] This demonstrates significant reductions in tributary inflows to the Barwon-Darling in recent years, likely due to a combination of increased extraction and the current drought conditions.

Figure 16 depicts the NSW rivers currently in drought, with the Barwon-Darling in stage 4 'critical drought'. At this stage, only restricted town water supply, stock and domestic and other restricted high-priority demands can be met and water quality cannot support most local values and uses.[278]

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272 Vertessy, R., Barma, D., Baumgartner, L., Mitrovic, M., Sheldon, F., Bond, N. (2019), *Independent Assessment of the 2018-19 fish deaths in the lower Darling – Final Report*, for the Australian Government, 29 March 2019.
273 Ibid.
274 Ibid.
275 Ibid.
276 Advised by DPIE-Water, via email 5 September 2019.
277 Vertessy, R., Barma, D., Baumgartner, L., Mitrovic, M., Sheldon, F., Bond, N. (2019), *Independent Assessment of the 2018-19 fish deaths in the lower Darling – Final Report*, for the Australian Government, 29 March 2019.
278 DoI-Water (2018), *NSW Extreme events policy*, available at https://www.industry.nsw.gov.au/__data/assets/pdf_file/0008/187703/Extreme-Events-policy.pdf.

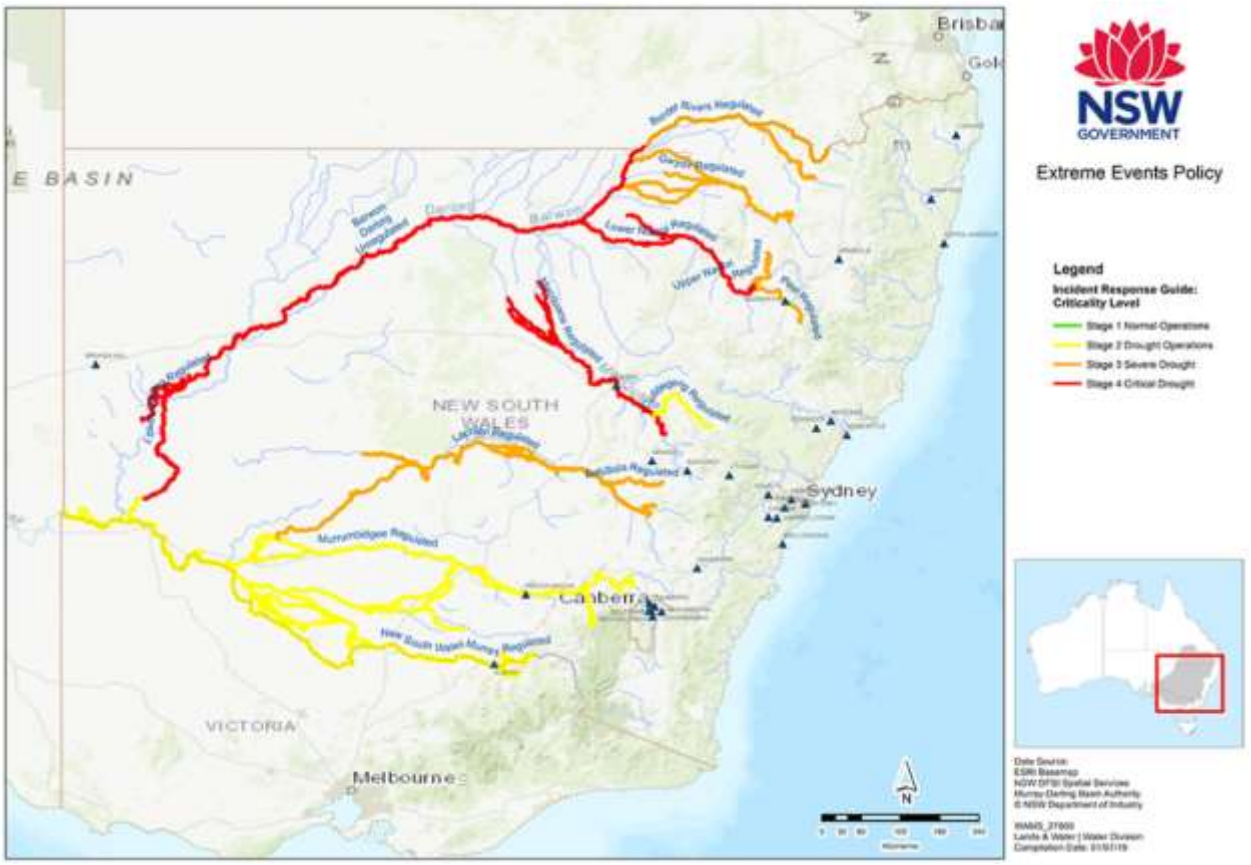

Figure 16: NSW drought status in May 2019 showing the Barwon-Darling in critical drought[279]

Over the last two years, inflow to the Barwon-Darling has been reduced across all tributaries compared to the 20 year average. **Figure 17** shows how less than half the flow volume in the middle of the tributaries actually reaches the Barwon-Darling.[280] This is attributable to extraction and transmission loss, with extractions having greater impact on the system in dry years.[281] Note that the tributary inflows in **Figure 17** are estimates, as not all flows are measured at the point they meet the Barwon-Darling resulting in a reliance on upstream gauged data and tributary models.[282]

In addition to an overall reduction in inflows to the Barwon-Darling from tributaries, the relative inflow contributions of each tributary have also changed in recent years. In the last two years the Border Rivers contributed the highest volume of flows (46 percent), followed by Macquarie-Bogan, Moonie and Gwydir tributaries.[283] However, over the last twenty years the Condamine and Balonne (22 percent) has contributed the largest volumes, followed by Border Rivers and Namoi (20 percent each).[284] NSW (including Border Rivers) has control of the bulk of these inflows – varying from 78 percent in the last two years, to 66 percent over the last 20 years.[285]

279 WaterNSW (2019), *PowerPoint presentation managing water shortages in NSW drought community meetings*, presented at the Goondiwindi Community Drought Information Session.

280 Vertessy, R., Barma, D., Baumgartner, L., Mitrovic, M., Sheldon, F., Bond, N. (2019), *Independent Assessment of the 2018-19 fish deaths in the lower Darling – Final Report*, for the Australian Government, 29 March 2019.

281 Ibid.

282 Ibid.

283 Vertessy, R., Barma, D., Baumgartner, L., Mitrovic, M., Sheldon, F., Bond, N. (2019), *Independent Assessment of the 2018-19 fish deaths in the lower Darling – Final Report*, for the Australian Government, 29 March 2019.

284 Ibid.

285 CSIRO (2008), *Water availability in the Barwon-Darling*, A report to the Australian Government from the CSIRO, Murray Darling Basin Sustainable Yields Project.

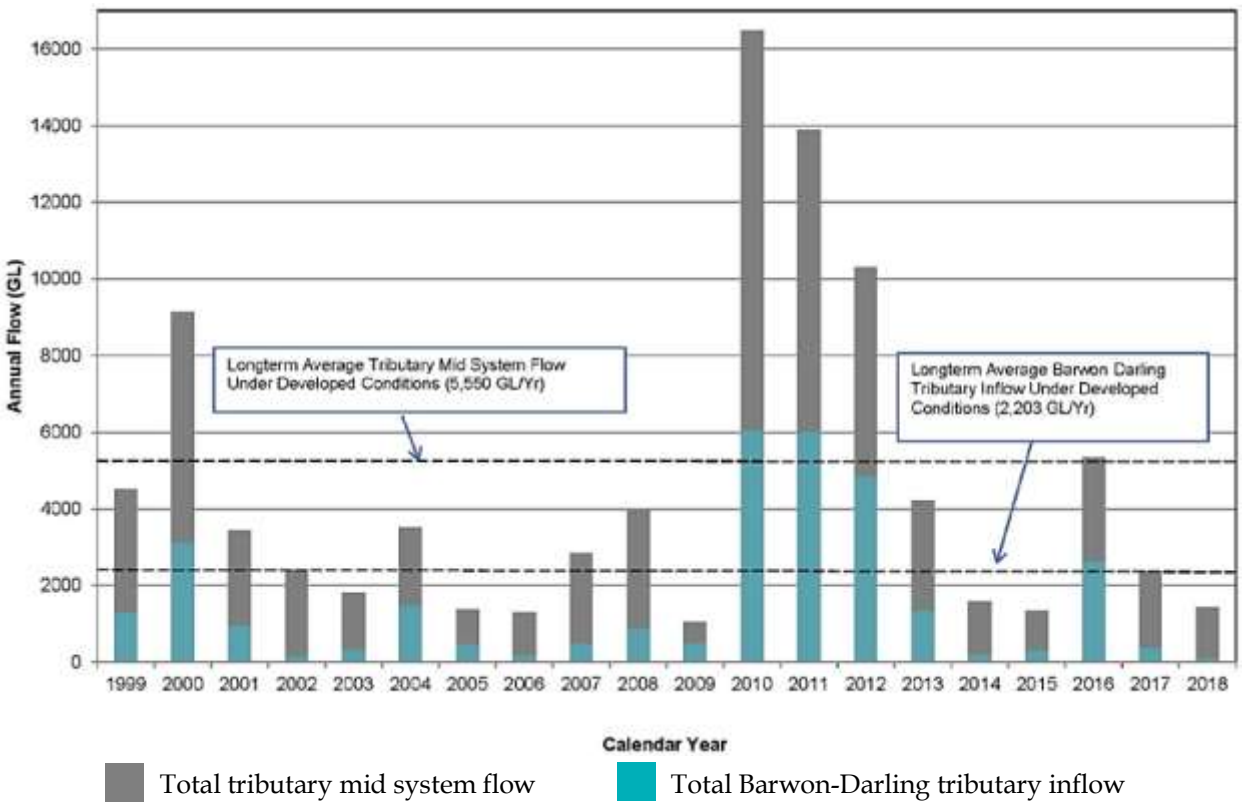

Figure 17: Mid-system tributary flows and end of system tributary flows into the Barwon-Darling[286]

The specific Plan rules linked to low flow impacts are identified in **Chapter 8**, while the Commission's recommended changes to address these impacts are set out in **Chapter 9**.

6.3 Flows need to be protected when they occur

The Barwon-Darling does not exhibit strong seasonal flow patterns. An analysis of actual and modelled data across the Walgett, Brewarrina, and Bourke gauges indicated a decrease in monthly discharges across all months. The Collarenebri gauge indicated higher actual flows in the months of February, May, September and December and the Wilcannia gauge showed higher actual flows in the month of June. An example of mean monthly flow data for the Bourke gauge is presented in **Figure 18**, illustrating the variability in discharges across months.

The seasonal timing of flows is important to meet the requirements of aquatic biota. For example, maintenance flows (small freshes flow band) over the spring and summer months are necessary for the spawning and recruitment of native fish, as well as being important for the reproduction of larger invertebrates including river mussels.[287] The increased frequency of cease to flow events highlighted in **Chapter 6.2** and flow reductions in summer months impacts on the maintenance of water quality, refugial pools and connectivity that serves to reduce the risk

286 Taken from Vertessy, R., Barma, D., Baumgartner, L., Mitrovic, M., Sheldon, F., Bond, N. (2019), *Independent Assessment of the 2018-19 fish deaths in the lower Darling – Final Report*, for the Australian Government, 29 March 2019.

287 Mallen-Cooper and Zampatti (2015). *Background Paper: Rethinking the Natural Flow Paradigm in the Murray-Darling Basin*. Report to the MDBA; Mallen-Cooper and Zampatti (2018). *History, hydrology and hydraulics: rethinking the ecological management of large rivers*; Sheldon, F. (2019), *Technical review of the water sharing plan for the Barwon-Darling unregulated and alluvial water sources 2012*, advice to the Natural Resources Commission.

of ecological impacts.[288] Given the lack of seasonal patterns in flows in the Barwon-Darling, it is important for the Plan to protect low flows whenever they occur. Plan measures to address protection of low flows whenever they occur are discussed in **Chapter 9.1**.

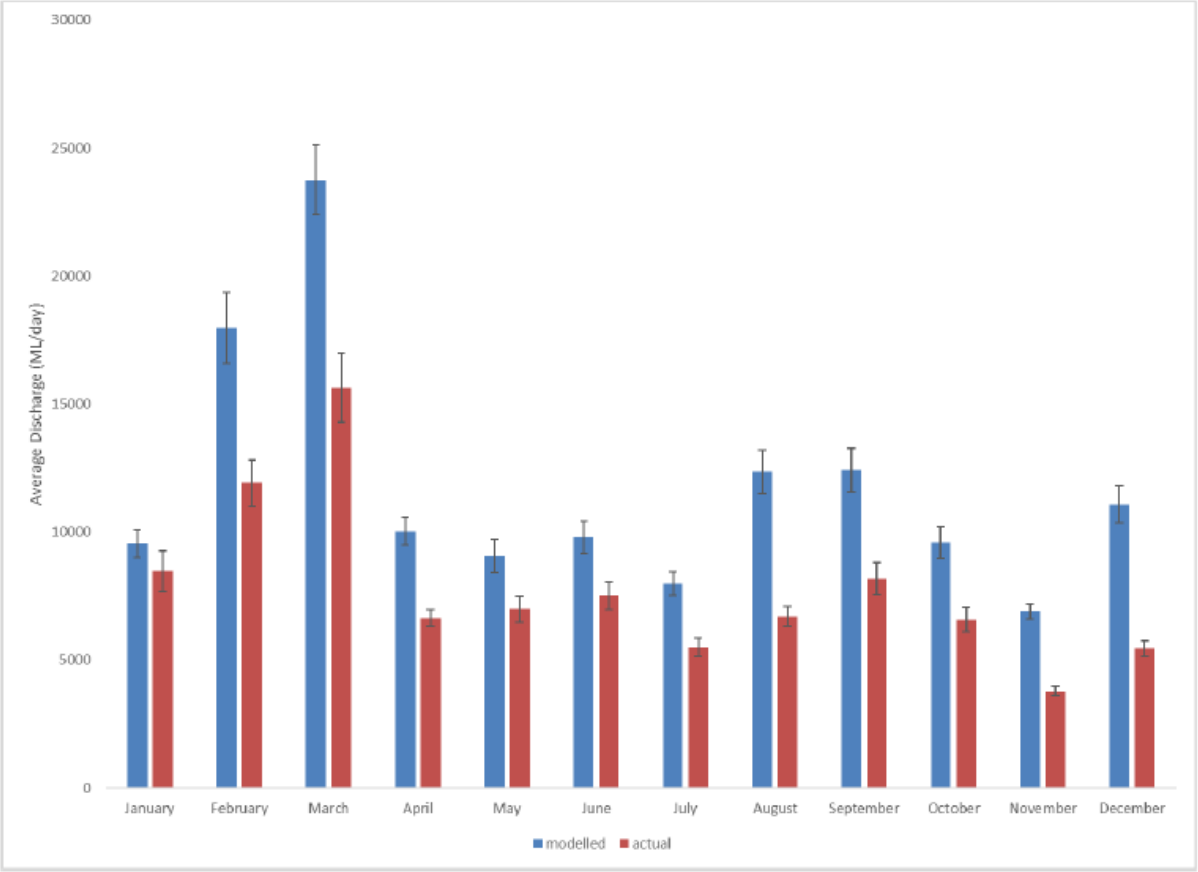

Figure 18: Mean monthly discharge (ML/day) for Bourke (gauge 425003) for modelled (1895-2009) and actual (1972-2019) flows[289]

[288] Sheldon, F. (2019), *Technical review of the water sharing plan for the Barwon-Darling unregulated and alluvial water sources 2012*, advice to the Natural Resources Commission.

[289] Ibid.

7 The current Plan is not meeting social needs

This chapter discusses the unsatisfactory social outcomes delivered under the Plan. In general, increased low and cease to flow periods under the Plan[290] have put strain on community members and how they interact with the river. All councils have had to implement critical water supply management strategies and are shifting to bore water for town drinking water needs. Supplying drinking water to communities affected by poor water quality is a challenge, as evidenced by the unpalatable water in Walgett and boil water alerts at Collarenebri. The only active provision favouring utilities is they are able to extract below cease to pump thresholds set for A, B and C class licences. Poor water quality also has economic impacts on affected users, including increased cost and effort to find alternate water supplies. These impacts are felt all along the river, but particularly downstream of Walgett.

Over half (54 percent) of submissions expressed dissatisfaction with the inequity of water sharing under the Plan. Water scarcity, poor water quality and water restrictions are impacting residents' physical and mental health, reducing fresh food availability and limiting recreational activities such as swimming, fishing, sports and gardening. Towns including Bourke, Collarenebri and Walgett are currently subject to the highest level water restrictions, the effects of which are particularly felt in the summer months when average maximum temperatures can be over 30 degrees Celsius. Aboriginal communities within the Plan area are being disproportionately impacted as connections with land, water and culture are critical to their health and well-being.

7.1 Basic landholder rights are not effectively protected

Under the Act and Plan objective 10c, the Plan gives priority (after environmental needs) to basic landholder rights, which includes domestic and stock rights, native title rights and harvestable rights.[291] While the Plan's objectives indicate an aim to protect basic landholder rights as required by the Act, the provisions as implemented do not sufficiently protect water for these rights, including those associated with native title (see **Chapter 10.1** for further detail on lack of native title access).

Despite the clear contribution of drought and reduced inflows from upstream extraction, the Plan rules are also contributing to recent water shortages and water quality issues, particularly below Bourke (see **Chapter 6.2**). There is therefore spatial inequity, with upstream landholders having greater access to their basic landholder rights compared to those downstream. IDELs could have helped address downstream equity and improved access for basic landholder rights, but were not implemented as intended under the Plan.

Stakeholder engagement and submissions for this review consistently highlighted that landholders have been unable to reliably access water, with most stakeholders citing increasing upstream extraction as impinging on their basic landholder rights. As a result of water shortages and poor water quality, families along the river are tankering in treated town water for domestic use and installing bores, pumps and pipework for stock survival.

Reduced water availability increases stress and work for everyone, but has a particular impact on graziers' workload. Properties must be destocked or stock moved between paddocks to

290 See **Chapter 6.2.**
291 Part 2, Clause 10c *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources 2012.*

ensure adequate water supply of an acceptable quality. The report cover page shows a remaining pool along the Darling outside Wilcannia. The neighbouring family noted that this was one of the deepest points of the river and described dozens of pelicans, flocks of galahs and emus, kangaroos and fish usually passing by, but without the river "*everything dies*".[292]

Graziers have also had to adjust for the loss of the river as a paddock boundary during periods of decreased flows. As they are unable to fence the floodplain, their useable farm area is significantly reduced. One riverside landholder outlined the productive loss of a third of their property (reduction of about 180 square kilometres) due to the Darling River drying out. When access drops, new troughs, pipes and pumps must be installed, water carted and bores sunk to maintain water supply. Stakeholders spoke not only of the mental stress, lost time and increased isolation from the additional work, but of the physical toll of more frequent periods of low flow, "*people are being pushed beyond comprehension*".[293] They spoke of the sense of hopelessness and inability to see how future generations would be willing to take on farms if access to water continued as it is.

Irrigation farmers have also been reported to be suffering from stress and mental health impacts arising from current water shortages and drought conditions. There is a social stigma due to media commentary blaming irrigation farmers for a lack of flows in the southern system, when these farmers are also without water, noting there was no water extraction by irrigators in the 2018-19 water year.[294]

7.2 Local water utility needs are met unevenly along the river

As well as ecological outcomes, low flows provide water for communities to ensure reliable, good quality water for critical human water needs (for example town water), and to support social, cultural and recreational values.[295]

Local utility requirements are not granted the same priority in the Act as basic landholder rights, but they do have precedence over most other licences.[296] The Background Document reflects the requirements of the Act; "*among licensed water users, priority is given to water utilities and licensed domestic and stock use, ahead of commercial purposes such as irrigation and other industries*". Utility licences are also not subject to cease to pump rules as per schedule 3 of the Plan, which is important in the Barwon-Darling as, unlike irrigators, towns do not have off-river storages. The Commission supports a review of off-river storage for towns, where feasible and appropriate as part of the *Regional Water Strategies*. This should improve utility supply in a highly variable system and reduce take of low flows, which are meant to be reserved for the environment.

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292 Commission stakeholder interview, 3 April 2019.

293 Ibid.

294 No licenced extractions occurred during the northern connectivity environmental flow event in 2018.

295 MDBA (2018), *Ecological needs of low flows in the Barwon-Darling*, available at https://www.mdba.gov.au/sites/default/files/pubs/ecological-needs-low-flows-barwon-darling_0.docx.

296 Act s58 (1) "*For the purposes of this Act, … (a) local water utility access licences, major utility access licences and domestic and stock access licences have priority over all other access licences … (2) If one access licence (the higher priority licence) has priority over another access licence (the lower priority licence), then if the water allocations under them have to be diminished, the water allocations of the higher priority licence are to be diminished at a lesser rate than the water allocations of the lower priority licence.*"

7.2.1 Towns are having to shift from river water to bore water

Table 14 summarises the water requirements for each town with a public water supply network from the Barwon-Darling system. To reduce treatment costs many of the towns have a dual water supply, with potable water for household kitchen and bathroom use and raw water for laundry, toilets, gardens, parks, firefighting and other uses outside the home.

Without access to off-river storages, all councils have historically been reliant upon river water taken from weirs for supply. Since the start of the Millennium drought, however, accessibility and salinity issues have forced towns to implement critical water supply management strategies. Most councils have opted to build additional infrastructure and switch supply – at least partially – to bore water where available. While six towns rely on groundwater as backup, only Louth and Wilcannia extract from the Upper Darling Alluvium. Collarenebri, Brewarrina, Walgett and Bourke instead extract supplementary supply from the Great Artesian Basin, which is not covered by this Plan. These towns will be looking to access groundwater if there are no substantial river flows over winter 2019.

Table 14: Water utility entitlements from the Barwon-Darling and description of water use status

Town (serviced population)	Utility entitlement and source	Description
Collarenebri (about 400)	416 ML/year Barwon River	Collarenebri sources its water from a weir pool. They run a dual reticulation system, with both raw and treated water.[297] The town is on level 5 restrictions and will be looking to move to artesian bore water if there are no substantial flows in the Barwon River in winter 2019. Council is investigating installing an artesian bore to replace the river as the town's main water supply to improve water quality and security.[298]
Walgett (about 1,500)	63 ML/year Barwon River (main source is Namoi River)	Walgett's water supply is generally sourced from the Namoi River, with supplementary water used during drought from the Walgett weir pool on the Barwon River.[299] Walgett has a dual reticulation system. Walgett is currently relying upon artesian bore water for its treated water supply, which is of poorer quality (more saline) than the river water source and which failed briefly in January 2019. Walgett raw supply is on level 5 water restrictions, with the potable supply having no restrictions.
Brewarrina (about 1,100)	1,000 ML/year Barwon River	Brewarrina relies fully upon their (relatively large) weir pool as it does not have an accessible source of groundwater, with the only source about 55 km from town.[300] Brewarrina Shire Council has developed a bore at that point and is providing bore water to property owners to cart for stock and domestic use at no cost. Brewarrina has a dual reticulation system for town water and is on voluntary water restrictions but would like to connect the bore to the town supply in the long term.[301] West Brewarrina and Barwon 4 are serviced by the

297 NSW Office of Water (2012), *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources: Background document*, NSW Government, Sydney.
298 Advised by DPIE-Water, via email May 2019.
299 NSW Office of Water (2012), *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources: Background document*, NSW Government, Sydney.
300 Interview with Brewarrina Shire Council, April 2019.
301 Advised by DPIE-Water, via email May 2019.

Town (serviced population)	Utility entitlement and source	Description
		Local Aboriginal Land Council, which connects to Brewarrina Shire Council's system.
Bourke incl. North Bourke (about 2,100)	3,500 ML/year Darling River	Bourke town supply is at very high risk with less than three months to potential failure and a solution to sustain demand still under development.[302] They are on level 5 water restrictions and have a dual reticulation system. Until about 2012, Bourke was reliant upon the Darling River but has since developed an artesian bore 6 km from town as an additional supply source.[303] This bore is limited to about 1 ML per day or 60 percent of demand. Another bore has been drilled which is expected to add another 1-2 ML per day. Emergency infrastructure is being built to link the bores and is expected to be operational before the weir runs out.[304] The NSW Government recently announced funding for the additional works.[305] Bourke was expected to move to full bore water for town supply in May 2019 to conserve the remaining weir pool water for firefighting and parks.[306] Council has been carting water to Byrock village and will cart to other villages as required; however, property owners must come to town to fill tankers themselves.
Louth (about 40)	25 ML/year Darling River	Louth sources raw water from the Darling River with backup supply from a bore next to the river drawing alluvial water. The town relies upon household rainwater tanks for potable water. In a drought potable water must be carted to town.[307] The NSW Government has recently funded dredging works to link water pools upstream of the town's weir to extend raw water availability.[308]
Tilpa (about 15)	Nil Darling River	The community has a reticulated raw water supply from the Darling River and like Louth, relies upon rainwater tanks and carted water for potable use.
Wilcannia (about 600)	400 ML/year Darling River 220 ML upper Darling alluvial	Wilcannia's water has historically been sourced mostly from their weir pool in the Darling River but with alluvial groundwater bores for drought supply.[309] It is currently on level 4 restrictions. Wilcannia has a dual reticulation system and the treated water system is currently drawing from bore water due to elevated algae and salinity in the river. The raw water system relies upon river water, this feeds the fire hydrants and is expected to run dry in winter 2019 without rain.[310] As of start of May, there was less than two months water supply in the weirpool after small rain events topped up levels. The bores are

302 Ibid.
303 NSW Office of Water (2012), *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources: Background document*, NSW Government, Sydney.
304 Advised by DPIE-Water, via email May 2019.
305 DoI-Water (2019), *Media release 23 May 2019 - Extra $811k to secure Bourke and Louth drinking water*, available at https://www.industry.nsw.gov.au/water/news/extra-$811k-to-secure-bourke-and-louth-drinking-water.
306 Interview with Bourke Shire Council, April 2019.
307 NSW Office of Water (2012), *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources: Background document*, NSW Government, Sydney.
308 DoI-Water (2019), *Media release 23 May 2019 - Extra $811k to secure Bourke and Louth drinking water*, available at https://www.industry.nsw.gov.au/water/news/extra-$811k-to-secure-bourke-and-louth-drinking-water.
309 NSW Office of Water (2012), *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources: Background document*, NSW Government, Sydney.
310 Interview with Wilcannia Shire Council, April 2019.

Town (serviced population)	Utility entitlement and source	Description
		expected to be able to meet town demand (under restrictions), but their capacity under an extended period of demand and extreme dry is untested.[311] Central Darling Shire Council roadtrains are carting treated water for domestic supply to around 50 properties in station country for $2/kL. The NSW Government has committed $30 million to upgrade the Wilcannia weir as its condition and functionality are declining.[312]

7.2.2 Variable water supply increases costs to utilities and consumers

Poor and variable quality water increases difficulty of operating and maintaining potable water supplies.[313] For example, Collarenebri experienced a boil water alert between 6 April and 15 May 2017 due to *E.coli* detection.[314] The highly variable river water quality meant the treatment plant's disinfection could not be maintained and there was poor water filtration.

The need for additional treatment to meet consumer expectations also increases the cost of potable water provision for councils and government, with flow on effects for rate- and tax-payers. To help meet these costs DPIE-Water provides support to councils for water treatment and infrastructure. For example, Bourke Shire Council has received technical support and emergency funding, including an additional bore and pipeline estimated to have cost $3 million to $3.5 million.[315] The cost of this critical infrastructure is relatively low. DPIE-Water's Safe and Secure Water Program (under the NSW Government's Restart NSW fund) is designed to ensure a minimum level of service in smaller towns and address the highest risks and issues for regional water safety and security.[316] This has funded:

- construction of a fishway at Walgett weir as part of a larger water supply security project
- scoping for pre-treatment at Collarenebri water treatment plant to reduce water quality risks
- design and construction of a replacement water treatment plant at Wilcannia to address water quality and public health issues
- completion of the Wilcannia weir upgrade to improve water security
- scoping of a gravity sewer system for Wilcannia township to improve waterway and public health issues.

Funding of up to $10 million has also been allocated in the 2019–20 NSW budget to improve the drinking water quality in towns such as Walgett and Bourke.[317]

311 Advised by DPIE-Water, via email May 2019.
312 NSW DoI-Water (2019), *Wilcannia Weir Upgrade*, available at https://www.industry.nsw.gov.au/water/plans-programs/infrastructure-programs/wilcannia-weir-upgrade.
313 Stakeholders interviews, 2019; Wentworth Shire Council submission, 2019.
314 Advised by NSW Health, via email April 2019.
315 Advised by DPIE-Water, via email May 2019.
316 DoI-Water (2019), *Safe and Secure Water Program*, available at https://www.industry.nsw.gov.au/water/plans-programs/infrastructure-programs/safe-and-secure-water-program
317 NSW Budget Media Release (2019), *Making every drop count during the dry*, available at https://www.budget.nsw.gov.au/sites/default/files/budget-2019-06/PAVEY%20-%20NSW%20Budget%20-%20Making%20every%20drop%20count.pdf

Stakeholders also report an ongoing personal financial burden for people in local towns as they purchase bottled water or tanker in top-up water for dry rainwater tanks, invest in additional rainwater storage options, and have to replace home appliances more frequently due to water quality being unsuitable or unappealing for use.[318] Multiple individuals commented that charities and other communities have been gifting bottled water from January 2019 to the present time.[319] This is a particular issue for Aboriginal people in the area who are more likely to earn less than the average NSW household.[320] Financial barriers for Aboriginal people to access clean and safe water can lead to preventable illnesses and impacts on well-being – see further discussion in **Chapter 7.4**.

There are also examples where switching to bore water has resulted in safe but less palatable water, which impacts residents' willingness to drink the tap water and may prompt a switch to bottled drinking water at additional cost to the consumer. Although drinking water quality in the towns supplied by the Barwon-Darling generally meet the health-related criteria for chemical and microbiological quality, there have been some exceptions to the aesthetic (taste) criteria.[321] For example, since moving to groundwater, residents in Walgett have complained of taste issues and a 'slimy feel' (due to sodium and bicarbonate respectively). Drinking water in Walgett has exceeded *Australian Drinking Water Guidelines* aesthetic (taste) guideline value for sodium (guideline is 180 mg/L, Walgett's water is around 270 mg/L); however, the water is safe to drink and only contributes a modest amount to personal sodium intake.[322] NSW Health provided advice to health practitioners recommending careful monitoring of fluid and electrolyte status of certain patients who may be sensitive to sodium. In contrast, the taste of Wilcannia's water improved when supply changed from the river to groundwater and the sodium level dropped.[323]

The cost of additional works to secure and treat supplies along the Barwon-Darling, as well as the costs incurred by other water users as a result of poor quality water supplies, should be considered as part of any economic analysis on water sharing.

7.2.3 Water restrictions and inequitable supply are impacting local residents

At the time of preparing this report, the highest level of water restriction – level 5 – is implemented in Bourke, Collarenebri and Walgett (raw water only) with level 4 in Wilcannia. As described in **Chapter 6.2**, while drought and upstream inflows play a role in the current water shortages, the Plan has impacted on downstream flows, disproportionately impacting communities downstream and extending and increasing community impacts.

During the Commission's consultation process, Councils described the significant mental impact of level 5 water restrictions on community members. Restrictions include no lawn watering, garden watering by watering can or bucket only in certain hours, no car washing, no window cleaning, no topping up of pools, three minute showers and 10 centimetre baths, only full loads of washing, evaporative air conditioning only in certain hours. "*Rivers are dry, people are resorting to any means necessary to bath, feed there [sic] children*".[324] When considering the

318 Submissions to the Natural Resources Commission for this review.
319 Submission to the Natural Resources Commission for this review.
320 Submission to the Natural Resources Commission for this review from the NSW Aboriginal Land Council.
321 According to NSW Health's Drinking Water Monitoring Program, which tests water across NSW regional utilities for safety in line with the *Australian Drinking Water Guidelines 2011*.
322 Advised by NSW Health, via email April 2019.
323 Ibid.
324 Submission to the Natural Resources Commission for this review.

temperatures experienced in these areas - the average maximum in Bourke and Wilcannia is over 30 degrees Celsius for five months of the year – these restrictions have a significant impact on quality of life.[325]

Stakeholders are critical of the provision of drinking water to communities under the Plan, with comments such as "*This is a breach of their human rights to access drinking water*".[326] While many also acknowledged the impact of drought, 43 percent of submissions were specifically concerned about the Plan's impact on town and domestic water supplies with a focus on community health outcomes, as well as the "*horrific*"[327] mental health impacts due to stress from water shortages.

There are also significant concerns about inequity of supply, especially for downstream users and Aboriginal communities where water restrictions are extreme or water has to be carted in. Stakeholders point to Walgett and Wilcannia, which should have priority access to water (over upstream irrigation use in previous years),[328] but the water cannot be delivered as rivers have run dry (Walgett is the last regulated user in the Namoi regulated system, Wilcannia is one of the last in the Barwon-Darling). Over half the submissions identify inequity of entitlements, or disproportionate disadvantage to downstream users.

Looking ahead, DPIE-Water are developing regional long term water security strategies, with the western regional strategy to be delivered in 2020.[329] DPIE-Water's strategic water security assessment identified that Bourke has the highest relative risk (very vulnerable) to its water supply. It also has the largest population of the towns along the Barwon-Darling (serviced population just under 2,100).[330] Wilcannia had the next highest relative risk (serviced population about 600), followed by Walgett (about 1,500) and Collarenebri (under 400).

The Commission is of the view that measures should be put in place that prioritise flows for downstream town supply throughout the system. The observed spatial inequity, which relates to the upstream extraction of low flows, could have been addressed at least in part through the use of IDELs and TDELs. These measures are provided for in the current Plan but are yet to be implemented (see **Chapter 8.6.1**). As a result, there is a feeling that under the current Plan "*socioeconomic benefits have been shifted upstream*",[331] for example via water trading, leaving towns such as Wilcannia with less and poorer quality water than under pre-Plan conditions.[332]

Overlaid on these flow impacts are the weirs that store water when the rivers cease to flow. As the weirs are emptied they create an airspace which allows upstream towns to capture flows. Capture of these small flow pulses contributes spatially to social inequity and environmental impact as they also extend cease to flow periods downstream.[333] Creating off-stream storage for towns and adding gates to weirs so they function at different levels would mitigate this impact.

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325 Bureau of Meteorology (2019), *Climate statistics for Wilcannia (Reid St) and Bourke Post Office*, available at http://www.bom.gov.au/climate/data/index.shtml.

326 Submission to the Natural Resources Commission for this review.

327 Confidential submission to the Natural Resources Commission for this review.

328 Note that water availability for extraction varies across the system, for example A class irrigators in Culgoa to Bourke were last able to pump 2 July 2018 and Bourke to Louth 22 December 2017 (NSW Land and Water Commissioner (January 2019), *Barwon-Darling River, Menindee Lakes and Lower Darling River Data Package)*

329 DoI-Water (2017), *NSW Regional Water Statement*, available at https://www.industry.nsw.gov.au/__data/assets/pdf_file/0019/218404/NSW-Regional-Water-Statement.pdf

330 Advised by DPIE-Water, via email May 2019.

331 Wilcannia community member, Commission interview 3 April 2019.

332 See **Chapter 6**.

333 Mallen-Cooper, M. (2019), *Barwon-Darling Water Sharing Plan: opportunities to link ecology, river hydraulics, culture, and social values to meet the objectives of the Water Management Act*, discussion paper for the Natural Resources Commission.

7.3 Everyone is impacted by increased water scarcity and poor water quality

The benefits of a healthy river system are enjoyed by the whole community; however, the Plan does not explicitly consider the general beneficiaries of the aquatic environment. There is also no Plan framework for measuring or monitoring water quality or social expectations. The Commission engaged with, and received submissions from, a wide range of stakeholders along the Barwon-Darling. The overwhelming majority of stakeholders feel that the Plan is not meeting its objectives, and that a lack of water and poor water quality is impacting environmental outcomes and affecting local residents and communities.

For example, water shortages and poor quality river water is preventing key recreational activities such as swimming and fishing. **Figure 19** shows the juxtaposition of the 'Home of the Cod' next to the currently inhospitable river. Almost all interviewees commented on the reduction in fishing and its impact on residents and tourism. One stakeholder in Wilcannia lamented that his daughters, aged six and three, had never been able to swim in the Darling River because it would make them sick. He and all his contemporaries grew up in the river, it brought their families together and gave them fitness, food and their sense of community and self - "*the river was like Wet'n'Wild, the happiness it brings*". Another stakeholder commented "*Wilcannia's children, for whom the low-flow river is an important adventure playground, are being deprived of this … all this summer, there have only been putrid ponds of water on the River bed*".[334]

Figure 19: The Barwon-Darling community highly value the river, its fish and fishing. Top, Collarenebri 'Home of the Cod' and the very low, algae-tinged Darling River adjacent to the sign (Natural Resources Commission, April 2019)

334 Submission to the Natural Resources Commission for this review.

Stakeholders also reported that there is no longer adequate water to maintain personal gardens, "*our gardens and fruit trees are dying*", "*dead fish, dry rivers, dead orchards*".[335] This makes fresh food harder and more expensive to access and impacts health outcomes. For example, raw water supplies in towns including Walgett, Wilcannia and Bourke have elevated salinity from groundwater inflow when there are low flows in the river. While not used for drinking, this is used for other outdoor purposes including watering gardens. Stakeholders noted the mental impact of being unable to keep gardens and pot plants alive due to water restrictions and salinity. The lack of green space has a mental toll on individuals with no relief from the dust and the dirt.

The Commission's consultation process also identified concerns that poor quality water is impacting community health outcomes in the region. Submissions suggested that poor river water quality due to insufficient flows was responsible for serious medical conditions in the area, including severe skin infections. There are also community fears expressed in some submissions that there is a link between ongoing contact with blue-green algae and motor neurone disease. These fears are not supported by the available evidence.[336]

Blue-green algal blooms are not uncommon along the Barwon-Darling (an example is shown in **Figure 20**), and the risk of algal blooms increases further during low and cease to flow periods (refer to **Chapter 6.1.2)**.

Figure 20: Wilcannia weir pool visible behind a blue-green algae warning sign. The river was at red alert for algae, turbid and green tinged (Natural Resources Commission, April 2019)

Blue green algae may impact the raw water provided to towns in the Plan area through dual reticulated water systems for external use. It is important to note that public drinking water

335 Submissions to the Natural Resources Commission for this review.

336 NSW Health advised that they and scientists from Water Research Australia have reviewed the available evidence and noted that the possible link with neurological disease, including motor neurone disease, remains unproven. NSW Health and Water Research Australia will continue to examine new information as it evolves. NSW Health advised that algal blooms can produce range of toxins that can cause other health effects.

supplies are carefully monitored for the risk of algal blooms and the water treatment plants for Brewarrina and Bourke townships treat blue-green algae.[337] Other towns such as Wilcannia switch 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. When warnings are in place residents (particularly children) are advised not to come into contact with the water and to not use it on vegetable patches or to water stock or pets.[338] Graziers are significantly impacted as any remaining pools cannot be used for stock watering and alternative supplies (bore water or tankering) must be used increasing costs and day-to-day workload.

An amber alert cyanobacterial bloom currently exists along the Darling River from Brewarrina to Wilcannia.[339] For many months, this section of the river was on red alert. NSW Health's Public Health Unit considers that the current bloom is more extensive and prolonged than in previous years and it is unusual for Brewarrina weir pool to be on red alert.[340] In January 2019, for example, four monitored sites had a red alert, a further four had an amber alert, and one a caution.[341] These included five town supply weirs.

In addition to physical health impacts, stakeholders report that stress due to water scarcity and the impact of water restrictions is also taking a toll on the mental health of residents. When visiting the region, the Commission saw firsthand the distress from reduced health and recreational opportunities for locals – especially children – in towns like Wilcannia due to low water levels and poor water quality in the river.

Activities that would usually contribute to positive mental health outcomes and social cohesion are also being impacted by water restrictions, for example sporting activities. Each Council highlighted the priority of keeping the oval green to enable rugby league games to continue as long as possible to provide entertainment, exercise, community cohesion and reduce boredom. When rugby league stopped, the social impacts were significant and multifaceted. For example, a Country Rugby League program *Tackling domestic violence* does not allow perpetrators to play.[342] Stakeholders anecdotally linked player attendance to river flow, with low and cease to flow periods linked to reduced attendance due to increased violence.

Similarly, stakeholders frequently commented on the link between local crime and the river level. This was specifically noted for Wilcannia, and linked to residents travelling to Broken Hill when the river is not flowing. The Commission was unable to quantify this observation with statistics. However, the linkage between river levels and social impacts is not new and is not confined to Wilcannia or to Aboriginal communities.

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337 Advised by NSW Health, via email April 2019.

338 WaterNSW (2019), *Blue-green algae warning*, https://www.waternsw.com.au/about/newsroom/2019/blue-green-algae-warning-to-communities-that-have-dual-reticulated-water-systems-on-the-darling-and-lower-barwon-rivers.

339 WaterNSW, *Current algal alerts in NSW map*, available at https://www.waternsw.com.au/water-quality/algae

340 Advised by NSW Health, via email April 2019.

341 *Red alert – blue-green algal 'bloom' conditions. Algae may be toxic to humans and animals, water contact should be avoided due to the risk of eye and skin irritation. People should not fish when an algal scum is present. Keep dogs away and provide alternative watering points for stock.*
Amber alert - blue-green algae may be multiplying. Consider water as unsuitable for potable use. The water may also be unsuitable for stock watering. Generally suitable for water sports, however people are advised to exercise caution in these areas, as blue-green algal concentrations can rise to red alert levels quickly under warm, calm weather conditions.
As summarised from WaterNSW (2019), *Blue-green algae warning*, https://www.waternsw.com.au/about/newsroom/2019/blue-green-algae-warning-to-communities-that-have-dual-reticulated-water-systems-on-the-darling-and-lower-barwon-rivers.

342 See http://crlnsw.com.au/country-clubs-tackling-domestic-violence/ for information.

A community member commented:

> "*The highs and lows of the river are also the highs and lows of the town. In the drought the crime rate in Bourke was way up, and the moment the rain came, and the river rose, the crime rate went down, because everybody had that connection to the river. When we get a big rain after a drought everyone went straight to the river. You're not just seeing blackfellas sitting on the river, you see kids sitting on the river bank, whitefellas, police officers, DOCS officers, everybody: fishing. It's the essence of our physical life, particularly to Aboriginal people. Without it, we're done. We're dead.*"[343]

Tying in to this sentiment, Broken Hill City Councillors suggested that end of system flows from the Barwon-Darling to the Menindee Lakes should be retained for social (and environmental) benefits.[344] It was stated that '*rivers die from the bottom up*' and that upstream shifts of socio-economic benefits must be acknowledged and addressed.

The current drought and upstream extraction has led to increased water scarcity and conflict between competing demands. Everyone in the community is being impacted, and water being used in one place will mean it is not available in another. The Commission is of the view that the social impacts described above and potential health impacts from reduced water availability, such as impacts on diet, exercise and mental wellbeing, along with additional personal costs should be quantified and considered in any social and economic analysis.

7.4 Aboriginal communities are disproportionately impacted by poor water quality and water shortages

The deterioration of the Barwon-Darling has a disproportionate impact on Aboriginal communities. Connections with land, water and culture are key determinants of Aboriginal health and well-being. As a Barkandji elder describes, "*The river is everything. It's my life, my culture. You take the water away from us, we've got nothing*".[345] Water is a basic human right and critical to ensuring not only health but also well-being in the form of social connection, physical activity and community networks. Water quality, not just flows, is important for maintaining wellbeing and cultural transmission activities, including: swimming; cultural food production; maintaining and teaching cultural practices and knowledge; and maintaining spiritual and ceremonial sites.[346]

Any impacts on water flows and quality can significantly affect health and well-being. These impacts are magnified in the context of Aboriginal communities characterised by a history of dispossession and socio-economic disadvantage (see **Chapter 2.7**). Half of submissions identified how the Plan's impacts on water quality and shortages are affecting Aboriginal people, including:

- damage to water-dependent culturally significant places

343 Frawley, J., Nichols, S., Goodall, H. and Baker, E. (2011), *Darling-Brewarrina to Bourke: Talking fish – Making connections with the rivers of the Murray-Darling Basin*, Murray-Darling Basin Authority, Canberra.

344 The flows are no longer required to maintain Broken Hill's water supply due to the newly commissioned pipeline.

345 Bates, B. (2017), *When they take the water from a Barkandji person, they take our blood*, available at https://www.theguardian.com/commentisfree/2017/jul/26/when-they-take-the-water-from-a-barkandji-person-they-take-our-blood.

346 Submission to the Natural Resources Commission for this review.

- limited ability to maintain and teach cultural practices and knowledge
- restricted cultural food production by way of fishing and hunting
- restricted swimming and recreation activities that support wellbeing
- reduced health and well-being in already disadvantaged community settings
- increasing social unrest and crime.[347]

The following statements drawn from the consultation process further highlight these impacts:

> *"Current rules governing sharing and use of water in the Barwon-Darling water sources are contributing to devastating impacts on Barkandji people, from the level of personal health and well-being to the survival of cultural knowledge, traditions and practices. The increasing frequency of cease to flow events, poor water quality, blue-green algae blooms, impacts on native fish populations and the ability to engage in recreational activities impact on Aboriginal people and militate against Barkandji people's cultural obligations."*[348]

> *"For the local Aboriginals, if there's water the kids can fish and muck about in the river, now they're just on the streets and it adds to the issues with alcohol ... Some of the younger kids haven't even be able to experience the river and fishing and hunting. This is all they know".*[349]

> *"Access to a sufficient volume of good quality water is of vital importance to the Barkandji Traditional Owners. The cultural identity, health and lifestyle of the Barkandji People is intrinsically tied to the water. When there is enough water in the river, the community is able to thrive. People who can access the river are able to swim, fish, catch yabbies and go camping. The river provides a social basis for the community. When the river is dry, we are deprived of these community activities. Young people do not have anything to do, and the lack of activity causes the crime rate to increase, communities to lose cohesion and become strained. Access to water and the river allows our communities to function. Further, the river is also linked to the mental and physical health of the Barkandji People. When there is no water, many Barkandji People suffer from mental issues and depression due to the loss of identity, hopelessness and loss of resource. Due to the poor flows and quality of water, Barkandji People also suffer from illness and a reduced quality of life. Decreasing the flow of the river has a real and tangible impact on the health and wellbeing of the Barkandji People."*[350]

Work undertaken by the MDBA notes that Aboriginal people in the Basin are concerned about the decline in water quality, introduced species, and the impact of chemicals, fertilisers and industry on the health of the river.[351] A recent survey of local Aboriginal people by Western Local Land Services found that the most important issues affecting Country are water related –

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347 Submissions to the Natural Resources Commission for this review including Brewarrina Shire Council; Dharriwaa Elders Group; Australian Floodplain Association; NSW National Parks Association; Central West Environment Council; Wentworth Shire Council; Healthy Rivers Dubbo; Inland Rivers Network; South West Water Users; Darling River Action Group; Lower Darling Horticulture Group; Menindee Water Users Group; Australia Institute; Jackson, Hartwig, Tan – Griffith University; Central Darling Shire Council; Wilcannia Tourism Association; Murray Lower Darling Rivers Indigenous Nations; Wentworth Shire Council; Ryde - Hunter's Hill Flora and Fauna Preservation Society.

348 Submission to the Natural Resources Commission for this review from MLDRIN, 8 April 2019.

349 Consultation feedback: community member in Brewarrina LGA

350 Barkandji Native Title Group Aboriginal Corporation (BDNTGAC) (2017) statement in the NTSCORP *Submission on Proposed Amendments to the Murray-Darling Basin Plan*, 22 February 2017.

351 MDBA (2011), *A Yarn on the River: Getting Aboriginal voices into the Basin Plan.* Commonwealth of Australia.

in particular, the presence of carp, loss of fish populations, lack of water, over use of water and water quality.[352]

Chapter 10 includes more information about issues affecting Aboriginal outcomes and recommendations for improvement.

7.5 Community trust and social licence for the Plan are minimal

In the context of these direct and ongoing social impacts, local communities are feeling ignored and misunderstood, and the social licence for Plan implementation is diminished.

Based on feedback from the Commission's consultation, disparate stakeholder groups show widespread distrust and cynicism in government water planning and management over a long time period. Indeed, there were numerous calls from community members, and more widely in media, for a Royal Commission and independent review body; *"There needs to be one body in NSW to run water … with ICAC type powers. It could even be federal. But it needs that level of oversight… we need real action to be convinced"*.[353]

There are community hopes that recent Commonwealth and state government responses and reviews (including establishing the Natural Resource Access Regulator, increasing compliance officers, forming the Water Renewal Taskforce and greater community engagement through roadshows) may signal a positive change. However, as discussed further in **Chapter 12**, to rebuild community trust in government, people need to see evidence of satisfactory action on current water planning and management issues.

The Commission notes that the NSW Government undertook detailed community consultation over twenty years ago to develop community endorsed river flow and water quality objectives for catchments.[354] These objectives are being revisited as part of the current water resource plan process and are discussed further in **Chapter 9.3**.[355]

352 In addition, 93 percent of Aboriginal respondents indicated that they knew of Aboriginal sites in their local area, yet only a third of respondents indicated they had access to Country. Fifty-four percent of respondents indicated that in the last 12 months they had undertaken activities which involved looking after Country. Forty-one percent of respondents had been involved in sharing traditional land management practices in the last year, with the two most commonly reported practices being 'sharing yarns' and 'collecting bush tucker' (Western Local Land Services (2017), *Social benchmarking project round 4: A survey of Aboriginal people*. Local Land Services, NSW Government).

353 Consultation feedback: community member in Wilcannia

354 See **Appendix E** for more details.

355 NSW DoI-Water (2019), *Draft Water quality management plan for the Barwon-Darling Watercourse SW12*, working draft provided to the Commission for information.

8 Access to low flows under the Plan needs to be revised

This chapter explains how several aspects of the 2012 Plan are contentious, outdated or poorly implemented, and should be revised as a priority if the Plan is to deliver better environmental and social outcomes. In particular, there are several provisions that allow access to low flows, such as the current cease to pump thresholds and rules that allow access when flows are imminent. Other provisions that could have provided important safeguards in the Plan have not been effectively implemented, such as IDELs and TDELs.

Implementation of cease to pump thresholds via daily pumping announcements has led to a risk of legal extraction below the cease to pump thresholds. Current Plan implementation also means held environmental water is unable to be effectively used.

There have been ongoing issues regarding inaccurate modelling of low flows. These should be resolved and expedited through the planned migration to 'Source' modelling software. DPIE-Water should incorporate both observed data and modelled scenarios when remaking the Plan, to ensure that outcomes are delivered based on best available evidence.

8.1 Cease to pump thresholds are based on outdated information

Planned environmental water is largely managed via two mechanisms: compliance with the LTAAEL; and via rules that govern access to entitlements, commonly referred to as the cease to pump rules. There are recognised issues and limitations with both of these approaches.

As stated in **Chapter 4.3**, the LTAAEL does not provide adequate protections for low flows as it only assesses annual take without accounting for when extractions occur and in which flow band. In a variable system such as the Barwon-Darling with natural flow extremes, the timing and source of extractions can be as, if not more, important than overall volume.

There are also concerns regarding the level of protection of low flows afforded under the current cease to pump rules due to their reliance on outdated information. The cease to pump rules are important as they set flow rates or levels below which take is not permitted for specific licence classes, therefore protecting ecologically significant flows, particularly in the low and cease to flow bands.

The current cease to pump rules were based on the 2000–01 environmental flow rules. An endangered aquatic ecological community and many threatened species have been determined and listed for the Plan area since these flow rules were created. Based on the recommendations of the Interagency Regional Panel during Plan development, provisions were included for the amendment of cease to pump rules after five years of the Plan based on evidence of impact to threatened species.

These Plan provisions allow for amendment of existing flow classes, or establishment of new or additional flow classes, flow reference points and access rules after year five of the Plan for any management zone in the Barwon-Darling. The amendments can only occur after a study shows to the Minister's satisfaction that current access rules are having an adverse impact on an endangered aquatic ecological community or threatened species in that community. The provisions also set the following conditions; that the amendments:

- do not apply to domestic and stock access licences and local water utility access licences
- do not alter the LTAAEL under A, B and C Class access licences

- take in to account socio-economic impacts of the proposed rules
- take place after Ministerial consultation has occurred with government agencies.[356]

The Plan notes that changes to flow classes may be designed to:

- protect refuge pools and connectivity between refuge pools
- protect instream habitat values
- maintain or improve water quality
- allow longitudinal movement of native fish during spawning and recruitment periods to support recovery of endangered aquatic ecological communities in the Barwon-Darling, or an individual listed threatened fish species.

The Commission recognises that since the environmental flow rules were established in 2000-01, and since Plan development in 2012, there has been a considerable volume of work to understand the environmental values in the Barwon-Darling and the hydrological needs of these various values. Despite the clear evidence that low flows are critical to a range of threatened species, and that the current rules allow access to these flows, to the detriment of those species, the Plan amendment to adjust access rules has not been enacted.

8.2 The Plan is based on modelling that does not accurately reflect low flows

For the purpose of the review, the Commission made all requests for modelling and model scenario reports to DPIE-Water. It is the Commission's understanding that DPIE-Water acts as the custodian of the valley-scale hydrologic models used to inform water sharing plan development. As DPIE-Water models are used for Cap compliance purposes these have been peer reviewed by the MDBA, or on behalf of the MDBA by independent technical experts. Many of these reports outlining limitations and assumptions of the DPIE-Water model are publicly available or have been made available to the Commission for the purpose of this Plan review. Recognised issues with currently available models have been detailed below.

The Commission did not seek modelling data from WaterNSW. As noted in **Chapter 6.2.1**, after the draft public report was released, the Commission and WaterNSW are have been collaborating to test the expert hypothesis regarding the impact of diversions on stream flows downstream of Bourke. Modelling to test this expert hypothesis is in progress with WaterNSW. The limitations and assumptions associated with current models provided will need to be discussed including the duration of modelling run, disaggregation of diversions from annual to daily volumes and consideration of transmission losses. Further discussion will also need to determine the current peer review status of the WaterNSW model of the Barwon-Darling.

The current integrated water quantity and quality simulation model (IQQM) used for the Barwon-Darling system is used for two primary purposes:

- reporting Cap compliance to the MDBA
- undertaking scenario modelling to understand water use in the Plan and inform water management options and policies.

356 Act Part 12, Section 78 (Part 8 (b))

The modelling remains deficient in its ability to simulate low flows.[357] However, DPIE-Water have indicated that modelling issues associated with low flows are below the current cease to pump threshold.[358] While this does not significantly affect modelling of when irrigation take can occur, the inability to effectively simulate low flows or cease to flow periods is significant. These ongoing modelling limitations impact the ability to consider water management options and policies that address low flows and cease to flow conditions. It is critical that the modelling is updated to improve decision making in low flow and cease to flow conditions, when impacts to water quality, basic landholder rights and ecological functions are significant.

Current modelling scenarios that would benefit from updated modelling, including the resumption of flows rule (see **Chapter 9.1.4**), where current modelling may not sufficiently capture the higher losses incurred after an extended cease to flow event. Despite these shortcomings in the model, there is sufficient information available to develop a resumption of flows rule that will improve environmental outcomes, and this is currently being pursued by DPIE-Water. This information includes observation of ecological impacts of flows, observed losses after low or cease to flow periods, and well evidenced understanding of flow requirements to protect ecological values that assists in determining the volume of water that requires protection. However, a revised model that more accurately captures low flows and cease to flow periods may help adjust these rules based on more accurate data.

The Vertessy report also notes that the ability to evaluate the effects of extraction and environmental water releases is impacted by the lack of a current pre-development or 'natural' model run.[359] The existing natural model run finishes in 2009, which leads to uncertainty on the hydrological impacts of extraction under the 2012 Plan and recent climate conditions. Current ecological knowledge on the importance of low flows and the significant volume of observed data provides more than sufficient information and rationale to change water management rules like the cease to pump thresholds. However, an updated pre-development model is still important to demonstrate the impact of water diversions on hydrological flows. Updating the natural model run will additionally allow a comparison between current simulated flows and pre-development flows. This will show the effects of water use more broadly, including irrigator behaviour and level of development infrastructure.

The Commission understands that the current modelling shortcomings around accurate reflection of very low flow and cease to flow periods will be resolved and updated in the migration from the current IQQM to the 'Source' modelling software. The Commission supports expedited migration to 'Source' in recognition of the ongoing issues with the Barwon-Darling model and the intention of DPIE-Water to make these improvements to calibration of flow simulation in the migration to the new software platform. The Commission understands that the WaterNSW model uses the 'Source' modelling software. While the peer review status of the WaterNSW Barwon-Darling model is to be clarified, a key issue relates to the work undertaken to calibrate flow used in the model. The Commission notes that it appears to be inefficient for additional models to be generated in isolation where these cover similar functionality. There may be efficiencies gained if the modelling teams across DPIE-Water and

357 See Vertessy, R., Barma, D., Baumgartner, L., Mitrovic, M., Sheldon, F., Bond, N. (2019), *Independent Assessment of the 2018-19 fish deaths in the lower Darling – Final Report*, for the Australian Government, 29 March 2019. This point has also been recognised by DPIE-Water at the Stakeholder Advisory Panel and reflected in earlier reviews by Podger, GM., Barma, D. Neal, B., Austin, K. and Murrihy, E. (2010). *River System Modelling for the Basin Plan Assessment of fitness for purpose*. CSIRO: Water for a Healthy Country National Research Flagship. Canberra.

358 Advised by DPIE-Water.

359 Vertessy, R., Barma, D., Baumgartner, L., Mitrovic, M., Sheldon, F., Bond, N. (2019), *Independent Assessment of the 2018-19 fish deaths in the lower Darling – Final Report*, for the Australian Government, 29 March 2019.

WaterNSW work together to develop one model that can meet reporting, policy and operational requirements. The Commission also recommends that it would be in the public interest to have a single source of modelling and that such a source should be from within the agency responsible for planning, monitoring and evaluating, namely DPIE Water.

The Commission also supports increased use of observed data, which is extensive for the Plan area due to significant research efforts in the Barwon-Darling. Using observed data, such as observed flow data and ecological modelling, rather than sole reliance on modelling scenarios to predict outcomes, will result in improved decision making.

Further, DPIE-Water has indicated that it is seeking to incorporate climate change risk to water management outcomes based on DPIE-EES NARCliM climate modelling that will extend consideration of the historical record beyond the current 120 years of data (see **Chapter 13.2**). The Commission fully supports the consideration and inclusion of extended climate variability data and climate change projections in DPIE-Water's updated models for the Barwon-Darling.

The model has additionally been shown to have deficiencies when using it for the assessment of LTAAEL and Cap compliance. The current Barwon–Darling model used by DPIE-Water to report on Cap compliance received provisional approval by the MDBA, which was granted until 2015.[360] Although provisional approval was given, further recommendations for improvement of the model were made in relation to inflow data and estimation of end of system flows for monitoring of long term compliance.[361] Reporting has raised the need to further investigate options to improve estimates of return volumes of held environmental water and to improve Barwon-Darling model inflows.[362] Further, the MDBA in their submission on the draft report stated that a key risk to Basin Plan outcomes in the Barwon-Darling is the application of the appropriate Barwon-Darling inflows for the purpose of calculating the annual expression of the LTAAEL. As noted earlier in this Section, it is the Commission's understanding that improvements to calibration of flows will be carried across in the migration to the Source platform.

LTAAEL compliance should be used to manage the impact of any growth in extraction resulting from increased tributary inflows arising from environmental releases and reduced consumptive use under the *Basin Plan*. Additional inflows of held environmental water (water licences purchased and held for environmental purposes) from upstream tributaries may arise as a result of:

- targeted releases from upstream storages
- additional volumes entering the Barwon-Darling through buybacks upstream
- incidental and diffuse increases in flow from upstream tributaries, such as return flows from wetlands.

The incorporation of improved understanding of floodplain harvesting extraction volumes into the Plan model should be expedited to ensure extraction is appropriately accounted for and considered in the LTAAEL.

360 MDBA (2016). *Water Audit Monitoring Report 2011–2012. Report of the Murray–Darling Basin Authority on the Cap on Diversions*.

361 MDBA (2018). *Transitional Period Water Take Report 2016–2017 – Report on CAP Compliance and transitional SDL accounting*.

362 Turner G, Vanderbyl T and Kumar S (2019). *Final Report of the Independent Panel's Review of the Sustainable Diversion Limit (SDL) Water Accounting Framework*, https://www.mdba.gov.au/sites/default/files/pubs/Final-Report-Independent-Panels-Sustainable-Diversion-Limit_0.pdf

Improved transparency of LTAAEL reporting by DPIE-Water will help close the information and compliance loop.

The Commission recommends that DPIE–Water:

6 In remaking the Plan for 2023, DPIE-Water should:

a) Expedite the transition from IQQM to Source modelling to address issues with model capture of cease to flow and low flows.
b) Conduct an updated 'natural' model run to allow for the assessment of Plan rules on natural flow hydrology.
c) Ensure that Plan decision making incorporates observed data and modelled scenarios to deliver the best outcomes based on evidence and assessment of impacts.

The Commission suggests that:

B The Secretary of the Department of Planning Industry and Environment review institutional arrangements for modelling to avoid duplication and provide a single modelling service for government decision making.

8.3 The Plan allows extraction if flows are imminent

The Plan allows the Minister to provide access to low and no-flows for up to three weeks before an anticipated flow event for A or B Class licences (imminent flow rule), a provision unique to the Barwon-Darling Plan. The Commission understands that this rule was put in place to provide users with permanent plantings earlier access to water in instances where a delay of three weeks might mean loss of their plantings.

There are caveats around this rule, including that the Minister may not permit the taking of water if the Minister is of the opinion that '*granting access is likely to cause unacceptable downstream or local impacts on the environment or on other users*'.[363] Evidence indicates these flows are critical to maintaining river health and water quality and, as such, any take under these provisions would inevitably adversely affect the environment and downstream users.

The Commission is aware of this provision being activated on at least two occasions, in 2013 and 2015, as well as an application in 2013 that was refused.[364]

8.4 Unlimited carryover and 300 percent take rules are contentious

Plan rules set annual extraction limits for A, B and C Class licences at 300 percent of their share component, plus net allocation trade. The rules also allow for unlimited carryover of unused water from one year to the next.

The Commission recognises that rules need to be flexible to accommodate water users in a variable river system like the Barwon-Darling. However, we found that non-irrigator stakeholders see these rules as evidence of preferential treatment of the irrigation industry.

363 See Plan Division 2, Section 48 (3) and Section 49 (3)
364 Advised by the expert panel and WaterNSW pers comm.

Some submissions raised concerns that these rules allow irrigators to accrue their annual entitlement during periods of low flow and extract relatively large volumes from the river when flows first become available. Other stakeholders feel aggrieved that the 300 percent take rule was put in place after the public consultation period for the Plan had closed and view the process as lacking in transparency. There is support among some stakeholders for the original provision in the draft Plan – 450 percent use over three consecutive years – as this had been modelled by DPIE-Water to have little effect on irrigation take or flow events (see also **Chapter 9.1.6**).[365]

There is evidence to indicate that the changes to these rules have contributed to impacts on low flows, including extension of cease to flow periods, which were not envisaged at the start of the Plan (see **Chapter 6.2**). The extension of cease to flow periods is likely due to several factors but, as highlighted in the Vertessy report, has been exacerbated in recent times by extraction by A Class licenses at low flows. The unlimited carryover rule has been reported to have contributed to increased extraction in lower flow years, effectively prolonging low flow periods downstream of extraction points.[366] The new Plan should be developed to appropriately manage water under observed conditions over the past thirty years.

DPIE-Water has recently made some proactive changes to limit excessive extraction under these provisions. Before 2018, licensees could legally extract more than 300 percent of the total share component of a licence class by trading allocation assignment water accrued in previous years. For example, in 2016–17, A Class extraction was 331 percent of the total share component for the licence class, over the intended 300 percent take limit. In 2018, the 300 percent plus net allocation trade rule was amended under the *Water Management Amendment Act 2018* to ensure that the 300 percent limit would include both water extracted and traded out of an account in the future.

The Commission is aware that occasionally accounts were taken into negative balance. This was often as a result of poor record keeping coming to light once extraction is reported (either self-reported or read by WaterNSW). More frequent reporting of water use under the recent metering reforms should bring these issues to light earlier (including the use of telemetry in specific circumstances). Available data indicates that over-extraction (taking accounts into negative balances) may have also contributed to the high level of A Class take (331 percent of the total share component) in 2016–17. WaterNSW advised that licensees were required to correct any negative balances (for example, via a water trade), and compliance matters are now to be handled by the Natural Resources Access Regulator. The Natural Resources Access Regulator is investigating negative balances identified by the Commission in this review.

The Commission considers that further review and amendment of these provisions is required, see **Chapter 9.1.6** for details.

8.5 There has been an increase in entitlements under the Plan

There has been a nine percent overall increase (15,572 ML) in the total amount of A, B and C Class share component in the river system since the commencement of the Plan in 2012–13.

365 DPI Water (2017). *Barwon-Darling annual take limit – model scenario report*. Presented to the Stakeholder Advisory panel.

366 Vertessy, R., Barma, D., Baumgartner, L., Mitrovic, M., Sheldon, F., Bond, N. (2019), *Independent Assessment of the 2018-19 fish deaths in the lower Darling – Final Report*, for the Australian Government, 29 March 2019.

The Commission understands this increase is the result of shares issued to A, B and C Class licences in 2014 due to the increases in the Barwon-Darling Cap to reflect 1993–94 diversion levels.[367] It is noted that the available water determination[368] was set at 1.09 ML for the 2013–14 and 2014–15 water years, and adjusted to 1.0 ML for 2015–16 and each subsequent water year in line with the Plan. It is unclear if the available water determination was higher before 2013–14. Increased entitlement and changes to available water determination do not necessarily result in increased extraction, as these are managed through account management rules and LTAAEL compliance.

The Commission understands that concessional conversions should not have resulted in an overall increase in the number of shares. The conversions only changed the numbers of shares in each class, as shares were taken from one class and an equal number added to another.[369] Given this, concessional conversions explains the shifts in A, B and C Class share component units. The Commission has not yet received data to confirm the number of concessional conversions that occurred over the Plan period.

The increase in A, B and C Class share component has resulted in differential increases in the percentage of share component across individual river sections over the last seven years. For example, A Class share component increased by 32 percent (272 ML) in River Section 2 (Walgett to Brewarrina). While the percent increases are relatively large, the volume changes are relatively small when compared to total share component for each licence class. However, given the increasing pressure on the system from drought and reduced tributary inflows (see **Chapter 6.2**), when low flows are not being appropriately protected even minor increases in entitlement are potentially a cause for concern.

In analysing the data presented in this chapter, the Commission observed discrepancies in the number of share components between data sources including the gazetted Plan, Background Document, Water Register and internal data provided by DPIE-Water. These discrepancies should be rectified by DPIE-Water, particularly for publicly available datasets to ensure transparency in how water is allocated in the system.

8.6 Implementation issues have contributed to low flow take

8.6.1 Individual and total daily extraction limits were not implemented

The Plan currently allows for the introduction of individual daily extraction limits (IDELs) and total daily extraction limits (TDELs). These important extraction limits have not been set by DPIE-Water to date.

IDELs limit the amount of water a licensee can take in a given day. The Commission understands that a provision allowing for IDELs to be implemented was included in the Plan to mitigate the impact of allowing a conversion to significantly larger pump pipe diameters for A Class licences. The Plan background document indicates:

> *In the Barwon-Darling Unregulated River water source, individual daily extraction limits (IDELs) are intended to provide a mechanism to limit extraction rates to those currently [2012]*

367 DPI Office of Water (2014). *Media release – changes to licences for Barwon-Darling water users*. Available at http://www.nswic.org.au/pdf/water_allocation/141210_Barwon%20Darling.pdf.

368 The available water determination informs water users of their allowed extraction volume per share (issued on 1 July, and periodically through the year). That is, it notifies licenced water users of their water allocation.

369 Advised by DPIE-Water, via email 30 August 2019.

> *permitted through authorised pumps, thereby allowing a free and opening trading regime whilst limiting third party and environmental impacts.*[370]

TDELs can be implemented to limit the total amount of water extracted across the system, or in portions of the system, in a given day.

The failure to limit daily extraction through IDELs and TDELs in combination with the changed pump size rules has allowed for a significant increase in the volume of water that A Class licence holders can take at a given time, contributing to negative environmental and social impacts.

8.6.2 Daily announcement of pumping thresholds allows take below cease to pump thresholds

The Barwon-Darling is operated through a daily review of the river level, as opposed to the use of 'live' cease to pump thresholds. At present, WaterNSW makes a daily announcement indicating if the water is above the cease to pump threshold.

Following a commence to pump announcement, licensees are allowed to continue pumping until a subsequent daily check indicates that the cease to pump level has been reached. Depending on when the water level drops below the cease to pump before the next daily check, licensees may in practice have been pumping well beyond the cease to pump threshold. This is particularly concerning given licensees ability to take significant volumes of water quickly under the current pump size, carryover and 300 percent take rules. Anecdotal evidence including from irrigators themselves is that they could conceptually 'pump the river dry' legally in these times.

370 NSW Office of Water (2012), *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources: Background document*, NSW Government, Sydney.

9 Changes to the Plan will improve environmental and social outcomes

This chapter summarises a range of core recommendations to amend the Plan to help improve environmental and social outcomes. Based on the findings of this review, the Commission proposes the following actions:

- **protecting low flows** – by:
  - updating cease to pump thresholds
  - implementing IDELs and TDELs
  - implementing resumption of flow rules
  - removing imminent flow rules
  - changing the 300 percent take and unlimited carryover provisions
  - supporting Commonwealth and NSW Government efforts to secure A Class licences to reduce extraction pressure
- **implementing active management** – to protect held environmental water both within the Plan area and from upstream, and to improve adherence to cease to pump thresholds
- **focusing on water quality** – by updating water quality objectives and developing targets, and improving the water quality management and reporting framework
- **enhancing connectivity across the Northern Basin** – by including, updating and implementing provisions enabling the *Interim Flow Plan*; protecting environmental water; reviewing rules in upstream plans; identifying complementary actions to enhance resilience of the system; and implementing state-wide *Reasonable Use Guidelines*.

9.1 Low flows need to be protected through revised Plan provisions

9.1.1 Cease to pump thresholds need to be updated

Chapter 8.1 outlined the current issues regarding the outdated cease to pump thresholds. Cease to pump thresholds should be revised to ensure they protect the environmental assets in the Barwon-Darling and their ecological needs.

The current Plan includes criteria under which cease to pump thresholds can be adjusted (see Part 12, Section 78 (Part 8 (b))). The Commission views that the delivery of critical low flows outlined in this chapter, and the outcomes that these flows will achieve, is consistent with the Plan's criteria to justify adjusting the cease to pump thresholds.

Identifying critical ecological needs of the Barwon-Darling

The draft *Long Term Water Plan* represents the most recent documentation of the objectives and environmental water requirements of: assets including:

- assets including native fish, native vegetation and waterbirds
- priority ecosystem functions (including instream, floodplains and wetland habitats).

The environmental water requirements in the draft *Long Term Water Plan* were developed by identifying groups of species with similar watering needs, and determining how to meet each group's collective asset objectives. The draft *Long Term Water Plan* identifies 49 environmental

objectives and 10 environmental water requirements. Noting that this is a draft version, the Commission's initial analysis highlighted that some targets did not identify specific flow requirements. We also noted that DPIE-EES, DPI-Fisheries and DPIE-Water need to progress work to highlight the critical flows and identify the most significant risks if they are not met.

While the Commission recognises that all low flows (very low flows and baseflows), as well as small freshes are important, we engaged experts to provide advice and assist with determining essential flow requirements. Significant risks to ecological assets and functions may occur if these essential flow requirements, deemed 'critical low flows', are not met.

Critical low flows are essential to provide the minimum environmental flows to maintain species and ecosystem health, specifically:

- maintaining the flow required for movement of specialist fish such as Murray Cod (vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999*)
- improving spawning in Olive Perchlet (endangered population under the *Fisheries Management Act 1994*)
- maintaining low-level habitat that is important for fish species, river mussels and river snails (critically endangered species under the *Fisheries Management Act 1994*)
- suppressing algal growth and maintaining connectivity between refuge pools and riffles.

The hydrologically variable nature of the Barwon-Darling system complicates identification of specific timing and duration of flows needed to meet essential flow requirements.[371] In contrast to the southern Basin, it is comparatively very difficult to deliver flows of a particular magnitude and duration at specific times in the year, as currently identified in the draft *Long Term Water Plan*. To ensure that the needs of the environment are met, rules need to be established that protect these flows if and when they occur.

Cease to pump thresholds are the key flow protection mechanism in an unregulated plan. In the Barwon-Darling Plan the cease to pump thresholds are a primary determinant for the delivery of planned environmental water.

Determining revised cease to pump thresholds

The inputs to the Commission's draft report focused on peer reviewed literature to determine the essential flow requirements, mapped these to flows in the draft *Long Term Water Plan* and used these to develop revised A Class cease to pump thresholds. As peer reviewed literature is only available for some gauge points, on-ground verification was needed to expand this method across the whole river. This was a significant challenge that would have prevented the immediate protection of critical low flows. Following the Commission's release of the draft report, additional work was undertaken to develop a method that can be applied immediately across the Barwon-Darling.

The Commission adopted a globally accepted approach to ensure a robust and transparent method that aligns with those in the draft *Long Term Water Plan* and can be applied across river gauges to assign cease to pump thresholds. The hydraulic habitat method, which is a type of hydraulic ratings method, calculates the minimum environmental flows to maintain species and

371 Puckridge, J.T., Sheldon, F., Walker, K.F. and Boulton, A.J. (1998), Flow variability and the ecology of large rivers, *Marine Freshwater Resources*, vol.49, pp.55-72.

ecosystem health.[372] It was used to determine the minimum flow requirements for ecologically critical habitats (critical low flows) and the revised cease to pump thresholds described below and recommended in **Table 15**.

Comparing the minimum flow requirements with current A Class cease to pump thresholds indicates current A Class extractions will impact on critical low flows. Specifically, the A Class cease to pump thresholds impact the very low flow and baseflows at Brewarrina, Bourke and Wilcannia. This is significant as A Class extraction, which impacts on the very low flow and baseflows, has generally been concentrated in the river section immediately upstream of Bourke over the Plan period.

The Commission recommends amending the cease to pump thresholds to address the current extraction of critical low flows and better provide for the minimum environmental flows to maintain species and ecosystem health. This would raise the A Class cease to pump thresholds to those identified in **Table 15**. The proposed limits protect the entire very low flow range and 10 percent of the baseflow range.

Table 15: Current cease to pump thresholds for A and B Class licences and Commission recommended A Class cease to pump thresholds at select Barwon-Darling gauges

	Discharge at a selection of gauge stations (ML per day)				
	Walgett	**Brewarrina**	**Bourke**	**Louth**	**Wilcannia**
Very low flows (as in **Table 10)**	95-320	100-500	105-500	70-450	30-350
Baseflows (as in **Table 10)**	320-700	500-1,000	500-1,550	450-1,500	350-1,400
Current A Class cease to pump threshold	600[373]	460	350	260	123
Commission recommended A Class cease to pump threshold (to protect critical habitat)	**358**	**550**	**605**	**555**	**455**
Current B Class cease to pump threshold	900	840	1,250	1,010	850

The Commission notes that even with the higher cease to pump levels, the Barwon-Darling may continue to experience cease to flow periods. Protection of very low flows and a portion of base flows will not result in continuous flow due to the hydrological variability of the river (see **Chapter 2.1**). However, the proposed changes will help protect these critical low flows when they occur and maintain the essential habitats for vulnerable and threatened species. The Commission has been consistent in the approach of revising cease to pump levels to protect the most critical low flows from the impacts of extraction to maintain species and ecosystem health.

372 Gippel, C.J. and Stewardson, M.J. (1998), *Use of wetted perimeter in defining minimum environmental flows*, Regulated Rivers: Research and Management, 14:53-67; and Arthington, A.H. (2012), *Environmental Flows: Saving Rivers in the Third Millennium*, University of California Press, 421pp; as referenced in Sheldon, F. (2019), *Technical review of the water sharing plan for the Barwon-Darling unregulated and alluvial water sources 2012*, advice to the Natural Resources Commission.

373 As discussed later in this chapter, the Walgett weir gauge A Class cease to pump threshold appears to have been set based on a different logic to the other gauges. The reasoning behind the relatively higher cease to pump (compared to baseflows) are unclear. DPIE-Water will need to determine the reasons for the historically higher levels of the Walgett weir cease to pump threshold and if this is required to protect other outcomes.

The hydraulic habitat method applied by the Commission has been peer reviewed and determined to be sound. Compared to the method proposed in the draft report, the hydraulic habitat method results in an increase in A Class cease to pump thresholds at all gauges except Walgett weir. As the Walgett gauge is within a weir, using the hydraulic habitat method may not be an appropriate method to revise the cease to pump thresholds as other requirements such as town water supply needs and weir pool stratification prevention, may impact on the flow levels needed at this point. The Commission recommends that DPIE-Water should determine appropriate A Class cease to pump thresholds for gauges not included in this review and re-assess any unique requirements of the Walgett weir gauge. The method outlined in this chapter will assist DPIE-Water in developing suitable cease to pump thresholds across river gauges**.**

Further adjustment of cease to pump thresholds in 2023 if necessary

Some licences have access to flows below A Class cease to pump thresholds, including domestic and stock licences, local water utility access licences and basic land holder rights, or as outlined in Schedule 2 and 3 of the Plan. These licences will impact on essential flow requirements between cease to flow and low flows. Potential adverse impacts on the environment from such pumping should be monitored after adjusting A Class cease to pump thresholds to determine if additional changes are warranted in the Plan remake. The Commission also supports the development and implementation of the *Reasonable Use Guidelines* for basic landholder rights (see **Chapter 9.5.1**) to ensure this take is consistent with what should be allowed and can be reasonably estimated.

The Commission notes that the timing of extraction impacts the rate of drawdown of river levels, however this may be more appropriate for impacts within the B Class licence band. Where pumping occurs on the recession curve[374] of a small or large pulse event, this increases the rate of drawdown, which then impacts river bank erosion.[375] As highlighted in **Section 3.1.2** larger pump sizes attached to A Class licences have led to faster rates of extraction. However, insufficient evidence is available at the current time to comment on river bank erosion and the current timing of extraction in the A Class flow bands. Upgrades to monitoring and metering enable further assessment of the timing of these impacts. The Commission notes that changes recommended by this review including implementation of IDELs and revised cease to pump thresholds may mitigate any impacts where pumping on the recession curve of an event occurs.

The Commission further recognises that changes to cease to pump thresholds, may result in a shift in extraction to B Class flow ranges. Greater extraction of B Class flow may impact the small and large freshes flow band and environmental outcomes achieved through these flows. It is the Commission's view that it is essential to protect critical low flows as enacted through the revised cease to pump thresholds for A Class licences in the first instance. However, the Commission supports monitoring changes to extraction behaviour and essential flow requirements to determine if B (or C) Class flow targets are consequently having an impact on environmental outcomes that needs to be considered in the 2023 Plan remake.

374 Recession curve is a hydrograph show the decreasing rate of runoff following a period of rain or snow melt. Since direct runoff and base runoff receded at different rates, separate curves, called direct runoff recession curves or base runoff recession curves, are generally drawn. Taken from Langbein, W. B. and Iseri, K. T. (1960). *General introduction and hydrologic definitions. Manual of Hydrology: Part 1. General Surface-Water Techniques.* Geological survey water supply paper 1541-A.

375 Advised by Thoms, M. peer review.

The Commission recommends that DPIE–Water:

7 Implement enhanced flow targets, with a particular focus on protecting low flows, to better deliver environmental and social outcomes, including:

a) Adopting the revised flow targets specified in **Chapter 9.1.1** of this report, or a similar set of targets based on best available information that can be demonstrated to meet riverine ecosystem, water quality and basic landholder needs.
b) Raising the cease to pump level for A Class licences to be consistent with the newly established flow targets.
c) Reviewing and updating the cease to pump thresholds for all access classes for the 2023 remake based on analysis of performance under the amended Plan, and best available information regarding any impacts on flow targets.
d) Assessing the impacts of current water use under B Class licences, considering observed data and information on actual user behaviour, against sustainable flow targets to be established for the new Plan.

9.1.2 Implement individual daily extraction limits (IDELs)

The Plan currently includes provisions for implementing IDELs. DPIE-Water has already expressed the intent to introduce IDELs following the Ken Matthews report and has general agreement from the Stakeholder Advisory Panel to do this. IDELs help protect low flows, freshes and resumption of flows and if implemented effectively would:

- contribute to more equitable sharing of water flows in each licence class available for take
- improve inequity between upstream and downstream users by maintaining connectivity flows below Bourke
- help mitigate risks identified in the water risk assessment for the Barwon-Darling. The *Basin Plan* requires mitigation strategies to be implemented to reduce the risk to instream values and assets.
- facilitate a possible event based mechanism that can be used by environmental water holders to meet important flow targets as recommended by the *Northern Basin Review*.

The Commission supports the introduction of IDELs to:

- reduce diversion rates to those permitted before the introduction of the Plan (such as A Class licence extraction restricted to the equivalent of 150 mm pump extraction)
- place daily extraction limits on A, B and C Class licences that apply at all times.

IDELs will effectively extend the number of pumping days required for licence holders to extract their entitlement. According to modelling this will benefit the downstream flows achieved at Wilcannia and move diversions from drier years to wetter years.[376] The Commission recommends that IDELs are implemented as part of a package of rules including a resumption of flows rule and active management. The effectiveness of this package of rules, including IDELs, in achieving ecologically important low flows, freshes and first flushes and improving downstream equity should be assessed for the Plan remake, with adjustments to IDELs made as necessary.

376 DoI-Water (2018). *Barwon-Darling: Individual Daily Extraction Limits Option 4 and 6 – model scenario report.*

Trading of IDELs could result in significant consolidation of licenced extraction into a small number of pumping locations, and consolidation upstream, reducing the effectiveness of implementing IDELs. The *Basin Plan* requires that trade is facilitated where possible, but allows restrictions to trade where there may be impacts on environmental outcomes. The Commission is of the view that IDEL trade should be restricted at a minimum to within a river reach to mitigate potential negative environmental impacts.

9.1.3 Apply total daily extraction limits (TDELs) to help manage over extraction risks

Total daily extraction limits (TDELs) could manage the associated risk of over extraction from trading IDELs. DPIE-Water is considering if TDELs are necessary within management zones or river reaches. The Commission understands the current proposed approach is to have a TDEL for each river reach, comprised of the sum of all the IDELs. Trading would be restricted to ensure each reach remained within the TDEL.

It appears that the driver for TDEL establishment is mostly based on ensuring consistency with historic irrigator access. However, licence distribution has changed over the past decade and evidence indicates extraction of low flows before the 2012 Plan may have been unsustainable.

To better ensure achievement of environmental outcomes, a top-down approach based on sustainable extraction and connectivity is needed in the longer term. The Commission understands that DPIE-Water is considering options that may be able to achieve this.

There are a number of changes underway likely to affect both inflows into, and extraction within, the Barwon-Darling. Consistent with the MDBA submission's recommendation, the Commission supports establishing TDELs based on the sum of the IDELs by river reach as an immediate measure to limit consolidation. However, for the Plan remake DPIE-Water should analyse if changes to the TDEL limits are needed to better deliver the targeted environmental and social outcomes. This analysis should also consider wider northern basin connectivity issues.

The Commission recommends that DPIE–Water:

8 Implement Individual Daily Extraction Limits (IDELs) based on the allowable extraction rates that existed before removal of restriction on pump sizes for certain licence classes and implement Total Daily Extraction Limits (TDELs) for each river reach.

   a) Implement trade rules that limit trade of IDELs to maintain river reach TDEL. As a precaution, initially restrict trade to at least within river reach, with an allowance in the Plan to expand trade if no unacceptable or unintended negative impacts are identified from greater trade of IDELs.
   b) In the 2023 remake of the Plan, implement TDELs based on consideration of system connectivity and best available evidence regarding any necessary changes to the TDEL to meet the flow rates that would protect the ecosystems targeted by the Plan.

9.1.4 Implement rules to protect resumption of flows

The Commission's analysis highlights how environmental outcomes are being impacted as a result of the Plan rules, including through extraction of resumption flows (also referred to as 'first flush' flows) once they pass the cease to pump thresholds. The Plan's reliance on passive

approaches allows consumptive users to take initial flows after a cease to flow event once they pass cease to pump thresholds, despite these being critical to ecosystem function (see **Chapter 6.1**). Extraction of these flows impacts on the ability of ecosystems to recover from cease to flow events and downstream flows.[377]

The government has recognised the need to protect the return of water after a cease to flow period and the Commission has recommended implementing a resumption of flows rule in the Barwon-Darling. Since the Commission's preparation of the draft report, DPIE-Water has clarified that work is well progressed to develop an approach to provide this protection. They advised that it will be incorporated into draft Plan amendments and released for consultation as part of the draft *Barwon-Darling Water Resource Plan* process. The approach is being developed based on flows reaching Wilcannia; accounting for tributary contributions and improving equity along the Barwon-Darling. This is good practice and will improve transparency around decision making.

Figure 21 illustrates how a resumption of flows rule would be 'triggered' when river flow has been below baseflow levels for a number of consecutive days and A, B and C Class licences would not be permitted to extract. When a flow event returns to the river, it would be protected from extraction from those licences until the top of the baseflow is reached at designated points. Once these requirements have been met, standard access rules would again apply.

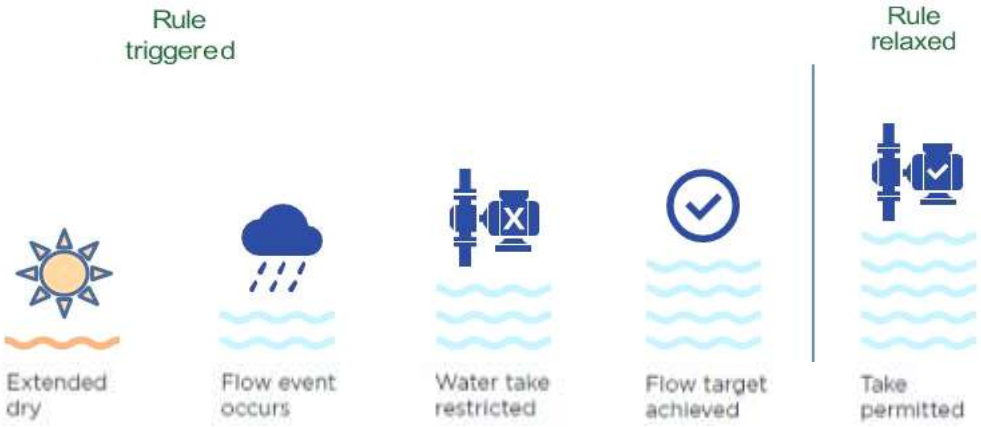

Figure 21: Schematic showing when a resumption of flows rule would be triggered and relaxed[378]

The aim of the resumption of flows rule should be to:

- protect critical low flows at environmentally and socially important times
- provide cultural benefits
- improve water quality during low flow periods
- provide flexibility within the rule to allow for equity among Barwon-Darling users
- minimise costs to water entitlement holders.

The Plan rules should be designed in line with the Act's principles. That is, to primarily achieve environmental outcomes, with a subsequent objective to protect basic landholder rights, and beyond this to minimise impacts to other extractive users. DPIE-Water has not fully quantified

377 Simpson P. (2017), *Barwon-Darling: low flow environmental watering impediments and opportunities*, report for Commonwealth Environmental Water Office.

378 Updated from DoI-Water (2019), *Resumption of flow in the Barwon-Darling*. Presented to the Stakeholder Advisory Panel, June 2019.

the benefits of the initial flows after a dry period due to difficulties in monetising its value for factors such as contribution to: town water supply; domestic and stock requirements; amenity; cultural practices; swimming, boating or fishing; and other direct and indirect economic uses. DPIE-Water advised that important benefits such as these are being considered. The Commission notes that a cost benefit analysis is only one tool in a decision making process. The Commission reiterates that if a cost benefit analysis is intended to be a primary decision making tool, it must be holistic in its assessment of benefits and impacts.

The Commission's review has highlighted the importance of protecting baseflows to achieve environmental and water quality outcomes (see **Chapter 6.1**). The baseflow values being used by DPIE-Water to develop the proposed approach were provided in a draft form by DPIE-EES while under review concurrently with DPIE-Water's work. DPIE-EES is updating the draft *Long Term Water Plan* flow bands to incorporate best available evidence. The Commission considers that the work being undertaken by DPIE-Water should reflect the baseflows in the draft *Long Term Water Plan*. The Commission acknowledges the evolving and collaborative nature of this work being undertaken by DPIE-EES and DPIE-Water under tight timeframes.

The Commission understands the DPIE-Water approach is based on MDBA reporting and considers water security at Wilcannia.[379] While a resumption of flows rule would protect the initial return of water to the river after a dry period, it may not benefit thermal stratification in weir pools beyond the first couple of days or algal suppression. The interflow frequency may not be adequate to avoid increased risk for aquatic fauna due to lack of flowing water, high temperatures and increased algal risk. To address these issues, the duration between cease to flow periods should not exceed one month in summer, or seven days if there are continuous hot days (over 40 degrees Celsius).[380] Temporary water restriction orders under section 324 of the Act may still be required on rare occasions to protect riverine ecosystems and downstream communities to help mitigate these conditions.

A flow volume of 20 GL at Bourke is required to achieve a very high likelihood of connectivity to Wilcannia,[381] with a 30 GL cumulative flow past Bourke estimated to connect to Lake Wetherell. However, it is unclear if these volumes will result in the baseflow being reached through to Wilcannia and achieve the desired outcomes of improving ecosystem and community recovery after cease to flow events. The Commission recommends that the total volumetric target should be based upon achieving baseflows.

The Commission notes that a resumption of flows rule is as a critical response action and should be part of a suite of measures including active management. The Commission recommends that over the next few years DPIE-Water should monitor and evaluate outcomes achieved through implementing the new approach to protecting critical low flows and, if necessary, make adjustments in the 2023 Plan remake to further progress positive environmental outcomes.

DPIE-Water should adopt a monitoring program to assess the benefits of Plan implementation on water quality including salinity, as well as pool stratification and algal suppression. The monitoring requirements may need to be increased in high risk conditions such as high

379 MDBA (2018), *Ecological needs of low flows in the Barwon-Darling; Technical Report*, MDBA; DoI-Water (2018). *Barwon-Darling water resource plan – first flush protection*, presentation to the Stakeholder Advisory Panel.

380 Mallen-Cooper, M. (2019*), Barwon-Darling Water Sharing Plan: opportunities to link ecology, river hydraulics, culture, and social values to meet the objectives of the Water Management Act*, discussion paper for the Natural Resources Commission.

381 MDBA (2018), *Ecological needs of low flows in the Barwon-Darling; Technical Report*, MDBA.

temperatures during low flow periods, to allow for sufficient time to mitigate impacts through existing measures such as temporary water restriction orders under section 324 of the Act.

The Commission recommends that DPIE–Water:

9 To protect critical environmental and social flows, DPIE-Water should:

a) Develop and implement Plan provisions that protect resumption of flows updated to be consistent with the baseflows defined in the publicly exhibited draft *Long Term Water Plan* and as described in **Chapter 9.1.4** of this report. This rule should contribute to prioritising outcomes in line with the *Water Management Act 2000*.
b) Evaluate outcomes before the 2023 remake and revise rules as necessary to achieve Plan objectives.

9.1.5 Imminent flow rules should be removed from the Plan

The Plan includes provisions granting access to water under specific circumstances during cease to flow and low flow periods (as defined in the Plan) if adequate flows are considered to be imminent (see **Chapter 8.3**). The Commission is of the view that given environmental and social outcomes under the Plan have generally been poor, it is likely that all access under this rule would exacerbate these negative outcomes. The current Plan has a requirement that the Minister may not permit the taking of water if the Minister is of the opinion that '*granting access is likely to cause unacceptable downstream or local impacts on the environment or on other users*'.[382] The Commission is of the opinion that applications under the imminent flow rule are likely to cause unacceptable downstream or local impacts on the environment or on other users. As such, this rule is inconsistent with the prioritisation required under the Act and the Commission therefore recommends that this rule is removed from the Plan.

The Commission recommends that DPIE–Water:

10 Revise Plan rules to help ensure that the flow targets can be met, considering the highly variable nature of the Barwon-Darling and potential impacts of climate change, including:

a) Eliminating the provision allowing for take of 'imminent flow'.

9.1.6 Unlimited carryover and 300 percent take rules should be revised

Many of the current concerns around the Plan's impact on low flows focus on changes made to A Class licence rules as a result of Plan implementation. The Commission understands that A Class licences were originally intended to allow access to small amounts of water for 'drought proofing', specifically to keep permanent plantings on riverside properties alive in dry periods. As such the original Barwon-Darling river management rules severely restricted pump size, required water to be used directly and not stored, and had limited carryover[383] and usage provisions. **Chapters 3.1** and **8.4** highlight that many of these protections have been relaxed under the current Plan, allowing increased access to low flows. Further, there is significantly

382 See Plan Division 2, Section 48 (3) and Section 49 (3)
383 From 2006–07 when entitlement volumes were reduced to a Cap share, irrigators were permitted to carryover any unused portion of their Cap share, subject to the limitations of their pre 2006–07 annual volume entitlement.

enhanced understanding of essential environmental flow requirements, indicating that A Class take is within the range of critical low flows.

Issues around the unprecedented level of access to flows provided through the combination of unlimited carryover and 300 percent take rules are explained in **Chapter 8.4**. As part of this review, the Commission engaged in discussions with DPIE-Water to see if further changes could be made to the unlimited carryover and 300 percent take rules to provide greater protection of critical low flows.

Unlimited carryover is not consistent with rules in other water sharing plans. While the Commission recognises the unique nature of the Barwon-Darling, it does not consider that the rules should be this divergent from standard practice. As a result, the Commission recommends that carryover be capped within the 2023 plan remake. DPIE-Water should undertake analysis to determine a reasonable cap. It is noted that licence holders were allowed to carryover very large account balances at the start of the Plan, allowing them to take significant water, while also continuing to carryover water, maintaining these high account balances. While the Commission recognises these account balances are not in and of themselves a risk to the environment, provided that the rules sufficiently restrict take, it is not viewed to be sound water management practice to continue to allow such large account balances to accrue.

Regarding the 300 percent take rule, DPIE-Water advised that amending the 300 percent annual take limit with unlimited carryover is unlikely to assist in protecting critical low flows or meeting environmental outcomes. It cited the results from a recent analysis that found that amending the rule to limit take to 300 percent over three years did not demonstrate any beneficial environmental outcomes when assessed against a number of flow requirements, but it did negatively impact on irrigators.

However, the Commission identified other modelling undertaken by the former DPI-Water in 2017 that trialled other potential lower extraction limits. One of the limits trialled was 450 percent over three years. This provision was originally included in the draft Plan before being removed in the gazetted version. The modelling found that this limit had little effect on irrigation take or flow events. Even though limited benefit to flows events was identified, this result suggests the current contention over the 300 percent take limit between irrigator and non-irrigator stakeholders may have been minimised if the original provision in the draft Plan had remained in place and had not been replaced by less restrictive extraction rules.

The Commission recommends that DPIE-Water replaces the 300 percent take rule with a rule allowing for 450 percent use over three years, in the 2023 remake of the Plan. The potential impacts of this both ecologically and for irrigators should be further assessed over the coming years with the limit adjusted in the Plan remake as appropriate. Analysis of impacts should be consistent with the prioritisation required under the Act.

The Commission recommends that DPIE–Water:

10 Revise Plan rules to help ensure that the flow targets can be met, considering the highly variable nature of the Barwon-Darling and potential impacts of climate change, including:

b) Analysing an appropriate limit on the carryover provision and replacing the unlimited carryover provision with a capped carryover provision in the 2023 remake of the Plan.

The Commission recommends that DPIE–Water:

c) Analysing an appropriate limit on annual take to replace the 300 percent provision in the 2023 remake of the Plan. As a starting point, the allowable annual take should be reduced to a rolling average of 450 percent over three consecutive years. The potential ecological impacts and impacts on water users should be further assessed, and the provision should be consistent with the prioritisation required under the Act.

9.1.7 Support government securing A Class licences to reduce extraction of low flows

As part of the response to the Vertessy report, in April 2019 the Commonwealth Minister for Water Resources committed to seek to secure A Class licences to protect low flows in the Barwon-Darling.[384] The Commission understands that the Commonwealth Government are considering several options to secure A Class licences including buybacks and is working with the NSW Government to develop a plan for how this could occur.

Many stakeholders have suggested a 'buyback' of A Class licences to remove concerns around pumping of critical low flows under this licence class. The intent of this action would be to reduce the allowable extraction during low flow events to help mitigate environmental and social impacts. There are several specific risks to consider when buying back A Class licences in the Barwon-Darling.

Firstly, while some submissions called for compulsory buybacks, the Commission understands that the proposed buybacks would be voluntary, consistent with Commonwealth government policy. In this case, it is critical that the large users are willing to surrender their A Class licences to achieve a meaningful reduction in take. The Commission notes that, as of 2018–19, five users control 56 percent of the total A Class share component. One licence holder holds 42 percent of the total A Class licence share component, and has accounted for a large portion of A Class water use since the licences were acquired.

Secondly, there is a high risk that users with active licences may sell their licences, then use the Plan's trade rules to purchase additional currently unused A Class licences, thus undermining the buyback. DPIE-Water have stated that 76 of the total 110 A Class licences are unused, representing 3,751 of the 9,856 (38 percent) A Class licence shares. In the water year with the highest number of active accounts, 2016–17, only 14 of the 110 A Class licences extracted water while the remaining 96 licences did not use any water.

On the other hand, a buyback scheme could reduce risks associated with potential compensation obligations arising as a result of changes to the Plan affecting A Class licences. However, the Commission has sought legal advice on this issue (see **Chapter 15**), and understands that nearly all of its recommendations regarding protection of flows would not require compensation.

The Commission supports the Commonwealth's initiative to secure A Class licences to protect low flows. The Commission also notes the proposal from NSW Irrigators Council and NBAN to secure A Class licences to protect Aboriginal water interests and values by using these to

384 Hon David Littleproud MP (2019), *Federal Government responds to independent report into fish deaths*, media release 10 April 2019, available at https://minister.agriculture.gov.au/littleproud/media-releases/vertessy-report.

establish and resource 'cultural flows' (see also further discussion in **Chapter 10**). Our view is that the option of a voluntary buyback has merit for both environmental and Aboriginal outcomes but will suffer from significant shortcomings if it is not done in tandem with rule changes. Appropriate restrictions on when water can be extracted by A Class licences should also be implemented to meet ecological and social outcomes in line with the Act. These modifications should be taken into account when establishing the market value of A Class licences.

The Commission recommends that DPIE–Water:

11 Support the work of the relevant Commonwealth department's efforts to secure A Class licences, including the option of voluntary buybacks, to reduce extraction of low flows.

9.2 Management is shifting from passive to active approaches

9.2.1 Passive river management is inadequate in the Barwon-Darling

The Plan should include active management across all licence classes to supplement the rules and protect:

- held environmental water entitlements in stream and from upstream
- flows below the cease to pump threshold
- resumption of flows.

If an unregulated river is being actively managed, a river operator will manage the system by:

- forecasting system flows (timing and volume)
- determining the volume of water to remain instream based on the Plan's access rules, and the active environmental water travelling through the system at the time
- determining the volume of water available for all interested unregulated licence holders (including unregulated held environmental water licences) based on factors such as estimated tributary inflows, Plan rules and expected system losses
- determining how water will be distributed among licence holders including calling for expressions of interest to enable licensees to indicate if they wish to extract
- notifying licence holders of the volume they can take and when they can take it
- determining the volume of active environmental water in-stream that will reach the next zone or water source.

Active management should protect held environmental water coming from upstream tributaries to the Barwon-Darling, as well as water available under Barwon-Darling held environmental water licences. **Figure 22** demonstrates this concept, where an example 150 ML per day of active environmental water is protected by the standard cease to pump thresholds for each licence class in scenarios two and three. In scenarios four and five, as flows pass the standard cease to pump, the river operator adjusts the cease to pump thresholds to continue protecting the environmental water. The access threshold for each entitlement class would have

to be changed requiring the river operator to clearly define the volume of active environmental water and non-environmental water in tributary inflows.[385]

Held environmental water from upstream should be protected throughout the Basin, and not re-regulated at the start of each plan area. The Commission understands that DPIE-Water is looking at options to protect held environmental water that is released to achieve environmental outcomes in the Barwon-Darling. Active management should also reduce the risk of take below cease to pump thresholds to protect planned environmental water currently provided for in the Plan, as outlined in **Chapter 8.6.2**. Water sharing plan rules should be amended as necessary to ensure that active management is implemented as soon as possible to protect all held and planned environmental water in downstream plan areas.

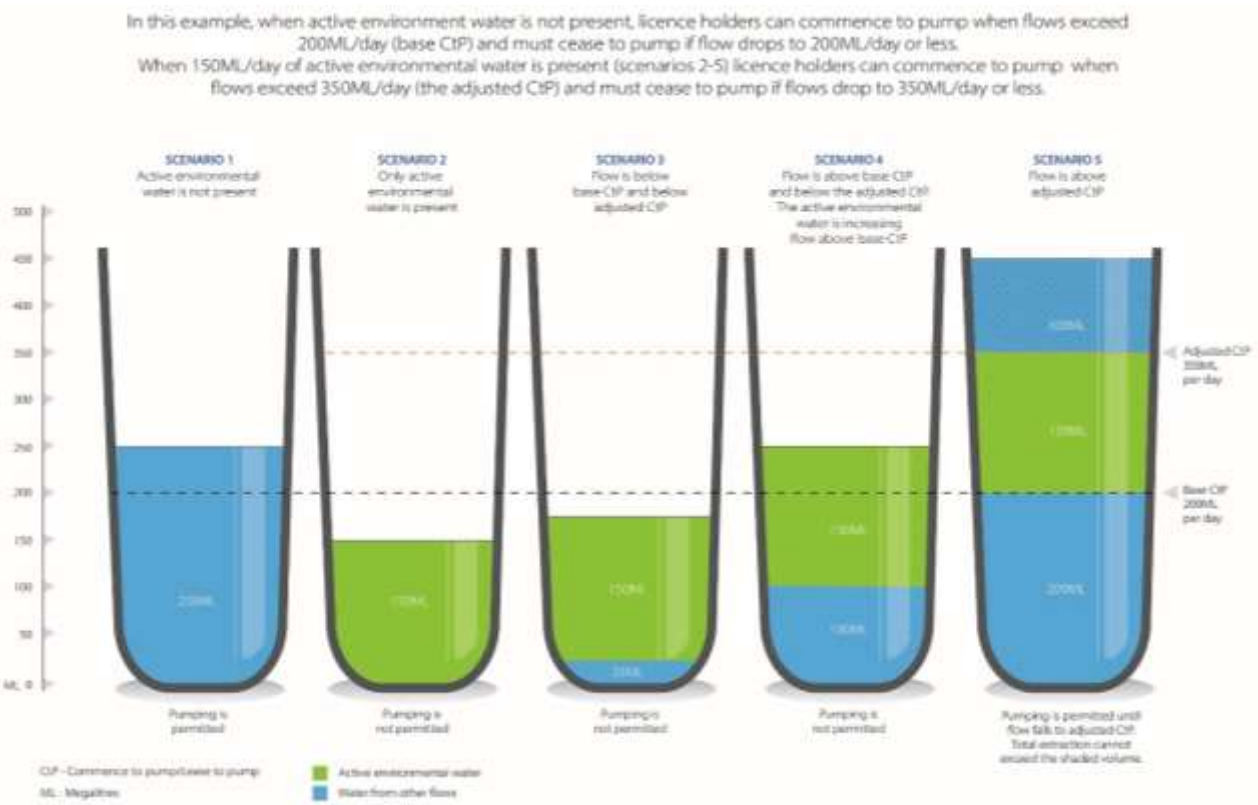

Figure 22: Schematic showing how active management could partition and protect held environmental water in-stream[386]

Some details of how active management will be implemented are still unclear. DPIE-Water will need to resolve the following implementation issues:

- how frequently should water availability be 'announced' (for example, every 12 or 24 hours)
- how will expected losses be estimated and shared
- how should the available water be allocated between users, including considering interactions with the implementation of IDELs
- how to manage uncertainty in flow forecasts
- who should bear the risk and costs of active management

385 MDBA (2019), *Active Management Case Studies Summary*, May 2019.
386 DPIE-Water Renewal Taskforce (2019), *Active management concept diagram*, provided 4 September 2019.

- how held environmental water originating in Queensland (beyond those in the regulated Border Rivers) will be accounted for into NSW.

These issues should be assessed taking into account the prioritisation required under the Act, as well as the revised environmental and social objectives and targets. The Commission also notes that successful implementation of active management depends on implementation of the necessary metering, gauging and information technology (IT) systems.

The Commission recommends that DPIE–Water:

12 Implement active management as soon as possible, applied to all flow classes and at all times, to achieve the full range of benefits, including:

a) Installing the metering, gauging and information technology (IT) systems necessary for effective active management as soon as possible to allow the transition to active management to proceed quickly and no later than the end of 2020.
b) Ensuring held environmental water within the Plan area and from upstream is protected.
c) Ensuring that the rules sufficiently allow for adaptive management by the river operators to adjust to new information about real time flows, such as loss estimates.
d) Implementing a monitoring, evaluation and reporting program that provides transparent, publicly available reporting on water allocated via active management and the estimated and gauged volumes of active environmental water protected and used instream.
e) Evaluating whether active management needs to incorporate consideration of basic landholder rights, domestic and stock, and utility take to ensure protection of held environmental water for the 2023 Plan remake.

9.3 Water quality is crucial to environmental and social outcomes

The Plan can provide water quality benefits via:

- cease to pump thresholds (see **Chapters 8.1 and 9.1.1**)
- IDELs (see **Chapters 8.6.1 and 9.1.2**)
- resumption of flow rules after extended dry periods (see **Chapter 9.1.4**)
- better protection of environmental water (see **Chapter 9.2**)
- flow targets (including targets in the *Interim Flow Plan*) (see **Chapter 9.4.1**).

However, improving the protection of low flows will only improve environmental and social outcomes if these flows provide water of a suitable quality to support both ecological functions and community uses. For example, social values like fishing, swimming and stock and domestic use rely on high quality water. It is therefore important to measure and manage water quality alongside flows. This does not currently occur, but should be required in any new Plan. This chapter outlines necessary improvements to help ensure that water quality objectives are clearly defined and met.

9.3.1 Water quality targets should be included in the Plan framework

As described in **Chapter 7**, DPIE-Water is developing a mandatory water quality management plan alongside the *Barwon-Darling Water Resource Plan*. This includes water quality objectives[387] for the Barwon-Darling, although the Commission notes that objectives previously identified by the community (for livestock water supply, visual amenity or cooked aquatic foods) have not been included in the early draft. The Commission recommends progressing this work through stakeholder engagement to ensure that objectives and indicators adequately reflect community values and facilitate a shared language for participation in plan development and implementation. The Commission understands that DPIE-Water are currently considering policy levers to help achieve water quality objectives[388] and suggests these are considered with respect to flow management and in conjunction with the suggested action in **Chapter 9.5.2**.

River flows, particularly low flows, and water quality are inextricably linked (see **Chapter 6.1.2**).[389] The impact of flow on water quality should be acknowledged and linked to Plan provisions via the revised strategies. The relationships between environmental values, water quality measures and their target values should be specified.

Water quality suitable for maintaining local ecosystems usually aligns with other water quality objectives relating to the uses people have for water, as these generally have lower quality thresholds than the aquatic species (noting that drinking water is treated before use). The relationship between the water quality measurements (for example pH, dissolved oxygen, total nitrogen) and the desired environmental value (for example swimmable, fishable) must be understood to enable reliable prediction based on monitoring.[390] This link must be clearly stated in Plan documents.

Water quality in dryland rivers, such as the Barwon-Darling, naturally changes over time and space. Developing and applying water quality targets is therefore complex. Guidelines should be developed for various flow bands using monitoring data and models incorporating flow, catchment and instream influences to help guide sustainable use and management. [391]

The Commission understands DPIE-Water is using the high level long term average water quality targets from the *Basin Plan* for three reaches of the Barwon-Darling, summarised in **Table 16**. However, the Commission is of the view that Plan indicators comparing changes in water quality should be more granular and specific than the *Basin Plan* targets. Potential SMART indicators to protect and maintain environmental social and economic values of the river could be:

- salinity does not exceed the 5 mS/cm threshold for severe impacts on most freshwater species 'x' percent of the time

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387 Water quality objectives consist of three parts: environmental values, their indicators and their guideline levels. For example, if an objective is livestock water supply (environmental value), the salinity and algae levels in the water (the indicators) must be below specified guidelines. The physical and chemical indicators and their guidelines are not the goal themselves, rather they demonstrate if environmental values such as amenity, suitability for domestic use or protection of aquatic ecosystems are met.

388 NSW DoI-Water (2019), *Draft water quality management plan for the Barwon-Darling Watercourse SW12*, working draft provided to the Commission for information.

389 The link between flows and quality is described in detail, for example in the Vertessy and Australian Academy of Sciences reports.

390 Department of Land and Water Conservation (2001), *Integrated monitoring of environmental flows: design report*, available at http://www.water.nsw.gov.au/__data/assets/pdf_file/0003/548805/imef_new_design_report.pdf.

391 Sinclair Knight Merz (2013), *Characterising the relationship between water quality and water quantity*, Department of Agriculture and Water Resources, Canberra

- salinity does not exceed the lethal threshold of 15 mS/cm 100 percent of the time including in representative pools along each reach below Louth.

Spatial spread and temporal incidence of water quality measures such as salinity and dissolved oxygen reaching sub-lethal or lethal levels should be included as indicators of Plan performance. As they stand, DPIE-Water's draft water quality objectives are inadequately specific or time-bound.

Table 16: *Basin Plan* water dependent ecosystem long term average water quality targets for the Barwon-Darling[392]

	Mungindi to above Collarenebri*	Above Collarenebri to above Bourke*	Above Bourke to below Wilcannia*
Turbidity	200 NTU	230 NTU	50 NTU
Total phosphorus	200 µg/L	250 µg/L	50 µg/L
Total nitrogen	1,000 µg/L	900 µg/L	500 µg/L
Dissolved oxygen	65-110%	85-110%	85-110%
pH	7.0-8.3	7.0-8.1	6.5-8.0
Salinity	End of valley target at Wilcannia main channel - median 389 µS/cm, 80th percentile 453 µS/cm and load of 576,400 tonnes/year[393]		
Temperature	Between 20th and 80th percentile values of natural monthly temperature		
Toxicants	The protection of 95% of species		

* River zone is described here to the nearest town for ease of interpretation

	The Commission suggests that DPIE–Water:
C	Revisit the NSW water quality and river flow objectives during community consultation to agree on currency of objectives and develop community understanding to improve participation in plan development and implementation.
D	Clearly state and communicate the link between water quality measurements (for example pH, dissolved oxygen, total nitrogen) and the desired water quality objectives (for example swimmable, fishable) in Plan documents
E	Develop and apply water quality targets for various flow bands using monitoring data and models incorporating flow, catchment and instream influences to guide sustainable use and management.
F	Address the costs or benefits of varying flows and water quality associated with non-extractive industries in any cost benefit analysis. Low flows and poor water quality should be considered from an economic as well as an environmental and social point of view, including costs of works to secure and treat water supplies.

392 Taken from DPI-Water (2015), *Assessment of the Basin Plan water quality targets in New South Wales*, available at https://www.industry.nsw.gov.au/__data/assets/pdf_file/0019/151174/Murray-Darling-Basin-Water-Quality-Targets-2007-12.pdf.

393 *Water Act 2007* (*Commonwealth*) Schedule B, Appendix 1 End of Valley Targets

9.4 Rules around connectivity across the Basin should be enhanced

As discussed in **Chapter 6**, most water in the Plan area comes from upstream inflows. It is therefore essential that in addition to the changes recommended for the Plan, DPIE-Water implements an integrated approach to managing the Northern Basin to address reduced inflows.

The Commission recognises that several initiatives, such as improved management of floodplain harvesting, improved gauging, metering and telemetry and active management in other unregulated tributaries should all assist in meeting the Plan objectives. Further, the *Basin Plan* itself, including the sustainable diversion limits and implementation of the *Northern Basin Toolkit*, should have a positive effect. These steps will be critical for enabling the Plan to fully meet its objectives and the Act's objects. The Commission recommends that additional steps should also be taken to address concerns around inflows as outlined in this chapter of the report.

As noted previously, these initiatives should not deter immediate steps from being taken to enhance the Plan itself.

9.4.1 Include and fully implement provisions enabling the *Interim Flow Plan*

The recent Vertessy report and the Academy of Sciences report highlight the need to recognise system connectivity in rules throughout the Northern Basin. The *Interim Flow Plan* was established in 1992, but it has not been meaningfully implemented since then, and has never been used in the life of the Plan.[394]. One performance report for the initial period of the operation of the *Interim Flow Plan* in 1992-93 was made available to the Commission via a submission to this review.[395] This report indicated that the drought conditions and low upstream river flows meant that some of the measures in the plan requiring large flow events could not be tested.

The primary objectives of the *Interim Flow Plan* were to better manage flows to achieve riparian flows, improve water quality by suppressing algae, and provide fish migration flows for the Barwon-Darling without severe adverse impacts on water users.[396] Each of these objectives had accompanying flow targets, specifically that access to unregulated flows will be managed to achieve:

- **riparian flows** - see **Chapter 3.3.3** for breakdown of these targets
- **algal suppression flow** - a flow of at least 2,000 ML per day for five days at Wilcannia from October to April inclusive, unless a flow of at least this size has occurred in the preceding three months
- **fish migration flows** - a flow of at least 14,000 ML per day in Brewarrina and, or 10,000 ML per day at Bourke for five days from September to February inclusive, unless such flows have already occurred in this period.[397]

394 Advised by DPIE-Water, via email 30 August 2019.
395 Department of Water Resources (1993), *Report on the Performance of the unregulated flow management plan for the North West for the period ended March 1993*.
396 Thoms, MC, Sheldon, F., Roberts, J., Harris, J., Hillman, TJ (1996), *Scientific Panel Assessment of Environmental Flows for the Barwon-Darling River*, report for the NSW Department of Land and Water Conservation.
397 Thoms, MC, Sheldon, F., Roberts, J., Harris, J., Hillman, TJ (1996), *Scientific Panel Assessment of Environmental Flows for the Barwon-Darling River*, report for the NSW Department of Land and Water Conservation.

Provisions enabling the *Interim Flow Plan* targets are included in the regulated river water sharing plans of some main tributaries (NSW Border Rivers, Gwydir Valley and Namoi Valley), which can restrict supplementary access in these tributaries if the downstream targets will be achieved. Due to technical and practical difficulties in implementing these rules, such as forecasting flow contributions from the upstream water sources required to achieve the specific downstream targets, these provisions have not been implemented.[398] The inclusion of these provisions in these upstream water sharing plans reflects the reliance of the Barwon-Darling on inflows and the importance of connectivity to its ecological functioning.

The Commission notes that the *Interim Flow Plan* had specific objectives and does not offer a complete suite of connectivity related rules to achieve broader outcomes in the Northern Basin.[399] However, the *Interim Flow Plan* is the only management tool currently available to facilitate flow event management across the Northern Basin, and it should be used as a tool to assist in meeting the Barwon-Darling Plan outcomes.

MDBA modelling has shown that *Interim Flow Plan* requirements were not met even when supplementary access was turned off over the 114 year modelling period, however implementation offered some improvement to flows at Brewarrina, Bourke and Wilcannia.[400]

The current provisions enabling the *Interim Flow Plan* should be updated based on best available information and trialled as soon as possible. This would likely serve to identify and address technical issues with implementation such as the need for improved gauging, predictive flow forecasting, and understanding of system losses. The Commission notes that steps are being taken to improve flow gauging across NSW (see **Chapter 5.2.1**). Upstream plans and the Plan itself should be amended as necessary to allow the routine implementation of updated provisions when the flow targets are not being achieved.

The Plan includes:

- a note under section 46 that a section 324 order may be made to meet the requirements of the *Interim Flow Plan* where it is in the public interest
- a provision to allow for Plan amendment to accommodate any amendment or replacement of the *Interim Flow Plan* if it meets certain restrictive criteria.

However the Plan does not include a provision to protect flows delivered through the *Interim Flow Plan* from extraction once they reach the Barwon-Darling.

The Plan should be revised and new provisions included to fully protect these flows without the need for an ad hoc section 324 order under the Act. Further, given the changes to A Class licences, the provision restricting extraction should apply to all flow classes. To align with the principles in the Act, the provisions should not prioritise avoiding impacts to extractive use over environmental outcomes or basic landholder rights. Consideration should also be given to *the Basin Plan* requirements, and the Northern Toolkit Measures.[401]

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398 As provided by DPIE-Water, and noted in NSW Office of Water (2012), *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources – Background document*, NSW Government.

399 Thoms, MC, Sheldon, F., Roberts, J., Harris, J., Hillman, TJ (1996), *Scientific Panel Assessment of Environmental Flows for the Barwon-Darling River*, report for the NSW Department of Land and Water Conservation.

400 MDBA (2013), *Effectiveness and Impacts of Interim Unregulated Flow Management Plan for the North West on the Northern Connected System, Draft Technical Report*.

401 MDBA (2016), *The Northern Basin Review: Understanding the economic, social and environmental outcomes from water recovery in the northern Basin*, available at https://www.mdba.gov.au/publications/mdba-reports/northern-basin-review-report

The Barwon-Darling does not have an end of system flow target. As part of the update to the provisions to enable the *Interim Flow Plan* outlined above, the algal suppression flow target should be reviewed and assessed for suitability as a periodic end of system flow target to meet environmental needs and improve social outcomes. The Commission recognises that a continuous end of system flow target is not appropriate or feasible for a highly variable, unregulated system with natural cease to flow periods like the Barwon-Darling. However, to acknowledge system connectivity, a periodic end of system flow target could be implemented in the Plan. This would be consistent with global practice of catchment management, rather than tributary management, and would be in line with NSW current practice in water management in other areas such as the Shoalhaven River system.[402]

DPIE-Water is currently updating the drafting of provisions related to the *Interim Flow Plan* in relevant upstream regulated river water sharing plans as part of the Water Resource Planning process. The draft plans for the Border Rivers and Gwydir have already been publicly exhibited.[403] The current versions of the relevant upstream plans have provisions that restrict or do not permit taking of water under supplementary water access licences when this is required to ensure outflows of the regulated river water source contribute to meeting the requirements of *the Interim Flow Plan*. The reasons given include the need to protect the passage of fish, suppress blue green algal blooms and provide for basic landholder rights.

In relation to the Plan, the Commission understands that DPIE-Water intends to retain the note referencing the flow targets, with a section 324 order as the means to protect flows. The Commission considers that the implementation of the *Interim Flow Plan* in the Barwon-Darling should be brought into the proposed active management framework (see **Chapter 9.2**) as soon as possible to improve transparency, decision making and clarity around extractive use.

DPIE-Water is currently working on development of draft MER plans as part of the water resource planning process. The intent is to assess how plan rules and the future use of held environmental water contribute to connectivity across the Northern Basin, which can then inform the Plan review prior to 2023. In addition, DPIE-Water is currently developing regional water strategies across regional NSW including the NSW Northern Basin regions. The Border Rivers, Gwydir and Namoi regional water strategies will inform the development of the *Western Regional Water Strategy* and provide an enabling framework to assist with the review of the targets and outcomes sought by the *Interim Flow Plan*.[404]

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402 Mallen-Cooper, M. (2019), *Barwon-Darling Water Sharing Plan: opportunities to link ecology, river hydraulics, culture, and social values to meet the objectives of the Water Management Act*, discussion paper for the Natural Resources Commission.

403 Relevant provisions in draft water sharing plans include:

- Clause 48 and Schedule 1 in the Draft Water Sharing Plan for the Gwydir Regulated River Water Source 2016 (amended 2019), available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0004/178780/gwydir-schedule-a-draft-wsp-regulated-river-surface-water-source.pdf
- Clause 61 and Schedule 3 in the Draft Water Sharing Plan for the Border Rivers Regulated River Water Source 2019, available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0010/206101/draft-nsw-border-rivers-wsp-regulated-river-ws-2019.pdf
- Note that the draft Water Sharing Plan for the Upper and Lower Namoi Regulated River Water Sources is not yet on public exhibition, the relevant clause in the Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Waters Sources 2016 is Clause 48.

404 As advised by DPIE-Water.

The Commission recommends that DPIE–Water:

13 To enhance connectivity in the Northern Basin to better achieve Plan outcomes:

a) Include, update and implement provisions in the Plan to enable an updated *Interim Unregulated Flow Management Plan for the North-West* to be implemented and protect flows from extraction by all licence classes. These provisions should be clear and transparent and not require a section 324 order under the *Water Management Act 2000*.
b) Revise Plan provisions as necessary to contribute to Plan objectives in the 2023 remake based on best available information.

The Commission suggests that DPIE–Water:

G To enhance connectivity in the Northern Basin to better achieve Plan outcomes:

a) Update the *Interim Unregulated Flow Management Plan for the North-West* based on best available information.
b) Improve consideration of connectivity across the Northern Basin by updating and implementing provisions of all relevant water sharing plans enabling an updated *Interim Unregulated Flow Management Plan for the North-West*.
c) Undertake necessary enhancements including gauging and tools for estimating losses as required to facilitate implementation.

9.4.2 Review rules in upstream plans

The Commission understands that the upstream Gwydir and Lower Macquarie unregulated plans have been (or will be) amended to allow for active management (see **Chapter 9.2**), consistent with the Barwon-Darling Plan. Further, Border Rivers, Gwydir and Namoi regulated river plans already allow for implementation of provisions enabling the *Interim Flow Plan*.

Beyond including, updating and implementing provisions to enable the implementation of the *Interim Flow Plan* the Commission supports a more integrated approach to the management of the Northern Basin. DPIE-Water should take steps to address any findings from the *Northern Connectivity Stocktake* to improve connectivity between Northern Basin water sharing plans. This should include consideration of equity between plans and review of any rules that are leading to a failure to meet the prioritisation specified in the Act. Plans should also clearly allow for the protection of held environmental water from upstream plans. Held environmental water would historically have been extracted within the plan area from which it is released and therefore would not have been available for extraction downstream. Protecting held environmental water will ensure all licences of the same classes are treated equally.

9.5 Complementary actions are needed to improve outcomes

9.5.1 Finalise and implement the *Reasonable Use Guidelines*

The Commission recommends that DPIE-Water, via the Water Renewal Taskforce, should finalise the *Reasonable Use Guidelines* by the end of 2020.

The *Reasonable Use Guidelines* are essential for ensuring that basic landholder rights are clearly defined and can be enforced. Guideline implementation will improve estimation of basic landholder right take from the system, facilitating the modelling and management of the system. Without these guidelines it is extremely difficult to enforce compliance of basic

landholder rights and ensure that water is not being taken beyond what is intended under these rights. This is a significant gap in the water allocation rules and compliance management.

Government has been indicating for over a decade that they would implement these guidelines to enhance transparency, compliance and equity. DPIE-Water committed to finalising and implementing *Reasonable Use Guidelines* as part of the Water Renewal Taskforce activities. In the all state Stakeholder Advisory Group meeting in mid-2018, DPIE-Water indicated a commitment to do this beginning in July 2019. However, the Commission has more recently been informed that Government may no longer be committed to this action.

It is essential that the guidelines are finally developed and implemented across NSW. In making the 2023 Plan, DPIE-Water should update estimates and modelling to reflect extractions under the *Reasonable Use Guidelines.*

	The Commission suggests that DPIE–Water:
H	Finalise and implement the *Reasonable Use Guidelines* by the end of 2020 so that basic landholder rights can be better enforced and properly estimated for each water sharing plan.

9.5.2 Commit to additional actions to improve habitat and ecosystem resilience

A healthy, resilient riverine ecosystem is dependent on several factors and their interplay. Much of the discussion of this report has focused on the importance of flow, especially low flows. Habitat management is likewise integral to achieving the desired environmental outcomes. Both elements need to be managed together as part of wider integrated catchment management. This management extends beyond in-channel habitat to include the riparian zone and the wider floodplain. The whole system, its drivers and threats must be managed together.

The importance of complementary measures and actions that extend water management beyond flow considerations was recognised in the recent MDBA *Northern Basin Review* through the introduction of a series of toolkit measures. The toolkit measures include (but are not limited to):

- enforcement of new rules to allow for protection of environmental flows to enhance low flows and fresh flows
- targeted water recovery
- coordinated release of environmental water across the northern basin
- targeted environmental works to promote fish movement and habitat including the construction of fishways.

The Australian Government will provide up to $180 million to assist the NSW and Queensland Government with implementation of environmental works and measures.[405] The importance of fishways to ensure fish passage is documented later in this chapter.

Further in channel mechanisms that improve environmental outcomes include habitat restoration to improve low flow refugia and in channel complexity.[406] The Commission

405 Department of Agriculture (2018), *Delivering environmental works and measures for the northern basin*, http://www.agriculture.gov.au/water/mdb/basin-plan/commitments/environmental-works-measures.

406 Advised by Thoms, M. peer review.

understands that projects have been previously undertaken to improve in-channel habitat within the Barwon-Darling

Efforts to improve riparian zone and floodplain habitats will help enhance river health and allow it to tolerate greater shocks. Such management includes preventing pollutants such as sediment and nutrients entering waterways through land, soil and vegetation management.[407] Improvements in riparian condition also generate further benefits through shading of river channels. The interconnectivity between broader environmental management, water quality and river health is recognised in the *Basin Plan*.

Outside the Plan, water quality and habitat can be improved and ecosystem resilience increased by:

- maintaining groundcover
- vegetating buffer strips
- good agronomic practices
- managing riparian vegetation areas to reduce stream bank erosion and improve shading
- reducing presence of feral species (carp and pigs) which increase turbidity
- improving fish passage and habitat.

Such complementary measures should be examined as part of broader catchment management efforts across the Department of Planning, Industry and the Environment. Key agencies include DPI-Fisheries, DPIE-Water, Local Land Services, DPIE-EES and the Biodiversity Conservation Trust. DPI-Fisheries is responsible for providing Habitat Action Grants to deliver small scale on-ground actions to improve fish habitat and recreational fishing in NSW, as well as compliance and research services for habitat management. DPIE-Water is currently preparing *Regional Water Strategies*, noting that the *Western Strategy* is due for release in 2020. If suitably funded these strategies could provide the framework to not only deliver water security but also improved environmental outcomes.

Integrated catchment management is not a new concept. However, funding for integrated catchment management through investment programs National Landcare Program 2 and Catchment Action NSW has been significantly reduced by the Commonwealth and NSW Governments. This has happened in part because governments have invested in iconic sites such as the Great Barrier Reef or created new programs such as DPIE-EES's Saving Our Species. The Ministerially approved Western Local Land Services *Local Strategic Plan* contains several actions aimed at improving instream habitat, connectivity and water efficiency for irrigators.[408] These actions to date have not received sufficient investment to achieve the desired riverine outcomes.

New organisations such as the Biodiversity Conservation Trust also play an important role in investing in private land conservation and restoration of priority riparian vegetation corridors. The Barwon-Darling riverine corridor is recognised as being in the second highest priority

407 NSW DoI-Water (2019), *Draft Water quality management plan for the Barwon-Darling Watercourse SW12*, working draft provided to the Commission for information.

408 Western Local Land Services (2016), *Western Local Strategic Plan: 2016-2021*, available at https://western.lls.nsw.gov.au/__data/assets/pdf_file/0005/657986/Western_local_strategic_plan.pdf

classification under the NSW Government *Biodiversity Investment Strategy*.[409] However there has been no conservation investment in the Western Biodiversity Conservation Trust region to date. The Commission notes that the *Biodiversity Investment Strategy* is in its first year and understands that investment is planned for these regions in the future.

Many solutions outside water sharing can help deliver water sharing plan outcomes. For example, off stream storage for town water would reduce reliance on low flows that are critical for downstream environmental outcomes. Such opportunities should be examined as part of the development of integrated *Regional Water Strategies*.

The Vertessy report also highlights several factors contributing to the recent fish deaths just downstream of the Plan area. One of these was the inability of fish to move past the weirs. The risk of being unable to meet drown out flow requirements to overtop Bourke Weir (enabling fish passage) has been identified as being a high to very high risk under climate change.[410] Improved fish passages should be constructed to assist fish migration as identified in the Vertessy report, the 1996 *Scientific Panel Assessment of Environmental Flows for the Barwon-Darling River* and numerous reports between.[411] CSIRO has also identified fish passage as a high to a very high risk under climate change projections to 2030 as there are sizeable reductions of inflows that will result in weirs not being drowned out (see **Chapter 13**).

As outlined in **Chapter 7.2.3**, in very low flows and cease to flow the present fixed-crest weirs create an airspace as the water is pumped out. The airspace enables capture of low flows and prevents small inflows passing downstream. Although infrastructure such as weir gates are outside the scope of the water sharing plan, the weirs have direct bearing on the transparency of low flows and the ability of the Plan to meet low flow objectives.

	The Commission suggests that the NSW Government:
I	Fund and implement integrated catchment actions to improve riverine health objectives drawing on relevant agencies across the cluster of Planning, Industry and Environment. Such complementary actions include but are not limited to investment in fish passageways, refuge restoration, catchment management and private land conservation.

409 OEH (2018), *Biodiversity Conservation Investment Strategy 2018*, available at https://www.environment.nsw.gov.au/resources/conservation/biodiversity-conservation-investment-strategy-2018-180080.pdf

410 NSW DPI (2017), *Barwon-Darling Watercourse Water Resource Plan Surface Water (SW12) Status and Issues Paper*

411 Thoms, MC, Sheldon, F., Roberts, J., Harris, J., Hillman, TJ (1996), *Scientific Panel Assessment of Environmental Flows for the Barwon-Darling River*, report for the NSW Department of Land and Water Conservation.

10 Cultural outcomes need to be defined and delivered

This chapter discusses the extent to which the Plan has achieved its stated cultural outcomes. It focuses on provisions in the Plan relating to native title rights and the wider Aboriginal, cultural and heritage values of these water sources.

In summary, the Commission found that existing native title rights have not been recognised in a timely manner, despite provisions within the Plan that allow for amendments to reflect native title determinations. More broadly, Aboriginal cultural values and objectives within the Plan are poorly defined, therefore it is difficult to assess how well the Plan is meeting its objectives in this area. There has also been no access to water under cultural water access licences and, until recently, engagement of Aboriginal traditional owners and communities had been piecemeal and ineffectual.

The Commission notes DPIE-Water's recent efforts to better support Aboriginal outcomes, particularly as part of the water resource plan process and the revised water sharing plans currently on public exhibition. The issues outlined above should also be addressed as part of any revised plan.

10.1 Native title rights require recognition

Native title rights require recognition. In the Plan, native title rights are addressed in the objective "*manage these water sources to ensure equitable sharing between users (domestic and stock rights, native title rights, local water utility requirements)*", and the performance indicator "*the extent to which domestic and stock rights and native title rights requirements have been met*".

The Commission has found that the stated objectives and performance indicators related to native title have not been achieved due to a lack of timely recognition of native title determinations, and a failure to provide allocations for native title.

Clause 20 of the Plan currently states: "*At the commencement of this Plan, there are no native title rights in these water sources. Therefore the water requirements for native title rights are 0 ML per year.*" Although this clause was correct at the commencement of the Plan in October 2012, the Plan should have been amended to reflect the Barkandji's native title rights determined in 2015 and 2017. Clause 84(3) supports such an amendment, stating that "*This Plan may be amended following the granting of a native title claim pursuant to the provisions of the Native Title Act 1993 (Commonwealth) to give effect to an entitlement granted under that claim.*"

Public submissions received as part of the review consistently noted the lack of action in regards to the native title rights of the Barkandji and Malyangapa people despite many reported attempts by representative groups and individuals to raise the issue. This includes attempts by legal representatives of the Barkandji Traditional Owners (NTSCORP Limited), as described below.

> "*Attempts to raise this matter and seek clarification by two of the authors of this submission, as well as attempts by legal representatives of the Barkandji Traditional Owners, have faced slow and dissatisfying responses. NTSCORP Limited, the legal representatives of the Barkandji native title holders, raised these matters in their 2016 submission to the NSW Legislative Council's Inquiry into the Augmentation of Water Supply for Rural and Regional NSW. They described a process that was culturally insensitive and misleading, arguing that NSW's Water Sharing Plans (including the Barwon-Darling Water Sharing Plan) do not respond to legal recognition of native*

> *title rights and that this can be "extremely distressing for Traditional Owners" (NTSCORP Limited 2016, p. 15). We argue that the abovementioned objectives of the Barwon-Darling Water Sharing Plan (cl 10) to (b) protect, preserve, maintain and enhance the Aboriginal, cultural and heritage values of these water sources, and (c) protect basic landholder rights are not being achieved through this ongoing failure to recognise and accommodate native title to water held by Barkandji and Malyangapa peoples.*[412]

Despite the Barkandji's native title determination granting specific rights to water as identified in **Chapter 2.7.2**, 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.

The implications of excluding recognition of Barkandji native title rights from the Plan have resulted in a "*failure to protect water and maintain sustainable water levels that support Barkandji's enjoyment and exercise of their other water-related native title rights and interests*".[413] This has led to much frustration and disappointment in the Barkandji community.[414] In 2016 these frustrations prompted two Barkandji-led protests aiming to raise awareness with governments, politicians, and the public. However, the subsequent lack of response created further disappointment for Barkandji people.

In addition, some stakeholder submissions suggest the Plan violates the native title provisions in the Act and national water policy, as illustrated below.

> *"Since the successful native title claim, the Barkandji People have been recognised as Traditional Owners of the land which includes the rivers and groundwater. The determination of native title includes the right to take and use water…that must be recognised and protected. The government agree to our native title rights – but take our water away."*[415]

Moreover, it has been noted that the Plan has not adequately addressed the needs of confirmed and potential, or in process rights holders, nor the provisions of the 'future act regime' to regulate how third parties can affect or impact native title rights to water; this potentially leaves the Government exposed to procedural and compensation claims.[416]

Inadequate recognition of native title determinations is common across most water sharing plans in the region, which serves to undermine stated priorities for Aboriginal outcomes. Several submissions argued that the failure to update plans to reflect native title determinations and requirements is a poor measure of the 'extent of recognition' of Aboriginal peoples' water values.[417]

Research undertaken in the Barwon-Darling identifies gaps in how native title decisions are reflected in water sharing plans and the ways in which Aboriginal people are involved in water

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412 Jackson, S., Hartwig, L. and Tan, P.L. Griffith University – submission to the Commission for this review.

413 Hartwig, L.D., Jackson, S. and Osborne, N. (2018), *Recognition of Barkandji Water Rights in Australian Settler-Colonial Water Regimes*. Resources, 7, page 15.

414 Moggridge, B.J. and Thompson, R. (2019), *Aboriginal voices are missing from the Murray-Darling Basin crisis*, The Conversation 20 June, available at https://theconversation.com/aboriginal-voices-are-missing-from-the-murray-darling-basin-crisis-110769.

415 NTSCORP (2017), *BDNTGAC statement - Submission on Proposed Amendments to the Murray-Darling Basin Plan*, 22 February 2017.

416 NTSCORP (2017) *Submission: Proposed Amendments to the Murray-Darling Basin Plan*; NTSCORP (2016) *Submission: Inquiry into the Augmentation of Water Supply for Rural and Regional NSW.*

417 Jackson, S., Hartwig, L. and Tan, P.L. Griffith University – submission to the Commission for this review.

management.[418] This is supported by broader critiques of the application of Aboriginal water rights across state and national jurisdictions, including:

- the emphasis native title clauses place on 'traditional cultural purposes', which inadequately includes Aboriginal peoples' understandings, uses and relationships with water, and also precludes economic development options[419]
- the dependency of water rights on land rights, rather than any native title rights specifically in or to water; this means that Aboriginal water rights have not been tailored appropriately but rather 'shoehorned' to fit in a land rights framework[420]
- the fact that Aboriginal groups must tackle the significant hurdles and long timeframes of the Commonwealth native title process in order to have their water rights determined (albeit with limited native title provisions to water)[421]
- the low priority given to Aboriginal needs in fully-allocated catchments – "an entitlement to extract water does not ensure that there is any water to extract or that the water is of consumable quality ".[422]

Other government reviews have also commented on the poor implementation of actions relating to native title water rights.[423] The Commission recommends that the Plan is amended immediately to better support and deliver native title rights of the Barkandji and Malyangapa traditional owners in line with the native title determination and the *Native Title Act 1993* (*Commonwealth*, paragraph 6). Any future engagement should be undertaken proactively, and as part of Indigenous Land Use Agreements or other agreements where possible, and in line with:

- specific water-related provisions of the *Native Title Act 1993*, including government and third parties impacts on native title rights to water
- provisions under the *Water Management Act 2000* where native title rights must not be detrimentally affected by lesser priorities of water extraction.

The Plan should include set timeframes for amendment following future native title determinations, particularly in respect of the two current native title claims of the Gomeroi People (NSD2308/2011), and the Ngemba, Ngiyampaa, Wangaaypuwan and Wayilwan Peoples (NSD415/2012). Indigenous Land Use Agreements or other agreements should be used to

418 Hartwig, L.D., Jackson, S. and Osborne, N. (2018), *Recognition of Barkandji Water Rights in Australian Settler-Colonial Water Regimes*. Resources, 7: 16-32; and Tan, P.L. and Jackson, S. (2013), *Impossible dreaming - Does Australia's water law and policy fulfil Indigenous aspirations?* Environment and Planning Law Journal, 30:132–149.

419 Jackson, S. and Morrison, J. (2007), *Indigenous perspectives in water management, reforms and implementation.* In Hussey, K., Dovers, S. (Eds) Managing Water for Australia: The Social and Institutional Challenges, CSIRO Publishing, Melbourne, pp. 23–41.

420 Duff, N. (2017), *Fluid Mechanics: The Practical Use of Native Title for Freshwater Outcomes*. AIATSIS Research Publications, Canberra; and Macpherson, E. (2017), *Beyond recognition: Lessons from Chile for allocating Indigenous water rights in Australia*. University of NSW Law Journal, 40: 1130–1169.

421 Hartwig, L.D., Jackson, S. and Osborne, N. (2018), *Recognition of Barkandji Water Rights in Australian Settler-Colonial Water Regimes*. Resources, 7: 16-32; Taylor, K.S., Moggridge, B.J. and Poelina, A. (2017), *Australian Indigenous Water Policy and the impacts of the ever-changing political cycle*. Australasian Journal of Water Resources, vol. 20, no. 2, pp. 1–16; and Tan, P.L. and Jackson, S. (2013), *Impossible dreaming – Does Australia's water law and policy fulfil Indigenous aspirations?* Environment and Planning Law Journal, 30: 132–149.

422 Behrendt, J. and Thompson, P. (2004), *The recognition and protection of Aboriginal interests in NSW rivers*. Journal of Indigenous Policy, 3: 37-140.

423 National Water Commission (2009), *Australian Water Reform 2009: Second Biennial Assessment of Progress in Implementation of the National Water Initiative*; National Water Commission (2011), *The National Water Initiative – Securing Australia's Water Future: 2011 Assessment*; National Water Commission (2014), *A Review of Indigenous Involvement in Water Planning*; and Productivity Commission (2017), *National Water Reform Inquiry*, Draft Report.

prevent issues related to the long timeframes of native title claims and extended periods of inaction that often follow final determinations.

	The Commission recommends that DPIE–Water:
14	Take steps to improve Aboriginal engagement and outcomes, including: a) Amending current provisions to include recognition of Barkandji and Malyangapa native title rights. b) Including a timeframe of three months to undertake initial amendments of the Plan following future determination of any other native title claims and Indigenous Land Use Agreements, and a further 12 months to undertake the detailed engagement, final amendment and allocation process.

10.2 Aboriginal outcomes need to be better defined and supported

10.2.1 Aboriginal, cultural and heritage values need to be identified and recognised

Aboriginal cultural values and objectives have not been effectively and explicitly detailed in water planning to date.[424] Within the Plan, broader Aboriginal cultural and heritage values are described in the objective "*protect, preserve, maintain and enhance the Aboriginal, cultural and heritage values of these water sources*". However, these values have not been identified, described or mapped. There is also a relevant performance indicator "*the extent of recognition of spiritual, social and customary values of water to Aboriginal people*". It is unclear how this performance indicator can be measured without specifying the values.

This lack of identification of Aboriginal cultural values is also reflected in the Plan provisions. There is one provision that allows for amendment of flow classes for the Boorooma to Brewarrina Management Zone if a satisfactory study demonstrates that access rules are having an adverse impact on the Aboriginal cultural value of the fish traps at Brewarrina.[425] However, it does not specify the cultural value, uses, risks or impacts on the fish traps or any other cultural sites.

The Plan needs to better support Aboriginal cultural and heritage values and uses, objectives and outcomes in line with relevant legislation. Both state and national water legislation and policy integrate broader recognition of Aboriginal, cultural and heritage values and uses of water. Specifically in NSW, the Act notably includes a broad objective to '*recognise and foster the significant social and economic benefits to the Aboriginal people in relation to their spiritual, social, customary and economic use of land and water*' (section 3) and associated provisions.[426] The *National Water Initiative* acknowledges that "*native title should not be solely relied upon to deliver Indigenous peoples the access and rights to their traditional waters. Water planners should consider other mechanisms for giving access and rights to water to Indigenous peoples*". The *National Water Initiative* also sets a standard for improving Indigenous engagement in water planning and access to

424 Issues recognising Aboriginal values in water planning and management have been criticised widely, explored further in the following: National Water Commission (2009) *Australian Water Reform 2009: Second Biennial Assessment of Progress in Implementation of the National Water Initiative*; National Water Commission (2011) *The National Water Initiative – Securing Australia's Water Future: 2011 Assessment*; National Water Commission (2014), *A Review of Indigenous Involvement in Water Planning*.

425 Plan section 78, part 8, division 2.

426 Refer to Act provisions to meet this objective in division 3, part 2, section 13 (1(e)) and division 3, section 55.

water.[427] Provisions under the *Basin Plan* integrate these elements of Commonwealth and state policy.[428]

Public submissions to this review provide evidence that the Plan does not sufficiently recognise the spiritual, social and customary values of water to Aboriginal people. Submissions indicate that the Plan's objectives for Aboriginal outcomes are too general, values are not identified, and the Plan does not include specific compliance measures or clear benchmarks as required under the *Basin Plan*.

The Commission suggests that a better understanding and articulation of Aboriginal values and uses is needed for the Plan to protect, maintain and enhance these values. There have been significant efforts to provide guidance on how to undertake values assessments and consult effectively with Aboriginal people specifically in water planning and management.[429] However, these guidelines are not mandatory, so a proactive approach is required when identifying and protecting cultural values and uses, and involving Aboriginal people in water planning and ongoing management.

Fortunately, there is already a vast body of research to draw on that seeks to identify Aboriginal cultural values in this region. Water, rivers, lagoons and springs are identified as being particularly significant in key studies of Aboriginal culture in the area.[430] The Barwon-Darling is at the heart of this connection to country and underpins cultural practices and social structures, such as kinship relationships with fish and other beings. Indeed, iconic species such as Murray Cod and Bony Herring (affected by the recent fish death events), have specific significance in Aboriginal storytelling, folklore and medicine.[431] Water sustains the fish and underpins associated cultural practices. The presence and movement of water in rivers ensures that highly valued relationships with the river are maintained, as captured in the Northern Basin Aboriginal Nations (NBAN) Board statement to the MDBA:

> *"Good flows clean the waterways out. Food grows so we can hunt, fish and harvest wild tucker…When it rains and things grow we begin to see how the growth of one thing leads to the growth of another. That's when our Aboriginal science becomes visible to us: we see how the growth of certain plants leads to the increase in certain insect populations which leads to increases in bird populations. These populations of living things are related to our totemic obligations. We teach our science, obligations and ceremonies — these are all a part of healthy Country — to our children; and we do this teaching on the waterways where the growth is actually happening."*[432]

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427 Australian Government (2017), *Module to the National Water Initiative Policy Guidelines for Water Planning and Management: Engaging Indigenous Peoples in Water Planning and Management*.

428 Chapter 10 of the *Basin Plan* sets out the water resource plan requirements for Indigenous engagement in water planning. These were prepared in partnership with MLDRIN and NBAN. The guide assumes a principle-based approach to engage with Indigenous peoples on a nation-by-nation based model, consistent with the United Nations *Declaration on the Rights of Indigenous Peoples* and drawing on the Convention on Biological Diversity's *Akwé: Kon Guidelines* (2004).

429 Including additional modules for the *National Water Initiative* and the *Basin Plan*, and as part of the *National Cultural Flows* project.

430 Hartwig, L.D., Jackson, S. and Osborne, N. (2018), *Recognition of Barkandji Water Rights in Australian Settler-Colonial Water Regimes*. Resources, 7: 16-32; Jackson, S., Pollino, C., Maclean, B., Moggridge, B. and Bark, R. (2015), *Meeting Indigenous peoples' objectives in environmental flow assessments: Case studies from an Australian multi-jurisdictional water sharing initiative.* Journal of Hydrology 52: 141-151; and Muir, C., Rose, D.B. and P. Sullivan (2010), *From the other side of the knowledge frontier: Indigenous knowledge, social–ecological relationships and new perspectives.* The Rangeland Journal 32: 259–265.

431 Paszkowski, L.K. (1969), *Blandowski, William (1822 - 1878)*, Australian Dictionary of Biography, Volume 3, Melbourne University Press, pp. 182-183.

432 Statement from the NBAN Board, 14 January 2016, Moree. MDBA (2016), *Our water, our life: An Aboriginal study in the northern basin. Murray–Darling Basin Authority*, MDBA.

The river is the life force that sustains important areas such as scar trees that were used for canoes, coolamons, shields and other culturally important sites like boundary trees.[433] Water in the river preserves these sites as well as sacred sites throughout the region "*when flows are right our sacred sites, like burial sites, are protected*".[434]

Waterways are valued for the ways in which they integrate and support cultural history and connection; "*the river is our memory – we walk along it and remember our history and our ancestors by looking at the marks and places*".[435] Water and its flows act as critical pathways to protect cultural history and connection for traditional owners and Aboriginal communities in these areas.

Studies have also identified more specific cultural values in certain areas of the river system. For the Aboriginal people of the region, the river (the Barka) is at the heart of their culture and profoundly spiritual. The Barka is home to Ngatji, the rainbow serpent, who created the lands and rivers, and it is the Barkandji who are responsible for Ngatji's health and wellbeing.[436]

Aboriginal people's cultural and spiritual values are embedded in country across a range of spatial and temporal scales and sites.[437] For example, the Brewarrina fish traps described in **Chapter 2.4** are an important historical inter-tribal meeting place for local Aboriginal groups. Upstream of the fish traps, the Ngemba Old Mission Billabong is also culturally significant. In cultural terms these are treated as one complex site. The area was declared an Indigenous Protected Area in 2010, and is also a World Conservation Union Category V and VI protected area.[438] To meet local Aboriginal water requirements, the two sites and the river section that connects them need to be managed together.[439]

The Menindee Lakes have also been highlighted as an area of cultural significance in research studies, but most publicly in light of the significant fish death events.[440] The Menindee Lakes are important to local Aboriginal people with cultural sites dating back over 13,000 years.

Submissions have called for more studies to better understand the water resources, Aboriginal cultural values and cultural water requirements in the Plan area, in partnership with local

433 Vertessy, R., Mitrovic, S., Barma, D., Baumgartner, L, Bond N., and Sheldon, F. (2019), *Independent Assessment of the 2018-19 Fish Deaths in the lower Darling: Final Report*. Independent Panel Report for the Australian Government.

434 Statement from the NBAN Board, 14 January 2016, Moree. MDBA (2016), *Our water, our life: An Aboriginal study in the northern basin*, MDBA.

435 Badger Bates' submission to the South Australian Royal Commission on the Murray–Darling Basin, 13 February 2019.

436 Hartwig, L.D., Jackson, S. and Osborne, N. (2018), *Recognition of Barkandji Water Rights in Australian Settler-Colonial Water Regimes*. Resources, 7: 16-32.

437 Western Local Land Services have recorded the traditional language and specific uses of native plant materials in designated study areas for a series of 'Ecological Cultural Knowledge' projects across the area.

438 MDBA (2016), O*ur water, our life: An Aboriginal study in the northern basin.* Murray–Darling Basin Authority.

439 Maclean, K., Bark, R.H., Moggridge, B., Jackson, S., and Pollino, C. (2012), *Ngemba Water Values and Interests. Ngemba Old Mission Billabong and Brewarrina Aboriginal Fish Traps (Baiame's Ngunnhu)*. CSIRO, Australia, available at: https://publications.csiro.au/rpr/download?pid=csiro:EP127320&dsid=DS1; Bark, R., Barber, M., Jackson, S., McLean, K., Pollino, C.A. and Moggridge, B. (2015), *Operationalising the ecosystem services approach in water planning: a case study of indigenous cultural values from the Murray-Darling Basin*, Australia. International Journal of Biodiversity Science, Ecosystem Services & Management, available at: http://www.tandfonline.com/doi/pdf/10.1080/21513732.2014.983549

440 Vertessy, R., Mitrovic, S., Barma, D., Baumgartner, L, Bond N., and Sheldon, F. (2019), *Independent Assessment of the 2018-19 Fish Deaths in the lower Darling: Final Report*. Independent Panel Report for the Australian Government.

communities. Examples given include studies about impacts of groundwater extraction, and on groundwater dependent culturally significant sites.[441]

Overall, it is clear that Aboriginal people of the region view themselves as an integral part of the river and water system; which sustains life, well-being, history and identity. The Commission argues that these strong and ongoing cultural values and uses need to be better recognised in water planning, management and access into the future and should be immediately supported with an interim flow allocation for each Aboriginal nation in the Plan area; as has been implemented in other jurisdictions.[442]

The Plan also needs to specify Aboriginal water-related values, objectives and outcomes. This process needs to be undertaken in consultation with Aboriginal nations in the Plan area and in line with:

- guidelines for identifying and protecting Aboriginal values, objectives, outcomes included in the *National Water Initiative*, the Act and the *Basin Plan*, and operationalised in some parts of the Basin through the *Aboriginal Waterways Assessment* method[443]
- processes of flow allocations set out in the *National Cultural Flows Project*[444] to support Aboriginal water interests of nations
- guidelines for flow allocations that emphasise the need to include spiritual, cultural, environmental, social and economic purposes[445] and alignment but separation from environmental flow allocations[446]
- SMART performance indicators and targets to ensure progress against the stated outcomes, as part of an agreed monitoring and evaluation plan with clear resourcing and reporting responsibilities to deliver as intended.

The Commission notes DPIE-Water's recent efforts in supporting Aboriginal outcomes, particularly their work in integrating more detailed Aboriginal cultural objectives and measures in water resource plans and revised water sharing plans currently on public exhibition, and adopting nation-by-nation consultation. DPIE-Water should expand this work to address a significant gap in these activities over recent years (see examples in **Appendix E**).

The Commission recommends that DPIE–Water:

14 Take steps to improve Aboriginal engagement and outcomes, including:

c) Providing an interim water allocation for each nation in the Plan area. An interim allocation is required to deliver clear and immediate support for water rights that

441 Submissions to the Commission for this review, including: Jackson, Hartwig, Tan – Griffith University; Dharriwaa Elders Group

442 The Queensland Government has used unallocated flows to support Aboriginal water interests as part of their draft water resource plans, see: https://www.mdba.gov.au/sites/default/files/pubs/qld-water-connections-aboriginal-peoples-water-needs-in-the-murray-darling-basin-2019_1.pdf. Where systems are fully allocated, it is possible to investigate options for the use of market instruments to allocate these flows.

443 Available at http://www.mldrin.org.au/what-we-do/aboriginal-waterways-assessment/

444 Available at http://www.culturalflows.com.au/

445 Cultural flows are defined as "*…water entitlements that are legally and beneficially owned by the Indigenous Nations of a sufficient and adequate quantity and quality to improve the spiritual, cultural, environmental, social and economic conditions of those Nations. This is our inherent right*." (Echuca Declaration, 2010 quoted in the *Basin Plan*)

446 The NBAN Board found that there is a risk that environmental watering, which benefits Country, is confused with cultural water, a different water allocation necessary for cultural use as determined by Aboriginal Nations (MDBA, 2016, *Our water, our life: An Aboriginal study in the northern basin*)

The Commission recommends that DPIE–Water:

responds to a long period of inaction. This approach also acknowledges the significant amount of time needed to identify Aboriginal water-related values, objectives and outcomes, and develop final agreed flow allocations in consultation with all relevant Aboriginal organisations, including traditional owners and Aboriginal Land Councils.

10.2.2 Aboriginal water licences need to support values and uses

The Plan includes Aboriginal water licences to support cultural outcomes in line with the Act. The Act includes three categories of Aboriginal water access licences:

- cultural access licences
- Aboriginal community development licences
- Aboriginal environment licences.

These access licence categories have been implemented in different ways across the state. Cultural use licences are available in all surface water and groundwater management areas. In contrast, community development licences are only available in catchments where water extraction is not yet over allocated (largely in coastal water management areas), and Aboriginal environment licences for supplementary water are only available in areas of high river flows. All Aboriginal specific licences include conditions that set limits to volumetric entitlements, use options, and restrict or prohibit trade.

Within the Plan, cultural water access licences are included and capped at 10 ML per year, while the Aboriginal environment licences for supplementary water are set at 2,000 ML per year.[447] Community development licences are not included in the Plan (or any equivalent mechanisms to recognise and foster economic benefits to Aboriginal people) as it is a fully-allocated system.

Despite these licences being available, the draft audit of the Plan found that no communities in the Plan area have accessed water under these provisions and there is no water reserved for use under these entitlements. This lack of uptake has been related to the limits to volumetric entitlements and restrictions noted above, and also a lack of access to land and required infrastructure (pipes, pumps, fuel and storage). DPIE-Water does not appear to have a policy or protocol for processing applications for supplementary water (Aboriginal environmental) access. The process for obtaining cultural water access has been described as 'laborious', with no guidance for Aboriginal people and limited staff to assist with applications.[448]

Some stakeholder submissions stated that the Aboriginal community should be better supported to access water entitlements, and that water should be secured to allow allocations in line with the National Cultural Flows research project.[449] The Commission notes that DPIE-Water has taken significant steps recently to address these issues (see **Chapter 10.3**).

447 Aboriginal environment licences for supplementary water is a licence category that is only available in the Barwon-Darling.

448 Hartwig, L.D., Jackson, S. and Osborne, N. (2018), *Recognition of Barkandji Water Rights in Australian Settler-Colonial Water Regimes*. Resources, 7: 16-32.

449 Submissions to the Commission for this review including: Environmental Farmers Network; MLDRIN; MDBA; Dharriwaa Elders Group, Australian Floodplain Association; NSW National Parks Association;

The Commission recommends that Aboriginal licence categories, and the processes for applying for them, need to be simplified and clear to enable better access to water. This needs to address a range of Aboriginal water interests including economic opportunities[450] and acknowledge the other issues that can impact on access to water through licences, including:

- limits to volumetric entitlement
- restrictions on uses
- complexity of licence governance and application processes
- limited awareness and capability around water licencing
- restricted access to land and water infrastructure.[451]

The Commission recommends that DPIE–Water:

14 Take steps to improve Aboriginal engagement and outcomes, including:

d) Simplifying licence categories and processes for Aboriginal water access that can address include cultural, environmental, social and economic purposes.

10.2.3 Aboriginal involvement can be improved

Aboriginal involvement in water management has been variable and ineffective over the past 20 years. Water management committees, as described in the Act, were not used after 2004. From 2016, Stakeholder Advisory Panels were established, each with 14 or 15 members, including Aboriginal representatives. Regardless of native title rights, there are provisions for only one Aboriginal community representative member on each surface water Stakeholder Advisory Panel, and two on the single state-wide groundwater Stakeholder Advisory Panel.[452] Previously these roles were filled by staff under the NSW Aboriginal Water Initiative[453] who had an understanding of water management. However, with the cessation of this initiative in 2017, Aboriginal Elders are expected to take on these roles with often limited experience in water management.[454]

This type of piecemeal engagement of Aboriginal traditional owners and communities has not provided adequate representation.[455] For example, management of water resources in Barkandji country will be informed by at least three Stakeholder Advisory Panels, two of which currently

Brewarrina Shire Council; Central West Environment Council; Wentworth Shire Council; Healthy Rivers Dubbo; Inland Rivers Network; Ryde Hunters Hill Flora and Fauna Preservation Society.

450 Economic opportunities may include Aboriginal employment in NSW water management, leasing of water licences or native bush food centres.

451 Submissions to the Commission for this review including Commonwealth Environmental Water Holder; MLDRIN; Dharriwaa Elders Group.

452 Hartwig, L.D., Jackson, S. and Osborne, N. (2018), *Recognition of Barkandji Water Rights in Australian Settler-Colonial Water Regimes*. Resources, 7: 16-32.

453 The Aboriginal Water Initiative Program was established in 2012 and ran until 2017, funded at $1.69 million per year. It aimed to improve Aboriginal involvement and representation in water planning and management in NSW and monitor progress against targets established in water sharing plans.

454 Taylor, K.S., Moggridge, B.J. and Poelina A. (2017), *Australian Indigenous Water Policy and the impacts of the ever-changing political cycle,* Australasian Journal of Water Resources, 20:2, 132-147.

455 Moggridge, B.J. and Thompson, R. (2019), *Aboriginal voices are missing from the Murray-Darling Basin crisis*. The Conversation, 20 June, available at: https://theconversation.com/aboriginal-voices-are-missing-from-the-murray-darling-basin-crisis-110769

have one Barkandji representative each. Moreover, Barkandji traditional owners have representation on Murray Lower Darling Rivers Indigenous Nations (MLDRIN) but not on Northern Basin Aboriginal Nations (NBAN).

A number of submissions raised the need to improve involvement of Aboriginal stakeholders, noting the limitations of current 'community engagement' approaches rather than active involvement in water planning and ongoing management. Submissions note continued efforts by multiple stakeholders to raise these issues and frustrations at the lack of government response.[456]

The Commission recognises DPIE-Water's recent efforts to address these issues by engaging on a nation-by-nation basis as part of the development of water resource plans – see **Chapter 10.3** for more information about recent initiatives to improve Aboriginal engagement and outcomes.

Due to the long time frames to undertake meaningful engagement and build trust, it is important to follow clear and transparent guidelines. The Commission recommends agreeing on an appropriate engagement process and timeframe with nations, traditional owners, the NSW Aboriginal Land Council and Local Aboriginal Land Councils that is then led by these groups; noting this will vary between nations and communities and cannot rely on the limited representation provided by existing Stakeholder Advisory Panels. DPIE-Water should also ensure engagement activities are well resourced and supported by Aboriginal staff with knowledge of water planning and management that can help to build water literacy and capability in communities.

The Commission recommends that DPIE–Water:

14 Take steps to improve Aboriginal engagement and outcomes, including:

e) Building on the established nation-by-nation engagement already being undertaken to identify Aboriginal values and uses, objectives and outcomes, and flow allocations. This should use relevant guidelines, be well-resourced with Aboriginal staff experienced in water management, and include a specific process and clear timeframe for implementation in consultation with all relevant Aboriginal groups.

10.3 More can be done to improve Aboriginal outcomes

The Commission notes recent efforts of DPIE-Water in supporting Aboriginal outcomes, particularly their work in integrating more detailed Aboriginal cultural objectives and measures in revised water sharing plans currently on public exhibition. Key initiatives of DPIE-Water include:

- **Nation by Nation consultation -** with Aboriginal Peoples across 29 Aboriginal nations to better understand each nation's values and water objectives to inform water resource plans. Consultation began in March 2018 and should involve around 70 workshops and 180 face to face interviews with traditional owners by the end of 2019. The outcome will

456 Submissions to the Commission for this review including: Environmental Farmers Network; MLDRIN; MDBA; Dharriwaa Elders Group, NSW Aboriginal Land Council, Australian Floodplain Association; NSW National Parks Association; Brewarrina Shire Council; Central West Environment Council; Wentworth Shire Council; Healthy Rivers Dubbo; Inland Rivers Network; Ryde Hunters Hill Flora and Fauna Preservation Society.

see 29 nation reports included in the 22 water resource plans in the Basin, including the four nations in the Plan area - Barkandji, Murrawarri, Ngemba and Ngiyampaa Nations.

- **funding to Barkandji -** to make sure the Barkandji Peoples are adequately supported in water reforms in NSW, DPIE-Water has provided funding to the Barkandji Prescribed Body Corporate over two years to assist them to participate in the water reform processes.
- **metering traineeships -** as part of new metering rules, meters need to be validated by certified meter installers. DPIE-Water is funding two Aboriginal traineeship positions to undertake meter validation and will result in the individual becoming qualified to validate meters under the NSW Government's new metering framework.
- **two additional Aboriginal staff -** in Broken Hill and Albury in addition to four existing permanent Aboriginal staff to help DPIE-Water service First Nations across the state.
- **coordinating engagement activities -** DPIE-Water is also working internally to better coordinate engagement with Aboriginal stakeholders, for example by having a single point of contact for the Barkandji Peoples to reduce confusion and engage more effectively.

DPIE-Water should progress and expand this work to address the inaction and setbacks experienced in NSW since the disbanding of the *Aboriginal Water Initiative* in 2017. Many submissions noted that significant efforts are needed to redress Aboriginal values and uses, objectives and outcomes across all water sharing plans, in consultation with Aboriginal stakeholders.[457] This state-wide activity needs to be undertaken in a consistent and transparent way, led by an overarching NSW Aboriginal Water Strategy or similar, with supporting governance, staff and resources. Submissions have raised valuable examples of such approaches including: an overarching Aboriginal Water and Land Holder and an associated Trust Account; dedicated Aboriginal roles in water management (for example Aboriginal Rangers and Water Officers for monitoring and compliance); and Cultural Flows Projects and Officers.[458]

Support for broader activities at the state and Commonwealth level are also fundamental to ensuring an effective coordinated response from DPIE-Water. DPIE-Water also advised that the Commonwealth has committed $40 million to support cultural and economic water entitlements for Murray-Darling Basin Aboriginal communities through the Indigenous Land Corporation, and another $20 million in grants to remote, rural and regional Aboriginal communities impacted by the *Basin Plan*.

These efforts need to be supported and further developed through a formal strategy and funded policies as adopted in other states,[459] to support ongoing Aboriginal involvement and leadership in water management across NSW, and beyond the current water resource plan and water sharing plan processes.

457 Submissions to the Commission for this review including: MLDRIN Board; MDBA; Dharriwaa Elders Group NSW Aboriginal Land Council.

458 Submissions to the Commission for this review including: MLDRIN Board; NSW Aboriginal Land Council; NSW Irrigators Council.

459 Recent reforms in Victoria under the *Water and Catchment Legislation Amendment Bill 2019* have formalised obligations for Victorian water and catchment management agencies to engage with and support opportunities for Aboriginal involvement. The *Water for Victoria Plan* has also been central to providing opportunities for Aboriginal Nations to document water-dependent values, collaborate with water management agencies and pursue economic development opportunities through access to water.

The Commission suggests that DPIE–Water:

J Develop a NSW Aboriginal Water Strategy to provide consistent and transparent guidelines for Aboriginal involvement in water planning and management in NSW. At a minimum, the strategy should align with relevant international and national guidelines and consider:

a) Aboriginal water and its uses.
b) Processes for nation-by-nation engagement for allocating water for Aboriginal interests including cultural, environmental, social and economic purposes.
c) Governance and decision making arrangements.
d) Initiatives for capability building.
e) Accountability and monitoring, evaluation and reporting requirements.
f) Resources including dedicated Aboriginal staff and roles in water management and potential innovative funding arrangements such as an Aboriginal Water Trust
g) Tailored social impact management strategies.

11 Economic benefits have focused on extractive users

This chapter explores the extent to which the Plan has met its stated economic objectives. In summary, the Plan has generally met the following objectives:

- **supporting trade** – trading has occurred under rules that are broadly compliant with the MDBA trading rules
- **allowing flexible water use** - 300 percent take and unlimited carryover provisions have been used through the Plan period, and provided licence holders with flexibility to accrue and use water based on storage capacity, river flows and other water use drivers.

However, the Commission finds that these objectives are too narrowly focused on licenced water users and extractive water use. In future, the Plan should consider the costs and benefits incurred by other industries and non-extractive water users as a result of the Plan, for example the pastoral, tourism and recreation industries.

It is also not possible to report on indicators relating to the change in economic benefit derived from water extraction because of limited and inconsistent publicly available land and water use data for the Barwon-Darling since 2012.

11.1 Economic outcomes and objectives are narrow in focus

The Plan has three main economic objectives and indicators:

- to provide opportunities for enhanced market based trading of access licences and water allocations in environmental and system constraints (Plan objective)
- to provide water allocation account management rules which allow sufficient flexibility in water use (Plan objective)
- the change in economic benefit derived from water extraction and use (Plan performance indicator).

The Commission has reviewed the Plan's performance against the current economic objectives and indicators. The Commission has also identified a key issue with the objectives and indicators themselves; that they largely focus on the benefits of trade and account management rules for licenced water users.

By focusing on users who trade and extract water under licence, the objectives risk focusing on a relatively small number of licenced operations, particularly cotton producers and other irrigated industries, at the exclusion of other water users. There are no economic objectives in the Plan linked to activities that do not extract or trade water under licence.

Due to the overall importance of the irrigation industry and cotton production in the Barwon-Darling region, the Commission considers that the Plan's economic objectives should maintain some level of focus on extractive users. Cotton is the major irrigated agricultural water user in the Barwon-Darling catchment (see **Chapter 3.3.1**) and, based on 2010–11 data, is the highest value producing individual crop yielding $55 million or 45 percent of the gross value of agricultural production in the Barwon-Darling valley floodplain.[460] A review of the distribution

460 DPI-Water (2017) *Rural floodplain management plans: Background document to the Floodplain Management Plan for the Barwon-Darling Valley Floodplain 2017*, available at https://www.industry.nsw.gov.au/__data/assets/pdf_file/0006/146085/Background-document-FMP-Barwon-Darling-Valley-Floodplain-2017.pdf

of water access licences found that cotton producers around Bourke are some of the largest entitlement holders. Submissions from irrigator groups have also highlighted the overall importance of the cotton industry on regional communities in the Barwon-Darling and the potential for negative impacts on town populations and economies if available irrigation entitlements are reduced. They also referred to findings of the MDBA Northern Basin Review report, which showed that the effects of reduced water through water recovery are generally greater for smaller economies that depend on irrigation, compared with those that are larger and more diverse.[461] This report also noted there was a strong sense in irrigation communities that water reform has impacted their towns and resulted in job losses.[462]

However, irrigation should not be the sole focus of economic objectives. Many users believe the Plan has been detrimental to the economic viability of communities and pastoral operations downstream of major irrigation areas. Similarly, the Northern Basin Review noted a situation where future water recovery would be expected to result in some downstream economic benefits to floodplain graziers and communities.[463] Other agricultural industries are still significant contributors to the Barwon-Darling economy. For example, wheat and livestock and livestock products were relatively high value agricultural activities, yielding $36 million and $15 million respectively of the total gross value of agricultural production in the Barwon-Darling valley floodplain in 2010–11.[464] Livestock grazing is also the largest agricultural activity by area, using around 80 percent of land (see **Chapter 2.7.2)**. Some stakeholders also highlighted negative impacts on the local tourism and recreation industries (see **Figure 23**), and costs to communities and businesses of extra water treatment or switching to bore or bottled water when river water is of poor quality or unavailable.

Figure 23: Lack of flows negatively impacts social and economic outcomes such as recreation, amenity, tourism and fishing as seen at Louth (Natural Resources Commission, April 2019)

461 MDBA (2016), *The Northern Basin Review: Understanding the economic, social and environmental outcomes from water recovery in the northern Basin*, available at https://www.mdba.gov.au/publications/mdba-reports/northern-basin-review-report

462 The Commission notes that the Australian Government has engaged an independent panel to assess social and economic conditions in communities across the Basin. This will be completed by December 2019.

463 MDBA (2016), *The Northern Basin Review: Understanding the economic, social and environmental outcomes from water recovery in the northern Basin*, available at https://www.mdba.gov.au/publications/mdba-reports/northern-basin-review-report

464 Ibid.

The Commission considers that the Plan's objectives should be broadened to consider the costs and benefits to other agricultural industries and non-licenced water users in the region. For example, the costs and impacts of varying flows and water quality on utilities and non-extractive users (see **Chapter 7**). The major extractive and non-extractive users that should be considered in revised objectives, strategies and indicators are discussed in **Chapter 5.1**.

11.2 The Plan has supported trade

11.2.1 Trading has occurred over the Plan period

The Plan has provisions which provide for market-based trading opportunities, and trades have occurred throughout the Plan period. Water markets in the Barwon-Darling have been described as less mature relative to other river systems in NSW and trades have been fairly low in frequency, but have involved relatively large volumes.[465]

Based on publicly available data, there have been 259 trades recorded since the commencement of the Plan with a total reported value of $13.6 million. These trades have involved the transfer of 249,888 ML of account water, 24,635 share component units and 102,390 ML of access licences, noting that individual shares may have been traded multiple times (**Table 17**).

Table 17: Summary of water access licence trades[466]

Trade type	Licence class	Number of transactions	Total volume (ML) or share component (units)	Total reported value
Allocation (71T)	A	49	23,461	$1,006,244
	B	49	166,584	$1,844,626
	C	8	59,843	$331,785
	Sub-total	*106*	*249,888*	*$3,182,654*
Share assignment (71Q)	A	11	653	$617,105
	B	29	22,307	$7,541,972
	C	1	1,675	$1,340,000
	Sub-total	*41*	*24,635*	*$9,499,077*
Transfer (71M and others)	A	59	7,274	$ 889,885
	B	35	88,105	-
	C	12	6,760	-
	Stock and domestic	8	251	-
	Sub-total	*112*	*91,489*	*$889,885*
TOTAL		**259**	**376,912**	**$13,571,616**

465 Aither (2017), *Water markets in NSW: improving understanding of market fundamentals, development and current status.* Report prepared for Lands and Water, Department of Industry. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0006/155859/Water-markets-in-nsw-aither-report-for-dpi-water.pdf

466 WaterNSW (2019), *NSW Water Register*, available at https://waterregister.waternsw.com.au/water-register-frame

The three main types of trade dealings have been:

1 **allocation assignment trades** - trade of a volume of water from the account of one access licence to another

2 **share assignment trades** - trade of all or part of the share component of one access licence to another

3 **transfer trades** - transfer to an access licence from one licence holder to another.

Other dealings have also occurred to change, subdivide, consolidate and apply for access licences. DPIE-Water advised that the trade dealings described above have been used for three broad types of transactions:

- small entitlements selling to a few large irrigation properties
- trades between different irrigation properties belonging to a single owner, or transferring between one owner's various licences for account management purposes
- a smaller number of 'trades between equals' (for example between similar size properties) that are typical of a water market.[467]

In the Barwon-Darling, trade demand is linked to the use of on-farm water storages. Irrigators use large on-farm water storages to manage irrigation use within and between years. This use of storage influences the demand for allocation trading of account water, which is driven by different factors in unregulated systems compared to regulated systems. Drivers of demand for water include crop production decisions, irrigators filling their on-farm water storage facilities and selling any excess water, and irrigators needing more water to finish off a crop.[468]

It is noted that the movement of water licences has not been isolated to water for extractive purposes, with the Commonwealth also participating in the Barwon-Darling water market, using the trading provisions of the Plan to acquire a portfolio of A, B and C Class licences.

11.2.2 The Plan's trading provisions are broadly consistent with *Basin Plan* trading rules

The *Basin Plan* contains water trading rules that aim to reduce restrictions on trade except where this may impact on certain criteria, for example where the environment may be impacted. Reviews of the Plan trading rules conducted by NSW Government agencies in 2014 and 2017 indicated that the trading provisions are largely consistent with the *Basin Plan*.

Despite this, some stakeholders raised concerns that two subclauses of the Plan may be placing unintended restrictions on trade. These are described below, although the Commission considers them to be relatively minor in the context of other issues identified in this review.

First, an amendment was made in 2018 to subclause 42(3) on individual access licence account management rules (see **Chapter 3.1**). This change may potentially restrict trade and water use for access licences with no entitlement (zero share component units) but with water in their

467 DoI-Water (2017), *Water resource planning – Model scenario report – Barwon-Darling full A class activation, November 2017*.

468 Aither (2017), *Water markets in NSW: improving understanding of market fundamentals, development and current status*. Report prepared for Lands and Water, Department of Industry. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0006/155859/Water-markets-in-nsw-aither-report-for-dpi-water.pdf

allocation accounts. DPIE-Water advised there are a number of these cases, and the Commission's analysis also identified a small number of access licences that may be impacted.

Second, Subclause 66(1) was seen to be inconsistent with Subclause 66(2). Subclause 66(1) prohibits one type of licence dealing (71S) between river sections, whereas 66(2) specifies upper limits for share components in each river section for the same type of dealings. DPIE-Water advised it will consider the relationship of these two subclauses as part of the remake of the Plan. As a general principle, the Commission supports removing any inconsistent or conflicting provisions from the Plan where this is consistent with our other advice and recommendations, including any recommendations to protect the environment.

The Commission identified several other issues with the consistency of some trade and account data. These include some types of trades not being recorded in the public Water Register, variations in records between data sources, and the occurrence of negative water account balances due to water users extracting more water than was available in their accounts (see **Chapter 8.4**). These may have negatively impacted on the transparency and reliability of data for market participants, and the overall level of take in line with the Plan rules.

11.2.3 Trade has not materially impacted on the distribution of access licences and water use

Ownership and location of water entitlements is currently concentrated among a relatively small number of licence holders and management zones (which represent a portion of a river section), particularly around Bourke (**Table 18**). Some stakeholders raised concerns that trade is creating this concentration of water holdings in upstream locations, which reduces flows downstream. However, in general, the Commission found that licence holdings were relatively concentrated among holders and areas at the commencement of the Plan in 2012–13 and it does not appear that the Plan has been the key driver of this trend.

Despite this, a detailed review of changes to entitlement at the river-section level over the Plan period identified some increases in the percentage of share component in certain river sections over the last seven years. Ultimately the Commission found these shifts involved relatively small volumes compared to total share components for each licence class (see **Chapter 8.5**) and are within specified Plan limits.

The movement in water entitlement that has occurred between river sections over the Plan period is, at least in part, due to trade. The Commission was advised there has been a pattern developing with some small holders selling their accumulated allocation account balances, or permanently trading their entitlement, to a larger irrigation farm business. These trades between river sections may be indicative of water moving to where it is most valued by the market. This would be largely consistent with the intent of the trade provisions, which seek to encourage more efficient use of water resources and allow water to move to its highest value use.[469]

The ownership and geographic distribution of water entitlement (share component) does not necessarily reflect the location of water extraction. In any given year, water extraction may diverge from water entitlement due to a range of factors including the acquisition, disposal and extraction of account water through allocation trading, as well range of crop production

469 DPI Office of Water (2012) *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources – Background document*. Available at: http://www.water.nsw.gov.au/__data/assets/pdf_file/0006/549024/wsp_barwon_darling_background_document.pdf

decisions and other considerations by operators. A review of allocation trade data shows that trading has occurred across management zones and river sections over the Plan period.

Table 18: Distribution of access licence ownership and location, by licence class (2018-19)

Licence class	Distribution among licence holders and management zones
A Class	▪ 94 licence holders, top five control 56 percent of the total share ▪ Share component is distributed over 12 management zones, but a large portion (59 percent) is in the Culgoa River Junction to Bourke zone ▪ Eight percent or less across each of the other 11 zones.
B Class	▪ 61 licence holders, top five control 78 percent of the total share ▪ Share component is distributed over 13 management zones, but a large portion (37 percent) is in the Culgoa River Junction to Bourke zone ▪ 10 percent or less across each of the other 12 zones.
C Class	▪ Eight licence holders, top five control 78 percent of the total share ▪ Share component is distributed over seven management zones, but a large portion (70 percent) is in the Boorooma to Brewarrina zone ▪ 15 percent or less across each the other six zones.

Note: some licence holders may own licences across multiple licence classes, in different entities, or jointly with other holders.

11.3 Account management rules have allowed flexibility in water use

In the Barwon-Darling, licence holders are issued with their full available water determination at the beginning of each water year, generally at a rate of 1 ML per share component unit.[470] Water is reduced from accounts when it is extracted. Extraction limits for A, B and C Class licences are set at 300 percent plus net allocation trade (see **Chapter 8.4**) and any unused water is carried over from one year to the next.

The 300 percent take rule and unlimited carryover provisions have been used through the Plan period, and appear to have provided licence holders with the flexibility to accrue and use water based on storage capacity, river flows and other drivers of water use. For example, these rules have allowed licence holders to use more than their water entitlement in several years since the start of the Plan. A Class water use exceeded 100 percent of share component in three of seven years, and exceeded 300 percent of share component in one of those years (**Table 19**). Before the 2018 amendments, water users could extract more than 300 percent of the total share component of a licence class by trading allocation assignment water accrued in previous years (see **Chapter 8.4**). However, it appears that, in this case, the extraction above 300 percent was due to some over-extraction by taking accounts into negative balances (see **Chapter 8.4**). It is noted that there was no water extraction in the 2018-19 water year.

470 Note that available water determination was set at 1.09 ML for the 2013-14 and 2014-15 water years, and adjusted to 1.0 ML for 2015-16 and each subsequent water year in line with the Plan.

Table 19: Annual water use as a percentage of share component, by licence class

Licence category	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
A Class	15%	5%	132%	209%	**331%**	59%	**0%**
B Class	112%	55%	13%	36%	156%	8%	**0%**
C Class	122%	24%	**0%**	10%	132%	**0%**	**0%**

The level of use presented in **Table 19** was supported by unlimited carryover balances and the trade of temporary allocation assignment water. Further, licence holders began the Plan period with large carryover balances rolled over from their pre-Plan accounts. Having these large account balances at commencement provided additional flexibility as licence holders did not need to wait long periods of time to build up their account balances. **Table 19** shows that B and C Class licence holders were able to extract more than 100 percent of the total share component for each licence class in the first year of the Plan by drawing on their carryover balances at Plan commencement.

While these rules have provided flexibility in water use for irrigators, some non-irrigator stakeholders see them as being evidence of preferential treatment to the irrigation industry and impacting the environment. This was discussed in **Chapter 8.4.**

11.4 No reporting of economic benefits under the Plan

The Plan's primary economic performance indicator is the change in economic benefit derived from water extraction and use. The recipients of these benefits are not specified, but given the economic objectives focus on trade and water use flexibility, the focus appears to be on benefits to licenced irrigators.

Publicly available land and water use data for the Barwon-Darling is inconsistent and it is difficult to compare data from different years to infer trends since 2012.[471] However, some broad industry, water use and water value data has been reviewed to indicate the potential benefits from water extraction and use before and after the Plan began.

Grazing is by far the largest agricultural land use, followed by cropping then irrigated cropping (see **Chapter 2.7.2**).[472] Cotton has been the main irrigated crop in the Barwon-Darling both before and after the Plan implementation (see **Chapter 3.3.1**). Between 2006–07 and 2015–16, it was the largest irrigated crop in terms of both area and water use for all years except 2007–08.[473]

The total area under irrigation and the volume of water used in the Barwon-Darling has fluctuated over the years, and this has been the case before and after the Plan. Between 2006–07 and 2015–16 the largest irrigation years in terms of both area under irrigation and volume of water used were from 2010–11 to 2013–14.[474] This period includes two years pre-Plan and two

471 Aither (2017), *Water markets in New South Wales, Improving understanding of market fundamentals, development, and current status.* A final report prepared for NSW Department of Primary Industries Water

472 DPI Water (2017), *Barwon-Darling Watercourse Water Resource Plan Surface Water (SW12) Status and Issues Paper*.

473 Tableau Public (2018), *Australian Water Markets Dashboard 2016-17*, based on ABARES data, available at https://public.tableau.com/profile/australian.bureau.of.agricultural.and.resource.economics.and.sci#!/vizhome/AustralianWaterMarketsDashboard2016-17/AWMR2016-17

474 Ibid.

years post-Plan, and does not indicate a shift towards or away from irrigated production since the Plan commenced. Regardless, there would be many factors impacting irrigated crop production from year-to-year and caution should be taken in linking changes directly to the trading and account management provisions of the Plan.

The Commission reviewed the price paid for water since the start of the Plan to assess the value of water. Based on public records, we found there to be a large variation in prices paid for water, with prices ranging from $0–105 per ML for temporary allocation assignment water (71T), $0–$2,324 per unit to acquire share component entitlements (71Q), and $0–$1,632 per ML to transfer to an access licence from one holder to another (71M).

The Commission also reviewed trade data to assess the extent to which the value of water has changed over time. There were a relatively low number of trades overall and a relatively large proportion of these had no price data, or a price of $0, recorded against them, which makes it difficult to isolate trends in price with confidence. For example, there is an upward trend in the average price paid for A Class share component units acquired through share assignment trades (71Q) from 2015–16 to 2018–19. During this period the average price moved from $1,300 to $1,912 per share component unit. However, this range is based on only six trades with price data over $0, so the trend is considered unreliable. Also, the value placed on water or water entitlements by individual farmers may not be fully evident in the price paid for trades and may also include things like the level of investment in on-farm water infrastructure (such as dams and pumps), as well as the expected future returns from their irrigated agricultural operations.

No further data was provided by DPIE-Water around this indicator.

12 Social outcomes need to be better supported

This chapter examines how the social dimensions of the Plan's provisions can be improved, building on the findings in previous report chapters. This review has already described the current lack of clear social objectives in the Plan (**Chapter 5.1**), poorly defined community values, minimal community trust and social licence (**Chapter 7.5**), and social impacts related to water shortages and poor water quality (**Chapter 7**).

The Commission has found that the poor consideration and provision of social outcomes stems, to some extent, from a lack of understanding and definition of community water-related values and uses in the Plan. Addressing this issue requires effective and equitable stakeholder engagement and more attention to the management of social impacts, which has been lacking.

12.1 Implement equitable and effective community engagement

The Plan's implementation has suffered from a lack of effective community engagement. Feedback from consultation suggests that stakeholders feel that representation of landholders, water users and the public in water planning and management has been inequitable and ineffective.

DPIE-Water currently use the Stakeholder Advisory Panel to engage with water users in the Plan area. The Commission heard from existing panel members and external community stakeholders that it was not fulfilling its purpose, was poorly managed, and non-representative. The panel was viewed as inadequately representing the necessary range of water users and beneficiaries, being inequitably weighted towards irrigators *"everything has gone one way – to the irrigators"*, *"third party impacts just means impacts to the irrigators"*.[475] The panel has not had appropriate representation of Aboriginal stakeholders (discussed further in **Chapter 10.2.3**).

The operation of the panel was also viewed as ineffective and unstructured, such that stakeholders described a lack of genuine ability to engage and input meaningfully, *"at the Stakeholder Advisory Panel, decisions are made before we even get there"*.[476] The Commission saw evidence that technical reports were provided shortly before the meeting and minutes were poorly kept. The Commission was advised that support for representatives to understand the complex information was inadequate, leading them to became disenchanted and disengaged over time as they were unable to participate effectively and felt their presence was tokenistic.

The operation and structure of the Stakeholder Advisory Panel needs to be reviewed to implement a more equitable and effective mode of stakeholder involvement in water planning and management. Representatives of the whole community must be involved in setting and understanding Plan provisions. The revised stakeholder engagement process should focus on improving this understanding and definition of community values through the following foundational activities:

- identifying key water-dependent social values, objectives and outcomes for the Plan
- describing risks to these values, objectives and outcomes
- outlining mechanisms to maintain or improve stated social values and uses
- agreeing priorities for equitably sharing available water.

475 Consultation feedback: community member in Brewarrina LGA
476 Ibid

The aim must be to equitably share available water in line with the priorities set out in the Act and community expectations.

12.2 Provide ongoing support to achieve social outcomes

The Commission also suggests adopting social impact management strategies to ensure that the outcomes are achieved as planned. These should include:

- detailed mechanisms for complaints and grievances to be lodged and addressed in set timeframes
- mechanisms for data-sharing across plan areas for cumulative impacts
- 'community-based monitoring' and citizen science to enable community involvement in measurement and observations and experiences of social impacts
- early and ongoing community engagement in Plan revisions to ensure transparency
- early development of detailed monitoring and engagement plans for the Plan in consultation with stakeholders to ensure social outcomes are achieved (see **Appendix E** for suggested social objectives, strategies, measures and targets that could be included).

The Commission recommends that DPIE–Water:

15 To improve social outcomes, DPIE-Water should:

a) Review the Stakeholder Advisory Panel structure, representation and operation to develop more effective and equitable modes of engagement with local communities in the Plan area. Various forums should be used to gain comprehensive insights and the full spectrum of water users must be represented. This should begin immediately and continue until after the Plan is remade in 2023.

b) Use the revised stakeholder engagement model to identify key water-related community values, objectives and outcomes for the Plan, risks to these, as well as priorities for equitably sharing available water to inform the social objectives, outcomes, and strategies of the Plan. Specify links between flows, water quality measures and their target values to protect stated social values and uses of water.

The Commission suggests that DPIE–Water:

K Develop social impact strategies in consultation with stakeholders, to ensure that key mechanisms and outcomes are implemented (such as complaints and grievance mechanisms, data sharing agreements, community-based monitoring or citizen science programs, early and ongoing engagement in Plan revisions, monitoring and evaluation plans).

13 A better strategy to respond to climate change is needed

This chapter explores aspects of the Plan relating to climate change, a concern raised in many stakeholder submissions to this review. While the Plan Background Document mentions the CSIRO climate change projections, the Plan relies on existing mechanisms such as trading and carryover to allow users to adapt to reduced water availability. Climate change is not yet included in modelling of the environmentally sustainable level of take due to the complexity and uncertainties of many parameters. This is despite the clear need to assess options to account for changed water availability.

The revised Plan should better consider climate change given projected temperature increases and decreases in water availability. These revisions should:

- ensure the Plan is able to function under a range of modelled climate scenarios
- consider how water will be managed and shared equitably among all users, including the environment, as scarcity and demand on the resource increases.

13.1 Climate change is projected to reduce water availability

As outlined in **Chapter 2.8**, the CSIRO *Water Availability* report concluded that by 2030, under the best estimate of climate change, average surface water availability will reduce in the Barwon-Darling, and there will also be a 10 percent reduction in end-of-system flows.[477]

Table 20 summarises the modelling findings for the impact of wet extreme, dry extreme and best estimate climate change scenarios on two ecological values in the Barwon-Darling:

- the Talyawalka Anabranch system, which contains wetlands of national importance
- Bourke Weir, which must drown-out[478] to allow fish passage and downstream flow.[479]

Table 20: Summary of impacts of 2030 climate change modelling on two ecological values[480]

	Dry extreme	Best estimate	Wet extreme
Talyawalka Anabranch system inflow events	Inflow event volume 32% lower Period between inflows 31% longer	Inflow event volume 18% lower Period between inflows 8% shorter	Inflow event volume 8% lower Period between inflows 39% shorter
Bourke Weir drown-out events	Event volume 10% lower Period between drown-outs 66% longer	Event volume 2% higher Period between drown-outs 18% longer	Event volume 28% higher Period between drown-outs 24% shorter

477 CSIRO (2008), *Water Availability in the Barwon-Darling*, A report to the Australian Government from the CSIRO Murray-Darling Sustainable Yields Project
478 A weir is drowned, or submerged, when the water level on the downstream side is above the top of the weir.
479 CSIRO (2008), *Water Availability in the Barwon-Darling*, A report to the Australian Government from the CSIRO Murray-Darling Sustainable Yields Project
480 Ibid.

13.2 Plan provisions for adapting to climate change are limited

Stakeholders raised concerns that the Plan does not identify how increasingly scarce water will be managed and shared equitably among all users, including the environment. Community submissions also called for greater attention to climate change and projected reductions in end-of-system flows. Based on current projections, water availability is likely to decrease over the Plan's ten year duration. A process should be developed to ensure environmental water provisions, basic landholder rights and utility needs are maintained and system losses are shared across other extractive water users to prevent future water access inequity.

The NSW *Extreme Events Policy* and *Incident Response Guides* outline how water allocations will be prioritised in periods of drought or unacceptable treated water quality, however this is a reactive policy for individual events to account for climate variability, not climate change.[481] The Commission is of the view that provisions should enable gradual Plan adjustments to manage projected water availability reductions due to climate change.

Plan development considered the CSIRO climate change projections, but they were not used to develop specific provisions to enable the Plan to manage or respond to climate change.[482] The Plan relies on existing water allocation mechanisms intended to manage climate variability, such as trading and carryover to allow extractive users to adapt to reduced water availability from climate change.[483] This approach is made explicit in the both the *Barwon-Darling Water Resource Plan* and the *Basin Plan*. Consideration of climate change impacts are important to maintain the resilience of the Barwon-Darling system.

The *Barwon-Darling Water Resource Plan* identifies a low risk to water licence holders of reduced water availability under climate change as the (Water Sharing) Plan's water trading and allocation carryover help licence holders manage reduced water availability.[484] In contrast, the risk of being unable to meet drown out flow requirements to overtop Bourke Weir (enabling fish passage) under climate change was identified as a high to very high risk, to be monitored and reassessed for the 2023 Plan review.[485]

DPI-Fisheries advised that there are a number of other instream barriers in the Barwon-Darling with similar or greater estimated drown out volumes to the Bourke Weir.[486] There is a similarly high to very high risk that these structures will also not provide fish passage at appropriate times, durations and frequencies due to climate change. The cumulative impact of these structures on the health of native fish and aquatic ecosystem of the Northern Basin and

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481 DoI-Water (2018), *NSW Extreme Events Policy Policy framework for the management of NSW Murray– Darling Basin water resources during extreme events*, available at https://www.industry.nsw.gov.au/__data/assets/pdf_file/0008/187703/Extreme-Events-policy.pdf

482 NSW Office of Water (2012), *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources* Background Document, section 4.6

483 Part 3, Clause 14 of the Plan "*recognises the effects of climatic variability on river flow and groundwater levels in these water sources by having provisions that: (a) manage the sharing of water in these water sources within the limits of water availability on a long-term average annual basis and the priorities according to which water allocations are to be adjusted as a consequence of any reduction in the availability of water due to an increase in the average annual extraction against the long-term average annual extraction limit, ...*
Notes: 1 Other statutory tools are available to manage climatic variability within a water source, for example, temporary water restrictions under section 324 of the Act."

484 NSW DPI (2017), *Barwon-Darling Watercourse Water Resource Plan Surface Water (SW12) Status and Issues Paper*

485 Ibid.

486 DPI-Fisheries (2019), *Comment on the NRC's preliminary findings for the Barwon-Darling Water Sharing Plan review*, provided 25 June 2019.

Southern Connected Basin is significant and should be addressed as part of the 2023 Plan review.

The *Basin Plan* long-term average sustainable diversion limits are determined using an assessment of the environmentally sustainable level of take and come into effect in 2019 (see **Chapter 3.1**).[487] CSIRO has been part of the process to set these values, informed by detailed hydrological modelling.[488] However, climate change was not directly modelled as part of the environmentally sustainable level of take due to the complexity and uncertainties of many parameters.

Climate change is instead addressed in the *Basin Plan* by enabling the water allocation system to reduce the volume of extraction when water availability is reduced. This flexibility was intended to allow reduced availability including due to a warming and drying climate.[489] The *Basin Plan's* strategy for addressing reduced water availability include adapting to future changes through regular monitoring and review, for example:

- the 2026 *Basin Plan* review must have regard to climate change risk management
- regular review of the environmental watering priorities (annually) and environmental watering strategy(at least five-yearly) which may be updated at any time
- review of the *Basin Plan* considers evaluation criteria for protection of water-dependent ecosystems including resilience to climate change.[490]

DPIE-Water has advised the Commission that it is developing methods to better understand and address climatic risk to water management outcomes across NSW.[491] **Chapter 8.2** outlines the Commission's concerns regarding modelling, which has relied on the historic record (typically around 120 years of data). DPIE-Water is working on methods to incorporate climate change information based on DPIE-EES's NARCliM climate modelling project.[492] The project includes a more comprehensive representation of natural variability and integrates climate change projections, especially of increased evaporative demand.[493] The project extends climate information to 10,000 years of data using statistical techniques. This palaeo-climatological information indicates a likelihood of longer droughts than is represented in the historic record.[494] The climate data will be input to DPIE-Water's river system models, and the Commission recommends that this is used for future Plan development and testing to consider both climate variability and future climate change.

Submissions on the draft report repeatedly raised the importance of addressing climate change in the Plan as a priority. Given stakeholder concerns and the projected decreases in water availability, the Commission advises that the revised Plan should better address potential impacts from climate change. DPIE-Water should use a range of modelled climate scenarios to

487 MDBA (2011), *The proposed 'environmentally sustainable level of take' for surface water of the Murray-Darling Basin: Method and outcomes.*
488 MDBA (2019), *Climate change and Murray-Darling Basin Plan*, MDBA Discussion Paper.
489 Ibid.
490 Adapted from Figure 7 of MDBA (2019), *Climate change and Murray-Darling Basin Plan, MDBA Discussion Paper.*
491 Advised by DPIE-Water, via email 28 August 2019.
492 The NARCliM (NSW / ACT Regional Climate Modelling) project is developing regional climate projections for south-east Australia to span the range of likely future changes in climate. It is a collaboration between NSW and ACT governments and the University of NSW Climate Change Research Centre and will be subjected to an independent expert review, see http://www.climatechange.environment.nsw.gov.au/Climate-projections-for-NSW/About-NARCliM
493 Advised by DPIE-Water, via email 28 August 2019.
494 Advised by DPIE-Water, via email 28 August 2019.

ensure the Plan functions effectively and continues to achieve the Act's prioritisation under different potential climatic conditions. Plan provisions should also be tested under these scenarios and revised as necessary and as soon as possible, and additional allowances made within the Plan for further amendments in response to changing climatic conditions and water availability.

The Commission recommends that DPIE–Water:

16 In remaking the Plan for 2023, improve the consideration of climate change by:

a) Transparently modelling the impacts of various climate regimes considering ongoing environmental, basic landholder and utility requirements in and downstream of the Barwon-Darling to ensure the new Plan functions appropriately under a range of scenarios.
b) Reviewing and revising Plan provisions based on the climate modelling, and strengthen provisions to allow for Plan amendments to address longer-term water availability based on evidence of changing climatic conditions.

The Commission suggests that DPIE–Water:

L Outline a transparent process that will be initiated to review water sharing arrangements if significant changes in the availability of water in the system occurs as a result of climate change.

14 Groundwater management can be improved

This chapter identifies several areas for improvement relating to management of the Upper Darling Alluvial groundwater source. In summary, the Commission recommends the following:

- **clarifying management scope** – defining water source connectivity and the type of groundwater dependent ecosystems present in the area, and clarifying which are being managed under the Plan
- **identifying high priority ecosystems** – the area is likely to contain high priority groundwater dependent ecosystems that should be protected
- **addressing knowledge gaps** – particularly around the extent of localised fresh groundwater sources, and connectivity of groundwater and surface water.

14.1 Groundwater dependent ecosystems need to be better defined

Groundwater dependent ecosystems are classified according to the ecosystems they support (**Table 21**). All of these ecosystem classifications can be impacted by reduced groundwater quantity (flow or level) or an alteration to existing groundwater quality. However, the different groundwater dependent ecosystems vary in the level of water dependence, for example Types 2 and 3 may be obligate (need groundwater to survive) or facultative (opportunistically use groundwater when available). They also have differing risk profiles, with Type 3 likely more tolerant to changes in groundwater than Type 2, which are in turn more tolerant than Type 1.

Table 21: Classification of groundwater dependent ecosystems[495]

Type 1	**ecosystems living in an aquifer** - for example stygofauna, which is fauna found in groundwater systems such as caves.[496]
Type 2	**ecosystems supported by discharging groundwater to the surface** - for example wetlands, seeps, springs and river baseflow.
Type 3	**ecosystems supported by the subsurface presence of groundwater** - for example terrestrial vegetation.[497]

As a result of these varying dependencies and risk profiles, different groundwater dependent ecosystem types require different management considerations.[498] Water sharing plans currently do not distinguish the type of groundwater dependent ecosystems, although the Plan appears to focus on groundwater use by Type 2. A simple high, medium and low system is currently used to determine the value of and risk to groundwater sources.[499] Reference to groundwater dependent ecosystems in the Plan should be updated to clarify if all types are to be considered, and indicate risk tolerance.

495 These types are used by the Bureau of Meteorology and the Independent Expert Scientific Committee in its guidelines to assess groundwater dependent ecosystems

496 The Commission notes that DPIE-Water are progressing research into the science behind stygofauna watering requirements. These requirements are currently largely unknown making rule development difficult.

497 Cresswell, R for EcoLogical (2019), *Technical advice related to groundwater dependent ecosystems and groundwater as covered by the Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources (2012),* for the Natural Resources Commission 15 May 2019.

498 Ibid.

499 NSW Office of Water (2012), *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources Background Document*

Within the Plan, groundwater dependent ecosystems are protected only via rules applying to groundwater access and considering impacts to surface water-groundwater connectivity. Further, the rules in the Plan only apply to high priority groundwater dependent ecosystems, which neglects low and medium priority groundwater dependent ecosystems considered in other legislation such as the *Environmental Planning and Assessment Act 1979*.[500] Any intended protection or consideration of these ecosystems should be clarified.

14.2 High priority groundwater dependent ecosystems need protection

Plans are required to reserve water for the overall health of groundwater dependent ecosystems.[501] The current Plan includes provisions[502] specifically to protect high priority groundwater dependent ecosystems. However these rules are not in use because no high priority groundwater dependent ecosystems are identified in Plan Schedule 6, although some are likely to be present in the Plan area.[503] The Commission understands that the Upper Darling Alluvium groundwater source is likely to have high priority groundwater dependent ecosystems because:

- recent work by DPIE-Water identified that the Darling alluvium groundwater supports significant groundwater dependent ecosystems including wetlands, vegetation and base flow ecosystems, with mainly high or medium ecological value (**Figure 24**)[504]
- the Bureau of Meteorology's Groundwater Dependent Ecosystem Atlas maps high potential for groundwater dependent ecosystems widely throughout the Plan area[505]
- there are a number of terrestrial ecosystems (such as river red gum communities) in the Plan area that are defined in upstream tributaries (Gwydir, Border Rivers, Namoi, Macquarie, and Bogan) as high priority groundwater dependent ecosystems and listed as such in the relevant water sharing plans[506]
- the shallow water tables in the Upper Darling Alluvium makes it likely that wetlands in the Plan area are groundwater dependent.[507]

The Commission notes the significant work DPIE-Water has completed in identifying Type 3 groundwater dependent ecosystems (specifically high ecological value aquatic systems), as shown in **Figure 24**. The Commission advises that DPIE-Water should progress this work to identify and protect high priority groundwater dependent ecosystems in the Plan area and ensure that these are listed and protected under relevant Plan provisions. If a decision is made

500 Cresswell, R for EcoLogical (2019), *Technical advice related to groundwater dependent ecosystems and groundwater as covered by the Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources (2012),* for the Natural Resources Commission 15 May 2019.

501 NSW Office of Water (2012), *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources: Background Document*, NSW Government, Sydney.

502 Specifically provisions for water supply works approvals near groundwater dependent ecosystems, Plan clause 58.

503 NSW Office of Water (2012), *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources: Background Document*, NSW Government, Sydney; and Cresswell, R for EcoLogical (2019), *Technical advice related to groundwater dependent ecosystems and groundwater as covered by the Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources (2012),* for the Natural Resources Commission 15 May 2019.

504 DPI Water (2017), *Darling Alluvium Water Resource Plan (GW7), Status and Issues Paper*

505 Available online at http://www.bom.gov.au/water/groundwater/gde/.

506 Cresswell, R for EcoLogical (2019), *Technical advice related to groundwater dependent ecosystems and groundwater as covered by the Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources (2012),* for the Natural Resources Commission 15 May 2019.

507 Ibid.

to protect or consider the requirements of low or medium priority groundwater dependent ecosystems, this will also need to be updated and reflected in the Plan.

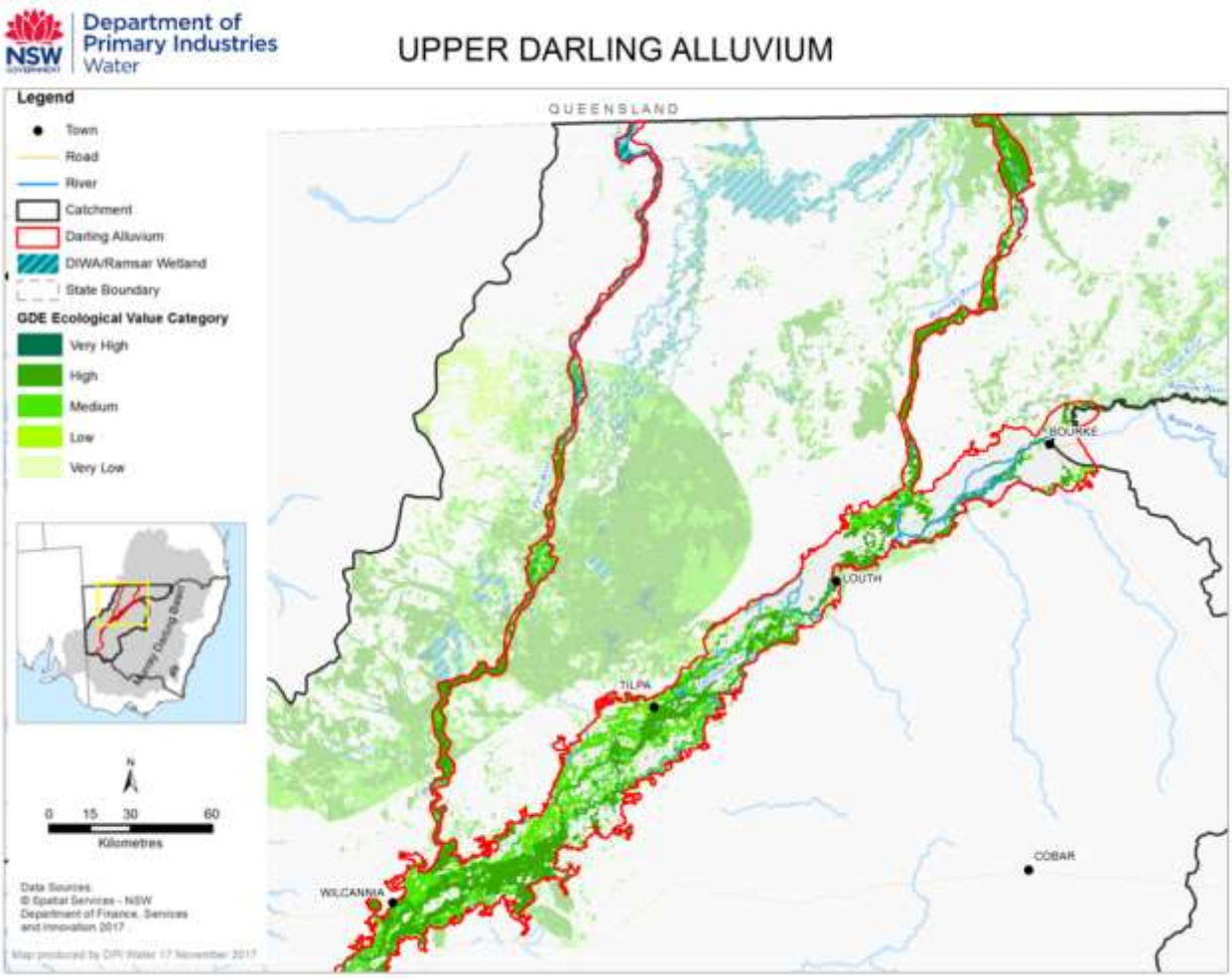

Figure 24: Ecological value for high probability groundwater dependent vegetation ecosystems in and around the Upper Darling Alluvium[508]

14.3 Set back distances for works should be consistent across policies

Set back distances aim to minimise potential impacts from groundwater extraction to environmental features such as groundwater dependent ecosystems. The NSW *Aquifer Interference Policy* holistically protects groundwater dependent ecosystems, considering both potential water level and quality impacts.[509] It represents a considered approach to groundwater dependent ecosystem protection and provides the basis for the set-back distances proposed under the *Draft Groundwater Policy*.[510] The *Aquifer Interference Policy* also proposes the method for assessing set back distance and provides a reporting framework.

Under the *Aquifer Interference Policy*, the onus is placed on the water access licence applicant to determine the safety margin of the development. It is currently unclear if the *Aquifer Interference*

508 Taken from DoI-Water (2019), *Draft Darling Alluvium Water Resource Plan: Groundwater Resource Description*.
509 NSW DPI – Office of Water (2012), *NSW Aquifer Interference Policy: NSW policy for the licensing and assessment of aquifer interference activities*, available at https://www.water.nsw.gov.au/__data/assets/pdf_file/0004/549175/nsw_aquifer_interference_policy.pdf
510 DoI-Water (2019), *NSW Government Draft Groundwater Policy*, as presented at SAP meeting 5 and 6 June, 2018.

Policy method will be retained in the *Draft Groundwater Policy*, though the inference is that existing rules (where stipulated) will be applied.

In the interests of consistency and transparency, set back distance rules should be consolidated across all water sharing plans and aligned with the *Aquifer Interference Policy*. Caveats currently in the Plan enable the Minister to use discretion to vary these distances following adequate studies and these should be retained.

Under the *Aquifer Interference Policy* if an entire aquifer is considered a high priority groundwater dependent ecosystem, all proposed extraction works require studies to determine the extent of impact and that impact in context of the water source as a whole. This is particularly relevant in the Upper Darling Alluvium, where many water sources are localised lenses in the shallow aquifer system.[511]

14.4 Groundwater connectivity and quality is a key knowledge gap

Connectivity[512] is a critical consideration in the management of surface and groundwater resources. A current Plan objective is *provide recognition of the connectivity between surface water and groundwater*"; however, the only directly relevant performance indicator related to groundwater is "*change in surface water and groundwater extraction relative to the long-term average annual extraction limits*".

Connectivity is not adequately considered in the Plan on the premise that the system is 'less highly connected'.[513] Further, the Plan focuses on the contribution of groundwater to surface water, and does not adequately consider the importance of shallow groundwater recharge from surface water. Although parts of the Upper Darling Alluvium may not be highly connected, there is evidence indicating connectivity between surface water and (shallow) groundwater. This connectivity is spatially and temporally dependent and varies according to climatic regimes and abstraction.

Direct connectivity is strongly dependent on river flow. The hydraulic head difference between the river and the aquifer determines the direction of flow with the flow rates determined by the hydraulic gradient between surface and groundwater. Connectivity generally varies with time as water tables fluctuate with seasons, floods and abstraction regimes. **Figure 25** shows various gaining and losing river reaches. There are areas where the high level of connectivity is crucial in maintaining both surface water flow (through base flow) and useable, shallow groundwater availability (through direct freshwater recharge).[514] The Plan should therefore consider both

511 Cresswell, R for EcoLogical (2019), *Technical advice related to groundwater dependent ecosystems and groundwater as covered by the Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources (2012),* for the Natural Resources Commission 15 May 2019.

512 Water systems can be considered as connected where abstraction:
- from groundwater can affect the quantity, quality and/or reliability of abstraction from surface water, or
- from surface water can affect the quantity, quality and/or reliability of abstraction from groundwater, or
- of water from surface or groundwater can affect water supply to ecosystems relying on both sources (such as low flows in rivers and some wetlands). Summarised from SKM (2011), *National framework for integrated management of connected groundwater and surface water systems,* Waterlines report series No. 57, National Water Commission, Canberra.

513 NSW Office of Water (2012), *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources* Background Document

514 CSIRO (2008). *Water availability in the Barwon-Darling. A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project*, CSIRO, Australia; and Department of Primary Industries (2017). *Darling Alluvium Water Resource Plan Groundwater (GW7), Status and Issues Paper,* available at https://www.industry.nsw.gov.au/__data/assets/pdf_file/0010/157348/Darling-GW-SIP.pdf

directions of exchange between surface and groundwater systems, managing the river and alluvial system as a single connected water source. This is consistent with the *National Water Initiative* recommendations.

The Commission notes there are significant knowledge gaps around lateral connectivity of the Upper Darling Alluvium (and therefore the recharge and movement of groundwater) that are of concern given the potential impact on localised sustainable extraction levels. Overall the groundwater system is allocated well below the estimated sustainable extraction limit, and as such the current level of extraction is considered to be sustainable. However, on a localised scale, the premise of sustainability relies heavily on the assumption that there is groundwater recharge though surface connectivity.

There are also knowledge gaps around current groundwater quality. Most government monitoring bores have not been sampled for water quality (specifically salinity) since they were developed, with bores sampled upon construction and in some cases periodically for a number of years after.[515] There has also been no seasonal assessment of salinity to compare with climatic variability and river flow, which are expected to be significant drivers of water quality. This is an issue for local communities that rely on alluvial groundwater for freshwater drinking supplies or for stock and domestic use.

Salinisation of existing freshwater supplies will be difficult to remediate except for in very shallow, connected sources. Further, even these shallow, connected sources rely on periodic recharge from flood events, which may reduce under projected climate change.[516] This raises concerns regarding the localised sustainability of freshwater extraction from the Upper Darling Alluvium due to uncertainties around recharge and supply. Most water supply bores, including the Wilcannia town supply bore, and stock and domestic use bores, access shallow, discrete lenses of water, which could be impacted by salinity if over extracted. This is a risk. Implementing the *Reasonable Use Guidelines* (see **Chapter 9.5.1**) will help quantify the un-metered local extraction by stock and domestic groundwater bores. As recommended in the recent business case addendum on the Wilcannia weir replacement, the local hydrogeology should also be investigated to better understand connectivity, both for risks to the weir pool supply and also risks to the groundwater supply and recharge.[517]

515 Taken from DoI-Water (2019), *Draft Darling Alluvium Water Resource Plan: Groundwater Resource Description*.

516 Cresswell, R for EcoLogical (2019), *Technical advice related to groundwater dependent ecosystems and groundwater as covered by the Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources (2012),* for the Natural Resources Commission 15 May 2019.

517 NSW Public Works Advisory (2019), *Wilcannia Weir Upgrade – Addendum to Business Case*, available at https://www.industry.nsw.gov.au/__data/assets/pdf_file/0019/235045/Wilcannia-Weir-Business-Case-Addendum.pdf

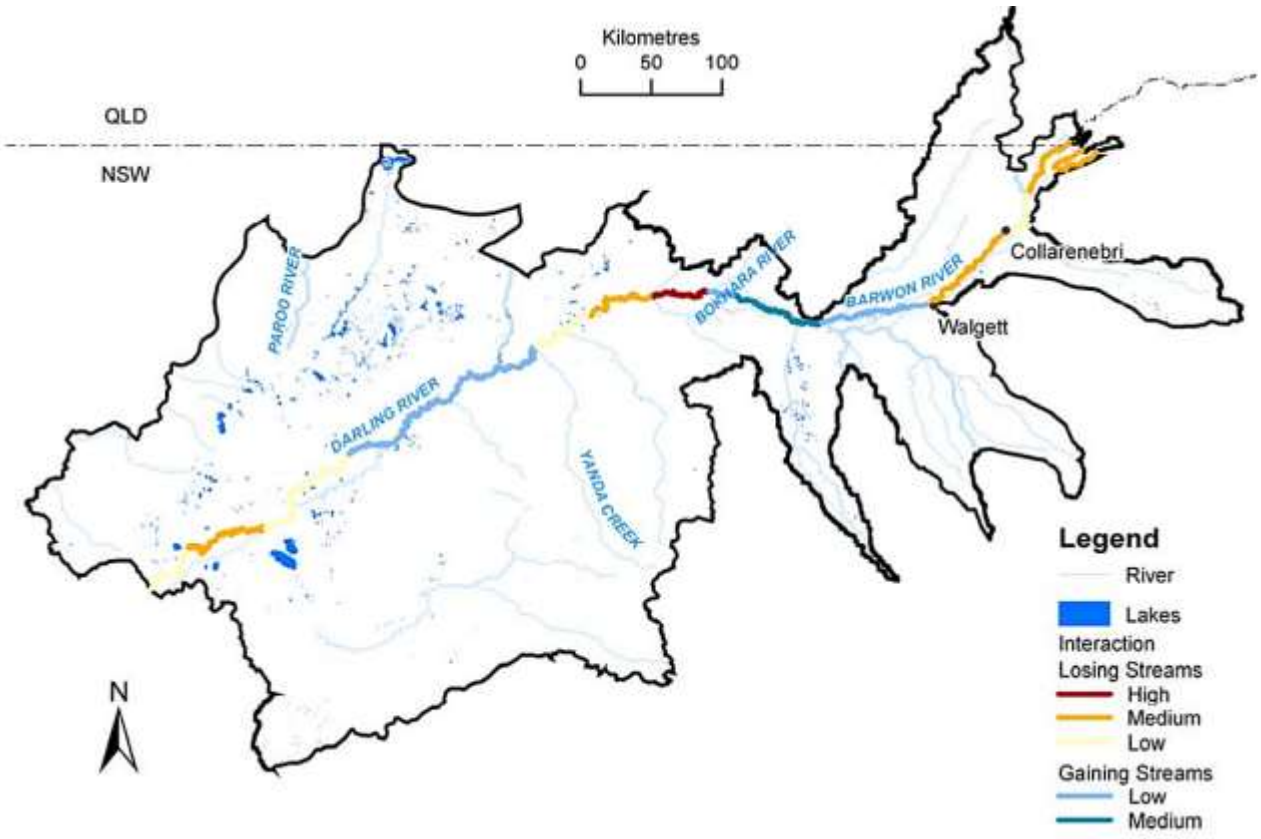

Figure 25: Modelled surface water-groundwater connectivity in the Barwon-Darling alluvial aquifers[518]

The Commission recommends that DPIE–Water:

17 Improve consideration of groundwater in the Plan by:

a) Confirming the presence, classification and extent of high priority groundwater dependent ecosystems across the Plan area through on-ground studies.

b) Clearly defining groundwater related terms in the glossary, including connectivity and terms used to describe groundwater dependent ecosystems – priority, ecological value, potential and type. Connectivity should include both discharge of groundwater to surface water and surface water recharge to shallow groundwater systems.

The Commission suggests that DPIE–Water:

M Improve groundwater understanding and management by reviewing the extent of localised fresh groundwater sources and confining beds in the sequence of aquifers to assess the lateral interconnectivity of groundwater supplies, focusing on connectivity around Wilcannia to better understand risks to freshwater used for supplementary town water.

[518] CSIRO (2008). *Water availability in the Barwon-Darling. A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project*, CSIRO, Australia.

15 Compensation implications are minimal

This chapter addresses the compensation implications of the recommendations put forward in this review. The Commission has examined potential compensation requirements under both sections 87 and 87AA of the Act on the basis that it is recommending some amendments are made to the Plan prior to the expiry of the Plan.

The Commission has been advised that there are unlikely to be compensation implications as a result of these recommendations, providing the changes do not amount to an involuntary de facto reduction in overall allocation.

15.1 The Commission must examine compensation requirements

Section 43(3A) of the Act requires the Commission to consider certain potential compensation requirements resulting from recommended changes to the Plan described in its report. Under the Act, compensation is payable by the state to holders of access licences only in certain circumstances where water allocations[519] under a water sharing plan are reduced.

Specifically, the Act states:

> *(3A) If a report of the Natural Resources Commission under subsection (3) recommends changes to a management plan that will result in a reduction of water allocations in relation to which compensation might be payable under section 87AA, the Commission is to state in the report whether the purpose of the proposed changes is:*
>
> *(a) to restore water to the environment because of natural reductions in inflow to the relevant water source, including but not limited to changes resulting from climate change, drought or bushfires, or*
>
> *(b) to provide additional water to the environment because of more accurate scientific knowledge that demonstrates that the amount previously allocated to the environment is inadequate.*

Key provisions related to compensation are set out in section 87 and section 87AA of the Act. Section 87 specifies that compensation applies for certain reductions in water allocations arising during the initial (10 year) term of a water sharing plan, only where amendments are not already contemplated in a water sharing plan. Section 87AA makes clear that compensation applies to amendments to the Plan after its 10 year term (30 June 2023). In addition, the Minister has an overriding discretion under section 87 (but not under section 87AA) to determine whether or not compensation should be paid and, if so, the amount of any such compensation and the manner and timing of any such payments.

The Commission's required considerations regarding compensation under the Act are fairly narrow. However, given that the Commission is recommending some changes to be made via upcoming amendments, the Commission has examined potential compensation requirements under sections 87 and 87AA.

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519 The definition of "water allocation" under the Act is "*the water to which the holder of an access licence is entitled from time to time under the licence, as recorded in the water allocation account for the licence*". "Water allocation account" is in turn defined by reference to section 85. Arguably the water allocation is the *total* amount which a holder is entitled from time to time (which would be based on annual allocations, amounts carried over, and amounts traded).

15.2 Compensation is considered unlikely for most recommendations

Table 22 summarises the likelihood of compensation arising from various changes being considered in this review. The Commission is of the view that nearly all of the recommended changes put forward in this report will not trigger compensation requirements as they are:

- **outside the 10 year term –** changes relating to A, B and C Class licences after the initial Plan period are not included under 87AA and therefore don't require compensation
- **already contemplated in the existing Plan** - for example IDELS and TDELS, cultural water allocations, introduction of active management and, in certain circumstances, amendment of cease to pump thresholds (examples are shaded in blue in **Table 22**)

  or
- **not resulting in reduction in total water allocation** - for example metering, active management, changes to the 300 percent take rule, introduction of resumption of flows rules.

One exception is the recommended changes to unlimited carryover. If changes to the carryover provision limited the feasibility of using accrued volumes in a required timeframe, then an entitlement to compensation may be triggered. However, where carryover has not yet accrued, there is no relevant reduction for compensation purposes.

There could also be compensation associated with other changes if they were made before Plan expiry in 2023 if changes restrict extraction to the extent that they could be considered to be a de facto reduction in allocation. For example, this could occur in the case of amendments to the cease to pump thresholds and the introduction of IDELs, TDELs or active management.

Table 22 is based on legal advice received from a Barrister external to the NSW Government. While the Commission has provided our understanding of compensation requirements, DPIE-Water should seek their own legal advice in regards to any potential compensation implications of implementing the recommendations.

Table 22: Summary of likely compensation implications for recommended Plan changes

Potential change	Compensation likely?		Comment
	Pre-2023	Post-2023	
Amendment of cease to pump thresholds	No, with conditions	No	No compensation post-2023. No compensation pre-2023 if it is in line with clause 78(b) (amendment after five years and evidence of impact on aquatic ecosystem or fish species) – and thus an **already contemplated amendment** - and does not alter long term annual extractions. Compensation considered unlikely in other pre-2023 instances unless the amendment is so restrictive it is a de facto reduction in water allocation. **Note:** Changes would need to keep the relative priority of A, B and C Class licences, otherwise a change from A to B could be seen as a compulsory acquisition of property.
Resumption of flows rule	No	No	Not expected to give rise to compensation, as it is not (in fact or in substance) a reduction in water allocations.
Introduction of IDELs and TDELs	No, with conditions	No	No compensation post-2023. It is possible that pre-2023 IDELs would count as an **already contemplated amendment** based on 78(g1), although there is some doubt around this as that provision was itself amended in 2018. Similarly, TDELs based on 78(h). Compensation still considered unlikely in pre-2023 instances unless the amendment is so restrictive it is a de facto reduction in water allocation. This advice assumes TDELs introduced before 2023 reflect the sum of the IDELs.
Introduction of active management	No, with conditions	No	No compensation post-2023. It is possible that pre-2023 this change would count as an **already contemplated amendment** based on 78(j), although there is some doubt around this as that provision was itself an amendment in 2018. Compensation still considered unlikely in pre-2023 instances unless the amendment is so restrictive it is a de facto reduction in water allocation.
Metering	No	No	Not expected to give rise to compensation, as it is not (in fact or in substance) a reduction in water allocations.
Limiting carryover	Yes	Yes	Changing the unlimited carryover rules may trigger an entitlement to compensation, particularly if the carryover limits to be applied in future years were such that it would not be practically feasible to use currently accrued volumes in the required timeframe.

Potential change	Compensation likely? Pre-2023	Post-2023	Comment
			However, if the rules maintained access to current carryover volumes and only prevented carryover of future volumes yet to be granted there would not likely be compensation. Changes to carryover provisions would be made taking into account the fact that more accurate scientific knowledge indicates water allocations to the environment are inadequate.
300 percent rule	No	No	Considered unlikely. This rule change would not affect the total water allocation, therefore not give rise to compensation.
Aboriginal cultural water allocation	No	No	Amending the Plan after year five to provide rules for the protection of Aboriginal cultural assets would not lead to compensation, as this is an **already contemplated amendment** by the Plan (clause 84(5))
Interim Flow Plan	No	No	Considered unlikely given the temporary restrictions.
Changes to Available Water Determinations and long-term average annual extraction limits	No, with conditions	No	There may be scope to change the Available Water Determinations and in future years (including, if necessary, changing the long-term average annual extraction limit), without triggering entitlements to compensation. This would depend on whether the current Available Water Determinations complies with clause 39 of the Plan, which refers to the calculation of the volume in megalitres per unit of share component in accordance with the provisions on long-term average extraction.

Note: blue shading indicates an already contemplated amendment

	The Commission suggests DPIE–Water:
N	While the Commission has provided our understanding of compensation requirements, DPIE-Water should seek their own legal advice in regards to any potential compensation implications of implementing the recommendations.

16 The road map: towards a new Plan in 2023

The Commission notes the recent efforts of DPIE-Water to address issues in NSW water planning and management. The recommendations in this report aim to enhance and progress improvements and better address the adverse environmental, social, cultural and economic impacts currently being experienced in the Plan area.

Local community members in the Barwon-Darling are expressing distrust in water planning and management. In this context, it is essential that the process of change is informed by diverse stakeholders, clearly communicated and consistently delivered.

To support this approach, the Commission has included a road map for change to provide staged guidance for developing and implementing immediate amendments and the Plan remake. Immediate amendments will help to demonstrate commitment to change and build momentum for the more detailed work required to deliver the new Plan in 2023. This type of staged approach will also help to rebuild community trust by recognising issues and improving outcomes as soon as possible.

It is imperative that DPIE-Water commits to clear timelines for implementing agreed actions and transparently reports on these to the public. The Commission proposes the following stages:

- **Stage 1**: implementing immediate amendments allowable under the current Plan by end December 2019
- **Stage 2**: undertaking research and engagement actions to support development of the new Plan in the period 2020–23
- **Stage 3**: supporting effective implementation of the new Plan from 2023 onwards.

Table 23 expands on the Commission's proposed timing, broadly grouping the various recommended and suggested actions within each of the three stages. We consider the recommendations and actions in Stage 1 to be the minimum required under the *Water Management Act 2000*. Further work including modelling by DPIE-Water will need to be undertaken to inform aspects of the Plan remake in Stages 2 and 3.

Table 23: Roadmap for a Plan remake in 2023

STAGE 1: 2019 Provide immediate amendments and outcomes	STAGE 2: 2020-2023 Remake the Plan based on best knowledge	STAGE 3: 2023 ONWARD Support effective and active Plan delivery
Key objectives: 1) Protect low flows 2) Begin active water management 3) Recognise Aboriginal rights 4) Accelerate changes already underway	**Key objectives:** 1) Identify water rights, values and needs 2) Plan for variability and future shocks 3) Improve stakeholder engagement 4) Improve knowledge base	**Key objectives:** 1) Undertake transparent active management 2) Implement ongoing monitoring, evaluation and reporting 3) Improve risk and issue management
Immediate amendments: a) Ensure amendments are consistent with the prioritisation specified in the Act. b) Implement flow targets c) Amend A Class licences: raise the cease to pump thresholds d) Implement IDELs and TDELs, limit IDEL trade to the river reach e) Protect resumption of flows and eliminate take of 'imminent flows' f) Include and implement updated *Interim Flow Plan* provisions in the Plan g) Provide an interim water allocation for Aboriginal nations h) Include recognition of Barkandji and Malyangapa native title rights i) Allow for future native title determinations	**Actions for developing the new Plan:** a) Ensure remake is consistent with the prioritisation specified in the Act b) Review the cease to pump thresholds c) Revise TDELs based on connectivity d) Assess entitlements under B Class licenses e) Improve and update modelling f) Analyse an appropriate limit on annual take and the carryover provision g) Identify key environmental, social, Aboriginal and economic values and objectives h) Define take and flow requirements to meet basic landholder rights and utility needs i) Apply water quality targets for flow bands j) Simplify processes for Aboriginal water access	**Ongoing actions for implementing the Plan:** a) Implement monitoring, evaluation and reporting program b) Undertake complete active management c) Implement a mid-term review d) Undertake the required end-term evaluation.

STAGE 1: 2019 Provide immediate amendments and outcomes	STAGE 2: 2020-2023 Remake the Plan based on best knowledge	STAGE 3: 2023 ONWARD Support effective and active Plan delivery
j) Protect held environmental water without a section 324 order k) Strengthen accountability of WaterNSW and DPIE-Water l) Finalise and implement monitoring, evaluation and reporting program m) Review representation and facilitation of the Stakeholder Advisory Panel.	k) Enhance planning for climate change l) Improve groundwater considerations m) Progress active management n) Explore remote telemetry o) Provide for regular independent reviews.	
Suggested actions: a) Support water operator to implement active management b) Support securing A Class licences c) Roll out metering, gauging and information technology d) Review institutional modelling arrangements e) Finalise floodplain harvesting policy f) Update and implement *Interim Flow Plan* provisions in tributary water sharing plans g) Seek legal advice regarding compensation implications	**Suggested actions:** a) Implement floodplain harvesting policy b) Improve Northern Basin connectivity c) Resource complementary actions d) Develop water quality targets for flow bands with community consultation *e)* Finalise and implement *Reasonable Use Guidelines* f) Develop a NSW *Aboriginal Water Strategy* g) Assess the interconnectivity of groundwater supplies. h) Develop social impact strategies i) Develop a transparent process for responding to climate change	

17 Appendices

Appendix A: Submission questions

The Commission developed five questions to determine the contribution of the Plan to environmental, social and economic outcomes. These were included in the call for submissions on the *Water Sharing Plan Barwon-Darling Unregulated and Alluvial Water Sources 2012*. Non-confidential submissions were made public on the Commission's website.

The questions were as follows

1. To what extent do you feel the plan has contributed to social outcomes?
2. To what extent do you feel the plan has contributed to environmental outcomes?
3. To what extent do you feel the plan has contributed to economic outcomes?
4. To what extent do you feel the plan has contributed to meeting its objectives?
5. What changes do you feel are needed to the water sharing plan to improve outcomes?

Appendix B: Demographic and socio-economic data charts

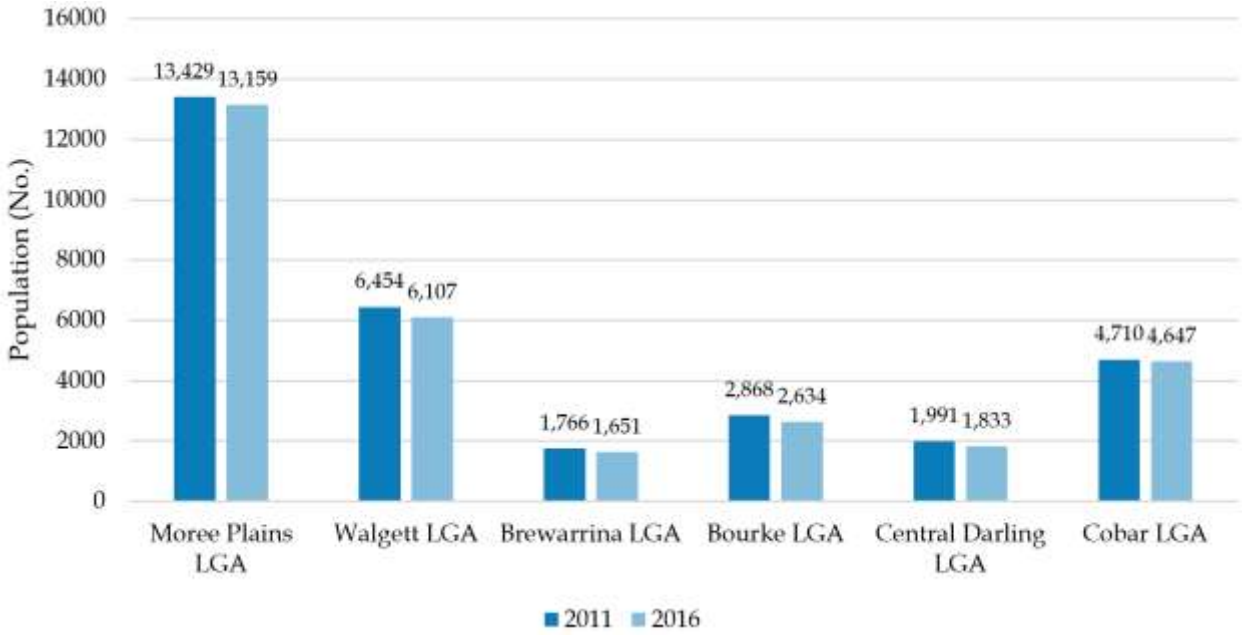

Figure B1: Change in population, Barwon-Darling LGAs 2011 and 2016[520]

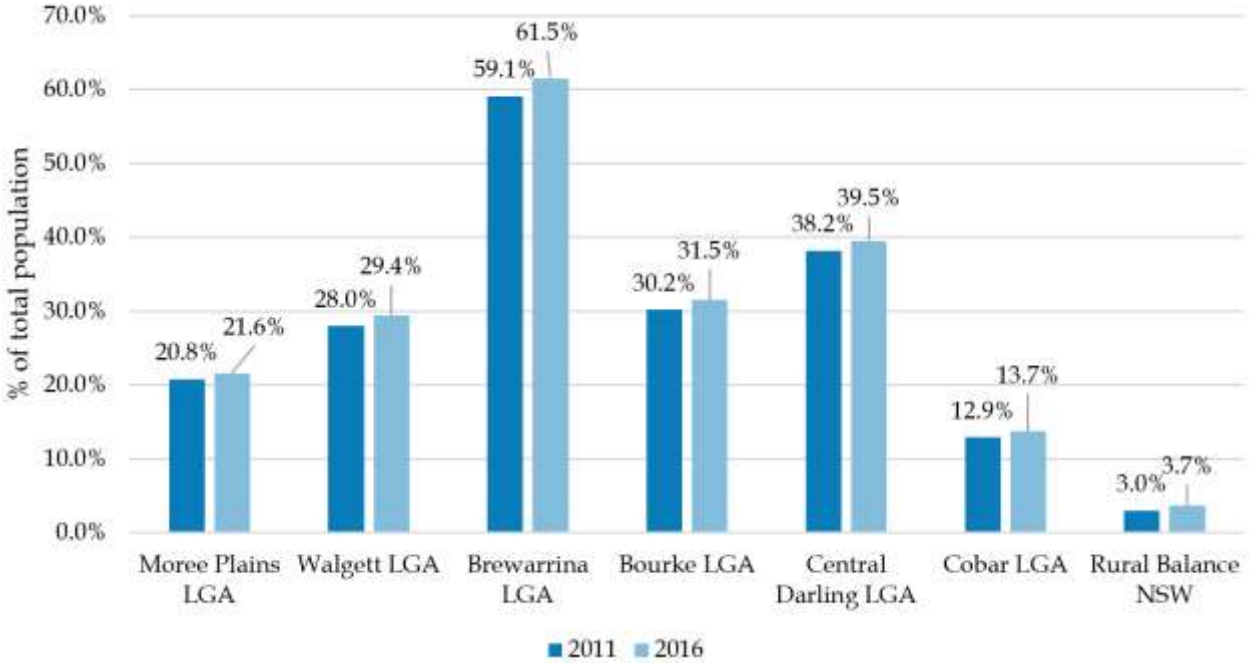

Figure B2: Aboriginal and Torres Strait Islander percentage of total population, Barwon-Darling LGAs[521]

520 Australian Bureau of Statistics (ABS) (2011), *Census of Population and Housing. General Community Profile*. Catalogue Number 2001.0 Brewarrina (A) (LGA11200); Bourke (A) (LGA11150); Walgett (A) (LGA17900); Moree Plains (A) (LGA15300); Central Darling (A) (LGA11700); Cobar (A) (LGA11750); NSW Rural Balance (Code SOS13)

521 Ibid.

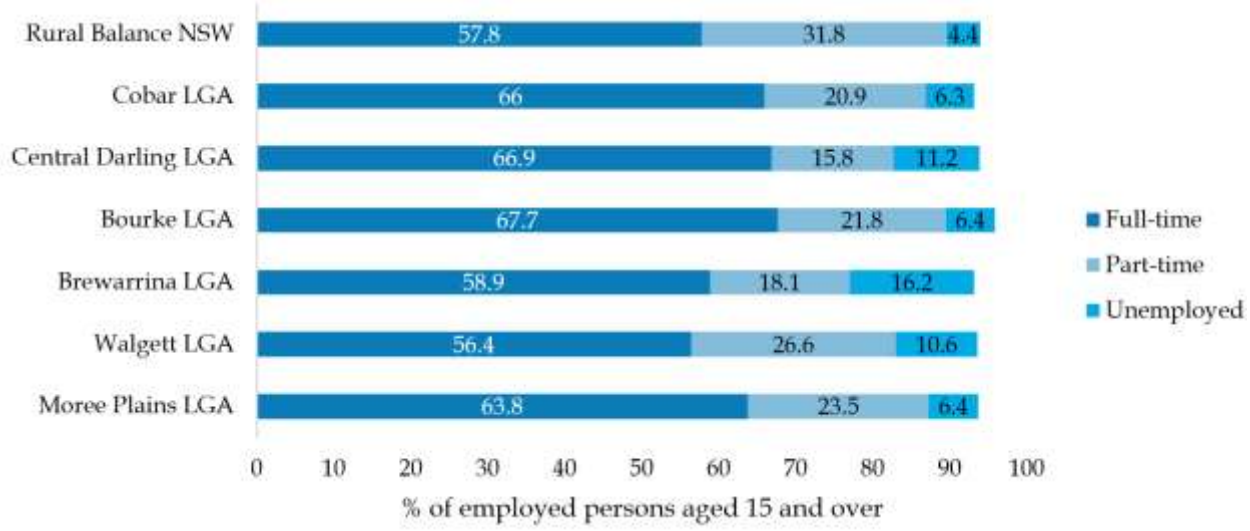

Figure B3: Employment status, Barwon-Darling LGAs 2016[522]

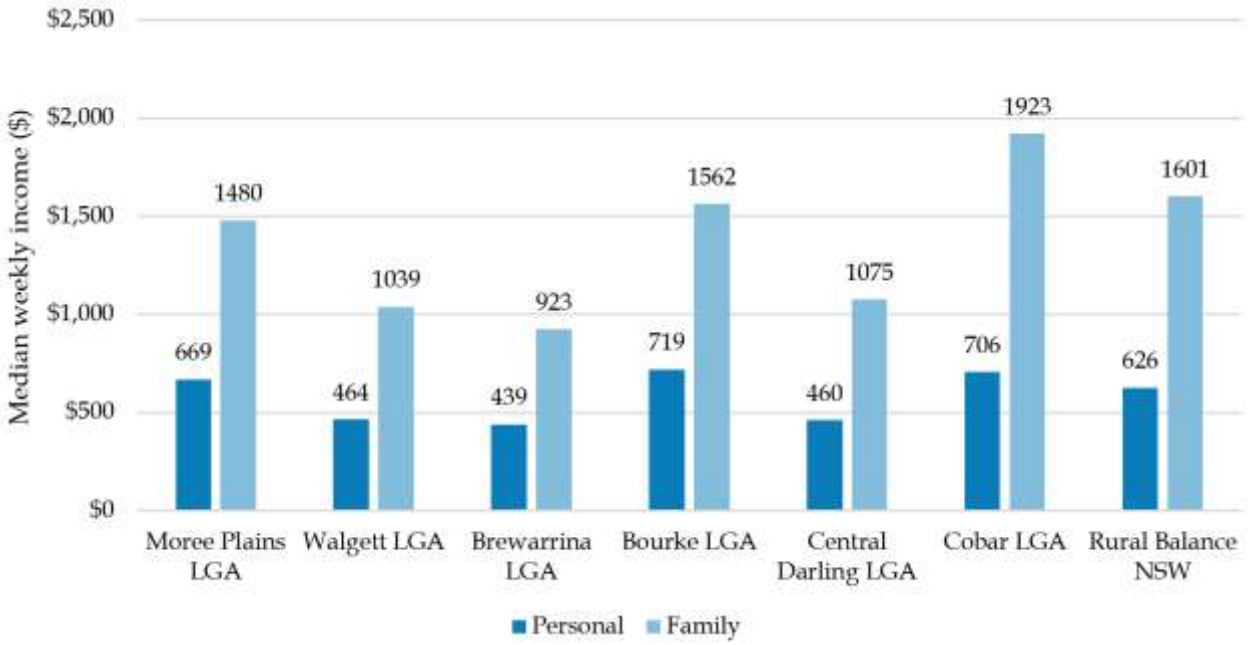

Figure B4: Median weekly income (personal and family), Barwon-Darling LGAs 2016[523]

522 Australian Bureau of Statistics (ABS) (2011), *Census of Population and Housing. General Community Profile*. Catalogue Number 2001.0 Brewarrina (A) (LGA11200); Bourke (A) (LGA11150); Walgett (A) (LGA17900); Moree Plains (A) (LGA15300); Central Darling (A) (LGA11700); Cobar (A) (LGA11750); NSW Rural Balance (Code SOS13).

523 Ibid

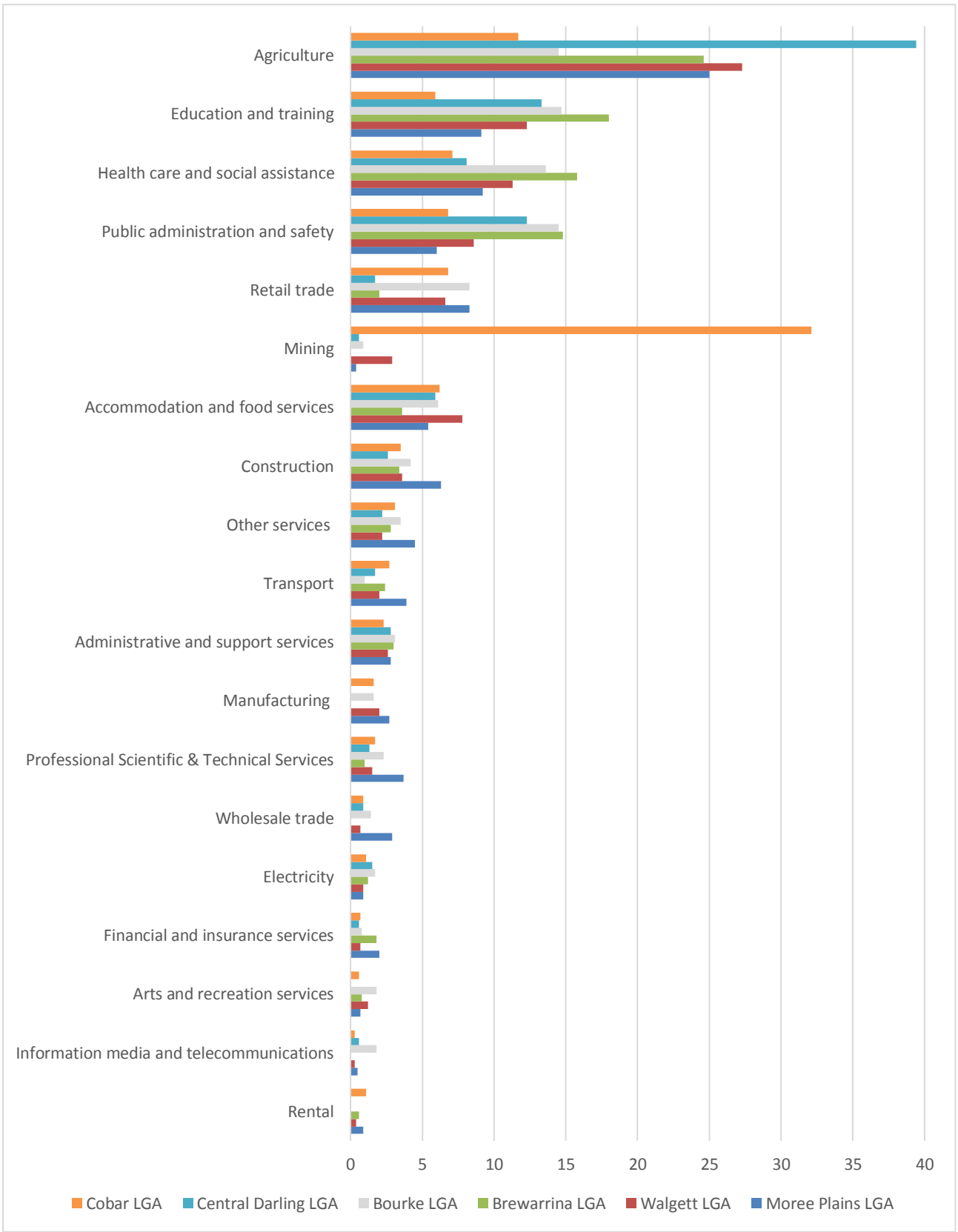

Figure B5: Industries of employment, Barwon-Darling LGAs 2016[524]

524 Australian Bureau of Statistics (ABS) (2011), *Census of Population and Housing. General Community Profile*. Catalogue Number 2001.0 Brewarrina (A) (LGA11200); Bourke (A) (LGA11150); Walgett (A) (LGA17900); Moree Plains (A) (LGA15300); Central Darling (A) (LGA11700); Cobar (A) (LGA11750); NSW Rural Balance (Code SOS13)

Appendix C: Changes in the exhibited and gazetted Plan

The table below provides an overview of notable changes that occurred between the 2011 draft Plan and the 2012 gazetted Plan. The table was prepared using the limited information that is publicly available which outlines the reasons for the proposed changes and also information provided in stakeholder submissions for this review. Whilst difficult in many cases to make an assessment of the impacts of these changes on the Plan outcomes given limited data some of the changes could have had substantive impacts on the Plan's operation and its outcomes.

In particular, the Commission has recommended that the change from a 450 percent share component take over three years to 300 percent share component take every year for A, B and C class licences be revisited to further understand associated impacts (see recommendation 10c).

2011 draft Plan	2012 gazetted Plan	Comments
Div 3, 23	Div 3, 23	The share component for local water utilities was changed in the final Plan. The change appears to be the result of more accurate modelling by DPIE-Water as well as stakeholder consultation about the needs of the six town water supplies in the Barwon-Darling.
Div 3, 26, 27,28	Div 3, 26, 27,28	The share component of A Class, B Class and C Class was changed. It is unclear (and information is limited) what caused the amendment in share component. However, it should be noted that the change in the share components of the A Class, B Class and C Class licences has also shifted the volumes of 'cease to pump' in the individual licence classes.
Div 3, 31	Div 3, 31	The clause relating to the amendment of share components of access licences was tailored to the Barwon-Darling. Without further information about the modelling or about Div 3, 31 (3), it is difficult to determine if the proposed weighting of active and inactive annual volumetric limits has an impact on Plan operation.
Div 1, 34 (2) Note	Div 1, 33 (2) Note	The long-term average annual extraction volume was changed following amendments to the IQQM model for the Barwon-Darling. Without further information about the model, it is difficult to determine if this had a material effect on Plan operation.
Div 1, 44 (2-3)	Div 1, 42 (2-3)	The clause on access licence account management rules was significantly rewritten. Of note, the gazetted Plan: ▪ includes separate access conditions for unregulated river access licences (A Class, B Class and C Class) and other access licences. ▪ replaces clause 44(3) limiting individual extraction to 450 percent of the share component over three years with clause 44(2) limiting extraction to 300 percent of the share component per water year for A,B and C class licences.
Div 2, 48	Div 2, 46 (3)	This revised clause limits the water take of 'stock and domestic' access licence holders during specific flow conditions in the Barwon-Darling.

2011 draft Plan	2012 gazetted Plan	Comments
		According to the 2012 Plan background document,[525] data gaps around stock and domestic existed at the time the Plan was gazetted.
-	Div 2, 47; Div 2,48; Div 2, 49 and Div 2;50	Clauses on access for survival watering, imminent flows for A and B Class licences and access for Aboriginal environmental licences were added to the Plan. These effectively replaced the previous 'notwithstanding' clause that gave the Minister the discretion to allow access to water other than under the conditions specified on the licence. Limited information is available whether any detailed analysis had been undertaken prior to the introduction of these clauses to assess the impact on extractions in the Barwon-Darling.
Div 2,49	Div 2, 51	In the gazetted Plan, the specific Total Daily Extraction Limits (TDELs) were removed. However, as TDELs had not been implemented at the time the Plan took effect in 2012 (and are still not implemented in the Barwon-Darling), it is difficult to assess if the previous limits would have been appropriate.
Div 2, 50	Div 2, 52	In the gazetted Plan, the Individual Daily Extraction Limit (IDEL) calculations were amended. However, as IDELs had not been implemented at the time the Plan took effect in 2012 (and are still not implemented in the Barwon-Darling), it is difficult to assess if the previous calculations (or the proposed amendments) would have been more appropriate. Average pump capacity and pumping rates were used for the assessment due to comments made during public exhibition period at the time that IDELs based on share component were insufficient (and what the potential impact might be).
-	63(3)	The clause for conversion of licences to a new category in the gazetted Plan added specific restrictions for 'concessional conversions'.[526] This limited the extent of conversions in specific river sections. It would be beneficial to source the original consultation documents that explain why C Class licence conversions were included (e.g. compared to information in other available sources). A five-year period for concessional conversions was introduced as it is consistent with the 2000 Cap management strategy.
65(2)	67 (1 and 2)	The assignment of water allocations dealings broadened the ability for temporary trade in the Plan.[527] A brief assessment of the NSW water register reveals that there have been temporary trades under the gazetted Plan.
67 (4&5)	69 (1, 2 and 3)	Changes were made to the nomination of water supply works dealings which relate to the amendment to water supply work and specific C Class licences in the Plan. It is difficult to fully assess the impact of this change without access to additional information.

525 Further information is available at http://www.water.nsw.gov.au/__data/assets/pdf_file/0006/549024/wsp_barwon_darling_background_document.pdf

526 Noting that concessional conversions were available before the Plan was gazetted in 2012.

527 The objective was to meet the commitment made under the *National Water Initiative*.

2011 draft Plan	2012 gazetted Plan	Comments
70(1)(b)	72(1)(b)	The amendment reflects the progress of the NSW metering policy.
	77	Clause 77 allows for amendment to the long-term average annual extraction limits for the Upper Darling Alluvial Groundwater and increases in the sum of available water determination for unregulated river access licences.
75	78 (a and b)	Clause 75 was significantly rewritten to limit amendments to existing flow classes if it adversely impacted the Brewarrina fish traps.
76		Clause 76 on water supply works approval restriction was removed.

Appendix D: Plan objectives

Commission's comments on achievement of each Plan objective and categorisation according the *Water Management Act*'s outcomes

Plan objective	Outcome	Extent to which it has been met	DPIE-Water's revised Plan objectives
The Plan's vision is to provide healthy and enhanced water dependant ecosystems and equitable water sharing among users in these water sources.			
(a) protect, preserve, maintain and enhance the important river flow dependent and high priority groundwater dependent ecosystems of these water sources	Environmental	Limited	2.10(1) The broad environmental objective of this Plan is to protect and, where possible, enhance the ecological condition of these water sources and their water dependent ecosystems (instream, riparian and floodplain ecosystems). (2) The targeted environmental objectives of this Plan is to protect and, where possible, enhance the following over the term of this Plan: (a) the recorded distribution or extent of target ecological populations including native fish and native vegetation, (b) the population structure of target ecological populations including native fish and native vegetation over the term of this Plan, (c) the connectivity between and within water sources, including to support downstream processes including priority carbon and nutrient pathways and priority fish passages during the term of this Plan, (d) water quality to support water dependent ecosystems and ecosystem functions, and (e) to support water dependent ecosystems and ecosystem functions in this water source by protecting connectivity with environmental watering events that have originated in upstream connected water sources
(b) protect, preserve, maintain and enhance the Aboriginal, cultural and heritage values of these water sources	Social	Limited	2.12.(1) The broad Aboriginal cultural objective of this Plan is to maintain or enhance the spiritual, social, customary and economic values and uses of water by Aboriginal people (2) The targeted Aboriginal cultural objectives of this Plan are as follows: (a) to maintain or improve access to water for holders of native title (b) to maintain or improve access to water for Aboriginal cultural use, including fishing. (c) to protect identified water-dependent cultural areas, including culturally importance riparian vegetation communities
(c) protect basic landholder rights	Social	Limited	2.12A.(2) The targeted social and cultural objectives of this Plan are to maintain or improve:

Plan objective	Outcome	Extent to which it has been met	DPIE-Water's revised Plan objectives
			(a) access to water for basic human needs, town water supply and domestic and stock purposes
(d) manage these water sources to ensure equitable sharing between users (Note) … Socio-economic impacts were a major consideration in the development of the rules in this Plan and are reflected in the outcome to manage these water sources to ensure equitable sharing between users.	Social	Limited	2.12A.(1) The broad social and cultural objective of this Plan is to maintain or enhance the efficient and sustainable access to water to support critical human needs, and water dependant values, culture, heritage and recreational uses. 2.12A.(2) The targeted social and cultural objectives of this Plan are to maintain or improve: (b) access to water for water dependent cultural, heritage and recreational uses, including recreational fishing
(e) provide opportunities for enhanced market based trading of access licences and water allocations within environmental and system constraints (f) provide water allocation account management rules which allow sufficient flexibility in water use	Economic	Met	2.11.(1) The broad economic objective of this Plan is to maintain or enhance an efficient and sustainable access to water in these water sources to optimise economic benefits for irrigation, water dependent industries and local economies. 2.11.(2) The targeted economic objectives of this Plan are as follows: (a) to provide water trading opportunities for agriculture, business and landholders, (b) to maintain or enhance access to water for agriculture, business and landholders, (c) to contribute to water quality for agriculture, business and landholders.
(g) contribute to the maintenance of water quality	Environmental and social	Limited	2.10.(2) The targeted environmental objectives of this Plan is to protect and, where possible, enhance the following over the term of this Plan:

Plan objective	Outcome	Extent to which it has been met	DPIE-Water's revised Plan objectives
			(d) water quality to support water dependent ecosystems and ecosystem functions (Note: Water quality target values for these water sources are defined in the *Water quality management plan for the Barwon-Darling water resource plan area (SW12)*). 2.12.(2) The targeted Aboriginal cultural objectives of this Plan are as follows: (d) to maintain or enhance water quality to ensure suitability of water for Aboriginal cultural use 2.12A.(2) The targeted social and cultural objectives of this Plan are to maintain or improve: (c) water quality for basic human needs, town water supply, domestic and stock purposes and water dependent cultural, heritage and recreational uses, including recreational fishing
(h) provide recognition of the connectivity between surface water and groundwater	Environmental	Met	2.10.(2)(c) – protect and where possible enhance the connectivity between and within water sources, including to support downstream processes including priority carbon and nutrient pathways and priority fish passages during the term of this Plan (e) to support water dependent ecosystems and ecosystem functions in this water source by protecting connectivity with environmental watering events that have originated in upstream connected water sources
(i) adaptively manage these water sources	All	Limited	None identified
(j) contribute to the "environmental and other public benefit outcomes"** identified under the "Water Access Entitlements and Planning Framework" in the *Intergovernmental Agreement on a National Water Initiative (2004)*	Environmental	Limited	None identified

Appendix E: Social and cultural objectives, measures and targets

Water quality objectives describe the community's uses for water

During NSW Government consultation on the water quality objectives,[528] the community identified a wide range of objectives that it wished to protect. Most people valued the river for recreation, with some specifying swimming and fishing. Most people used and valued the river for drinking or domestic use, while 64 percent referred to irrigation and associated economic values.[529]

Between Bourke and Menindee, the 1998 community wanted higher quality water; they thought the water was of much poorer quality than in the 1960s, that it caused health problems, and that town water was sometimes unfit to drink.[530] There was community support for greater protection of low flows, and concern that the government had insufficient knowledge of the rivers. There were several requests for further community involvement, education and consultation.[531]

Environmental flow rules were recommended for the Barwon-Darling by the Barwon-Darling River Management Committee and adopted and implemented in late 2000. **Figure E1** summarises the objectives identified for the Barwon-Darling and Far Western catchments.

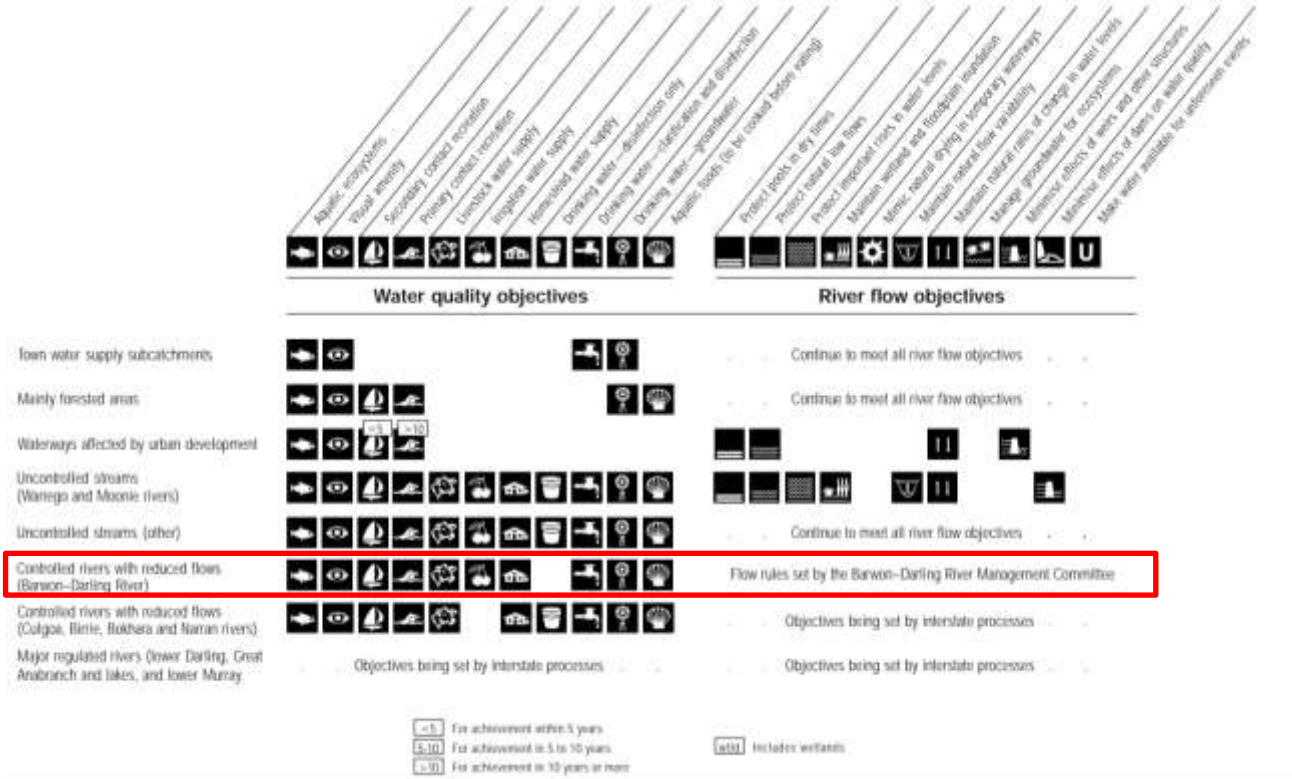

Figure E1: Water quality and river flow objectives, with the relevant objectives highlighted[532]

528 In 1998 the NSW Government held community meetings in Bourke, Wilcannia and Walgett to understand the community's uses, concerns and recommendations for river management.

529 NSW OEH (2006), *NSW Water Quality and River Flow Objectives: Barwon-Darling and Far Western Community comment on the objectives*, available at https://www.environment.nsw.gov.au/ieo/FarWest/report-01.htm.

530 Ibid.

531 Ibid.

532 NSW OEH (2006), *Catchment at a glance – Barwon-Darling and Far Western Catchments*, available at https://www.environment.nsw.gov.au/ieo/FarWest/caag.pdf.

Table E1 summarises these objectives as currently defined in a draft water quality management plan for the *Barwon-Darling Water Resource Plan*. It highlights how water quality is integral to both social and ecological communities.

Table E1: *Basin Plan* water quality objectives for the Barwon-Darling[533] (note: does not include previously identified objectives for livestock water supply, visual amenity or cooked aquatic foods[534])

	Barwon-Darling water quality objective
	Maintain water quality to protect First Nations people's water dependent values and uses Ensure water quality is sufficient to maintain the spiritual, social, customary and economic values and uses of water by First Nations people
	Maintain water quality to protect and restore water dependent ecosystems Ensure water quality is sufficient to: ▪ protect and restore ecosystems and ecosystem functions ▪ ensure ecosystems are resilient to climate change ▪ maintain the ecological character of Ramsar wetlands.
	Maintain the quality of raw surface water for treatment for human consumption Minimise the risk that raw water taken for human consumption results in adverse human health effects. Maintain 'good' palatability drinking water as defined in the *Australian Drinking Water Guidelines* with no offensive odour for consumers.
	Maintain the quality of surface water for irrigation use Ensure the quality of surface water, when used in line with the best irrigation and crop management practices and principles of ecologically sustainable development, does not result in crop yield loss or soil degradation. Note there are no irrigation infrastructure operators delivering services in the Plan area.
	Maintain the quality of surface water for recreational use Ensure a low risk to human health posed by water exposure through ingestion, inhalation or contact during recreation
	Maintain good levels of water quality Maintain the value of a water quality characteristic if it is better than the target value.

Social and cultural objectives should be refined further

Table E2 includes additional proposed social and cultural objectives, measures and targets.

533 NSW DoI-Water (2019), *Draft Water quality management plan for the Barwon-Darling Watercourse SW12*, working draft provided to the Commission for information.

534 OEH (2006), *Catchment at a glance – Barwon-Darling and Far Western Catchments*, available at https://www.environment.nsw.gov.au/ieo/FarWest/caag.pdf.

Table E2: Proposed social and cultural objectives, measures and targets

Proposed objectives	Proposed strategies	Proposed measures	Targets
Social – example additional provisions			
Prioritise basic landholder rights and provide greater equity between stakeholders in water allocations. Maintain and enhance water quality for basic human needs, town water supply, domestic and stock purposes, and water dependent cultural, heritage and recreational uses, including recreational fishing. Protect, maintain and enhance community values and uses of water.	Identify key social values, objectives and outcomes for the Plan area in consultation with community stakeholders. Revisit and include NSW water quality and river flow objectives during community consultation to ensure they are up to date. Derive indicators for basic landholder rights from the 'reasonable use' benchmarks set out in the relevant government policy currently being drafted.	The extent to which community stakeholders are satisfied that the Plan is meeting basic landholder rights (as stated in the Plan). The extent to which community stakeholders are satisfied that the Plan is achieving social objectives (as stated in the Plan). The extent to which community stakeholders are satisfied that the Plan is supporting broader social, economic and community well-being outcomes. The extent to which community stakeholders are satisfied that the Plan is enabling consultation and involvement in water planning and practices. Self-reported health and well-being of community stakeholders, including psychological distress, positive wellbeing, self-esteem, sense of support. Changes, or trends in the recorded values of water quality measurement including salinity, harmful algal blooms, total nitrogen and phosphorous, pH, water temperature and dissolved oxygen. Changes, or trends in community perceptions of water quality and availability.	Identification of social values and objectives, performance indicators by 2020. Increase in community stakeholders satisfied with the Plan achievement of native title and cultural outcomes 2020-22. Increase in community stakeholders satisfied with the Plan's support of social, well-being, and economic outcomes 2020-22. Improvements in key water quality measurements 2020-22. Increase in perceptions of water quality and availability 2020-22.

Proposed objectives	Proposed strategies	Proposed measures	Targets
Aboriginal – example additional provisions			
Ensure consistent and coordinated representation of traditional owners in water planning and practices. Provide traditional owners with more opportunities for the ownership and use of water entitlements to continue their role as custodians and support economic development. Maintain or enhance water quality to ensure suitability of water for Aboriginal cultural uses and well-being. Protect, maintain and enhance cultural practices by waterways.	Identify and map native title rights in line with determinations, Indigenous Land Use Agreements, and relevant provisions of Commonwealth and State legislation. Adopt established cultural flow guidelines to identify cultural values and objectives, performance indicators and cultural flow allocations. Include timeframe and process for amendment of the Plan following the granting of any future native title claims. Include licences or provisions that support economic development and opportunities.	The extent to which Aboriginal stakeholders are satisfied that the Plan is achieving: native title rights and Aboriginal cultural objectives (as stated in the Plan). The extent to which Aboriginal stakeholders are satisfied that the Plan is supporting: Aboriginal social and well-being and economic development outcomes. The extent to which Aboriginal stakeholders are satisfied that the Plan is enabling consultation, partnerships, and the integration of Traditional knowledge in water planning and practices. The extent to which Aboriginal stakeholders feel they have the capability to understand and participate in water planning and practices. Self-reported health and well-being of Aboriginal community members in the area, including psychological distress, positive wellbeing, self-esteem, sense of support. Changes, or trends in the recorded values of water quality measurement including salinity, harmful algal blooms, total nitrogen and phosphorous, pH, water temperature and dissolved oxygen. Changes, or trends in Aboriginal stakeholder perceptions of water quality, access and availability.	Identification of cultural values and objectives, performance indicators by 2020. Final cultural flow allocations underway by 2020. Native title rights of the Barkandji traditional owners are recognised and interim flows allocated by 2020. Timeframe is set for amendment of Plan following future native title claims by 2020. Increase in Aboriginal stakeholders satisfied with the Plan achievement of native title and cultural outcomes 2020-2022. Increase in Aboriginal stakeholders satisfied with the Plan's support of Aboriginal health and well-being, and economic outcomes 2020-2022. Improvements in key water quality measurements 2020-2022. Increase in Aboriginal perceptions of water quality, access and availability 2020-2022.

Appendix F: Summary of relevant native title rights

Native title rights are legislated at a Commonwealth level but are integrated in relevant state legislation and policies. The native title rights and interests under s47A of the *Native Title Act 1993 (Commonwealth) (NTA)* comprise the right of possession, occupation, use and enjoyment to the exclusion of all others. The non-exclusive rights and interests include an unlimited right to take and use the natural resources for domestic, social and cultural purposes.[535] The *Native Title Act 1993 (Commonwealth)* protects activities such as ceremonies, the preparation of food or bush medicines, the manufacture of artefacts, and the teaching of traditional laws, customs and practices such as fishing.[536]

The *Native Title Act 1993 (Commonwealth)* also makes specific provisions in relation to native title rights to water by:

- confirming Crown or government rights to the use, control and regulation or management of water;
- validating any water management legislation that was enacted between 31 October 1975 and 1 July 1993 (the period between the introduction of the *Racial Discrimination Act 1975* (*Commonwealth*) and the *Native Title Act 1993 (Commonwealth)*;
- confirming 'existing' public access to and enjoyment of waterways, beds and banks or foreshores of waterways, coastal waters and beaches where native title exists;
- preserving certain native title non-commercial activities in relation to water from some types of government regulation in Section 211 (meaning no licences are required); and
- providing a future act regime to regulate how government and third parties can affect or impact native title rights to water including procedural and compensation rights in Section 24HA.[537]

The law of native title has not, to date, recognised exclusive rights in relation to water for native title parties. The rights most commonly recognised are non-exclusive (in that native title holders cannot stop other people from exercising their rights and interests over the same water) and cover traditional uses only. Both the *Native Title Act 1993 (Commonwealth)* and the Act clarify that no water entitlement is needed to satisfy water-dependent native title rights.

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535 Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS) (2018), *Barkandji Traditional Owners #8 (Part B) v Attorney-General of New South Wales [2017] FCA 971*, available at: https://aiatsis.gov.au/ntpd-resource/29171.

536 Hartwig, L.D., Jackson, S. and Osborne, N. (2018), *Recognition of Barkandji Water Rights in Australian Settler-Colonial Water Regimes*. Resources, 7.

537 Under this provision, registered native title claimants and native title holders have the right to be notified prior to the grant of any water management or regulation related lease, licence, permit or authority that might affect their land or waters. This includes providing notice to the representative native title body corporate, otherwise known as the 'prescribed body corporate', which holds and manages native title, or to NTSCORP in its role as the representative body for NSW. Native title holders and claimants are given the opportunity to comment on, though not object to or prevent, any proposed actions. However, this does not apply in the making, amendment or repeal of water management or regulation legislation (Hartwig, L.D., Jackson, S. and Osborne, N. (2018), *Recognition of Barkandji Water Rights in Australian Settler-Colonial Water Regimes*. Resources, 7). Native title holders also have the right to compensation where these acts affect native title. Compensation may take the form of financial payments, include opportunities for employment, training and education, or cultural site protection, rehabilitation or monitoring. However, payment of compensation is still an emerging aspect of the *Native Title Act* regime (Bartlett, R.H. (2015) *Native Title in Australia*, 3rd ed.; LexisNexis Butterworths: Chatswood, Australia).

The *National Water Initiative 2004* integrates these native title rights with an expectation that native title water rights are accounted for by all Australian state and territory water regimes. Clause 53 of the *National Water Initiative 2004* states that: 'Water planning processes will take account of the possible existence of native title rights to water. State note that Plans may need to allocate water to native title holders following recognition of native title rights'.

NSW is one of very few jurisdictions to have implemented this recognition of native title rights in its water legislation. Indeed, under Section 55 of the Act, water required to exercise native title rights are reserved as 'Basic Landholder Rights' and so are afforded the same priority as domestic and stock rights of riparian land owners or occupiers. Accounting for native title water rights as basic landholder rights notionally means that these water requirements must be met first; prior to any other consumptive water uses, even in extreme drought conditions.[538] These basic landholder rights also need to be identified and accommodated in water sharing plans so that water needs can be protected from other consumptive uses.[539]

Indigenous Land Use Agreements also offer a potential way of leveraging water-related native title rights. In NSW, they are generally negotiated with the registered native title body corporate, which holds and manages native title on behalf of the group. NTSCorp represents many of the native title groups in NSW as the registered native title body corporate. Once authorised by the native title holders, the agreement is registered with the National Native Title Tribunal. While Indigenous Land Use Agreements present a reasonable means of prescribing native title rights to water, assessing their effectiveness is difficult as they are generally reached in-confidence.[540]

538 Tan, P.L. and Jackson, S. (2013), *Impossible dreaming – Does Australia's water law and policy fulfil Indigenous aspirations?* Environment and Planning Law Journal, 30: 132-149; and Duff, N. (2017), *Fluid Mechanics: The Practical Use of Native Title for Freshwater Outcomes*. AIATSIS Research Publications, Canberra.

539 NSW Office of Water (2012), *Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources Background Document*, NSW Government.

540 Hartwig, L.D., Jackson, S. and Osborne, N. (2018), *Recognition of Barkandji Water Rights in Australian Settler-Colonial Water Regimes*. Resources, 7; and O'Bryan, K. (2016) *More Aqua Nullius: The Traditional Owner Settlement Act 2010 (Vic) and the neglect of Indigenous rights to manage inland water resources*. Melbourne University Law Review, 40: 547–593.