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OF CONCERNED SCIENTISTS

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Are Murray-Darling Basin rivers getting the water they need to stay healthy?

The Commonwealth Water Act 2007 requires governments to ensure water extraction does not compromise ecosystems that depend on freshwater flows. The Wentworth Group has assessed the extent to which the Murray-Darling Basin's rivers have received the flows they need to stay healthy.

Environmental flow requirements represent the minimum flows needed at particular places and times to sustain important environmental assets and functions. They were defined by Basin governments as part of their commitment to the Murray–Darling Basin Plan, based on best available scientific evidence. Achieving these flow requirements are a pre-requisite for the health of the Basin's river systems.

The Wentworth Group evaluated environmental water requirements against actual river flows measured at stream gauges in rivers. We assessed achievement of 72 science-based environmental flow requirements at 23 strategically located stream gauges spread across the Basin over a period of 43 years from 1979 to 2022.

Our study found that less than a third (31%) of the Basin's environmental water requirements assessed were achieved in the past 43 years. In the decade since the Basin Plan 2012 was enacted, we found only about a quarter (26%) of all environmental flow requirements assessed were achieved, demonstrating an overall declining trend.

Against the backdrop of overall decline, there were increases in the frequency of small freshes at many sites in the past decade, which likely reflected an emerging signal of some flow recovery under the Basin Plan.

However, a more detailed examination of results over the decades showed a declining trend with respect to achievement of environmental water requirements at most locations. Only two of the eight Ramsar wetlands of International Importance (Gwydir Wetlands, Narran Lake) received the overbank flows required to stay healthy.

While these figures do not tell us about the overall health of the Basin, they indicate that most freshwater species and ecosystems we assessed are not getting the flows that the science said was needed.

The Commonwealth Water Act 2007 requires an environmentally sustainable level of water take in the Basin, but this is clearly not occurring. The consequences of this are evident in the poor condition of many species and ecosystems across the Basin.

Our results suggest progress under the Basin Plan has not yet been sufficient to overcome the impacts of overextraction, water mismanagement and the effects of climate and other environmental changes diminishing water in our rivers and contributing to widespread salinity, blue-green algae blooms, decline of freshwater species and degradation of floodplain ecosystems.

There is now more urgency than ever to recover water under the Basin Plan, and address impediments to the delivery of environmental water so that flows can be periodically released in sufficient volumes to inundate floodplain wetlands. These actions would improve achievement of environmental water requirements.

Our study, submitted to the journal Marine and Freshwater Research,[1] provides evidence of the need for flow requirements to be at the centre of water planning and management, including re-evaluating long term extraction limits and management rules which prioritise the flows needed for a healthy river.

With changes in climate and declining water availability, it may not be possible to achieve every water requirement in the Basin. Governments need to be transparent about what we are trying to achieve, what we are failing to protect, and how we manage the consequences.

This paper details the study's methodology and results, as well as laying out a practical and science-based path forward to reverse the current trajectory of decline.

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A Basin-wide assessment of environmental flow requirements

Thousands of environmental flow requirements across rivers in the Murray-Darling Basin were defined by Basin governments based on best available science, as part of their commitment to the Basin Plan. Flow requirements are achieved when minimum flow rates and volumes are met at a particular site, typically a stream gauge, over a particular timing window, often a season (e.g. between July and December) or duration, for a specified recurrence frequency (e.g. 2 out of every 5 years). These flows represent the best available knowledge of environmental requirements, such as the periodic overbank watering needed to keep red gum forests healthy, or a rising river level in spring that triggers breeding of particular native fish.

We evaluated 72 environmental flow requirements at 23 representative sites on rivers across the Murray-Darling Basin. They were defined for four ecologically important flow categories: small fresh, large fresh, bankfull, and overbank flow (Figure 1). Governments also identified three other categories: cease to flow, very low flow, baseflow and moderate/major overbank environmental water requirements. We did not assess these because of their known modelling and measurement difficulties.

Our assessment was based on all water flowing in a river, past its stream gauge, not only environmental water. This included unregulated and regulated flows, environmental water held under entitlement by Basin governments, water set aside through water management rules, water destined for consumptive take and operational releases. All this water is important for river health.

Our study spanned a 43.5-year period from 1 July 1979 to 31 December 2022. This period included five La Niña events, where rainfall and river discharge were higher than average, and eight El Niño events including the 2001-2009 Millennium Drought, one of the severest droughts on record, and the 2017-2019 period where inflows were the lowest on record.

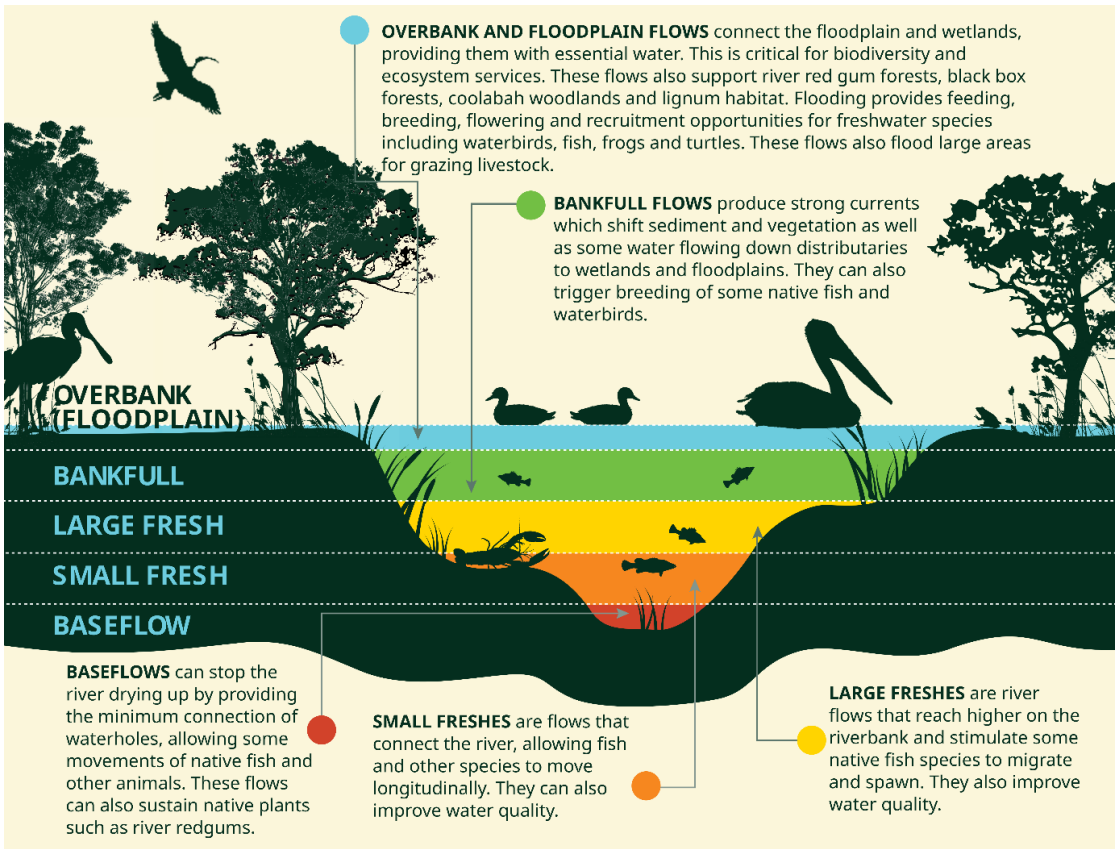

Figure 1. Flow categories linked to scientifically known environmental benefits, for which we used a subset (small fresh, large fresh, bankfull and overbank) to assess achievement of environmental water requirements at different sites on rivers in the Murray-Darling Basin.

The Murray-Darling Basin is not receiving the flows it needs to stay healthy

In our paper recently submitted to the journal Marine and Freshwater Research, we found only about a third (31%) of the Basin's environmental water requirements were achieved in the past 43 years (Figure 2). Within this period, we found that only 26% of the water requirements we examined have been met since the Basin Plan was enacted a decade ago (2012-2022). These are conservative estimates, probably overstating the level of achievement.

Water requirements were more likely be met in the tributaries of the Darling-Baaka River in the northern Basin, with sites further downstream and along the River Murray showing lower levels of achievement (Figure 2). This probably reflects later water resource development in the Darling-Baaka River catchment.

There were some improvements in achievement of environmental flow requirements during the Basin Plan years. In particular, we observed increases in small freshes or flows in the southern Basin, where environmental water was delivered. These findings are consistent with other studies which demonstrated the benefits of water delivered to ecosystems: these include protecting freshwater species and maintaining core floodplain wetland habitat inundated by environmental flows.[2-5]

However, a more detailed examination of results over the decades showed a declining trend with respect to achievement of environmental water requirements at most locations (Figure 3). This trend includes growing water resource development before the Basin Plan, making it increasingly difficult to meet the environmental water requirements.

These findings suggest that the Basin Plan may be slowing the long-term decline of flow requirements in the rivers in the Murray-Darling Basin, rather than halting or reversing the decline.

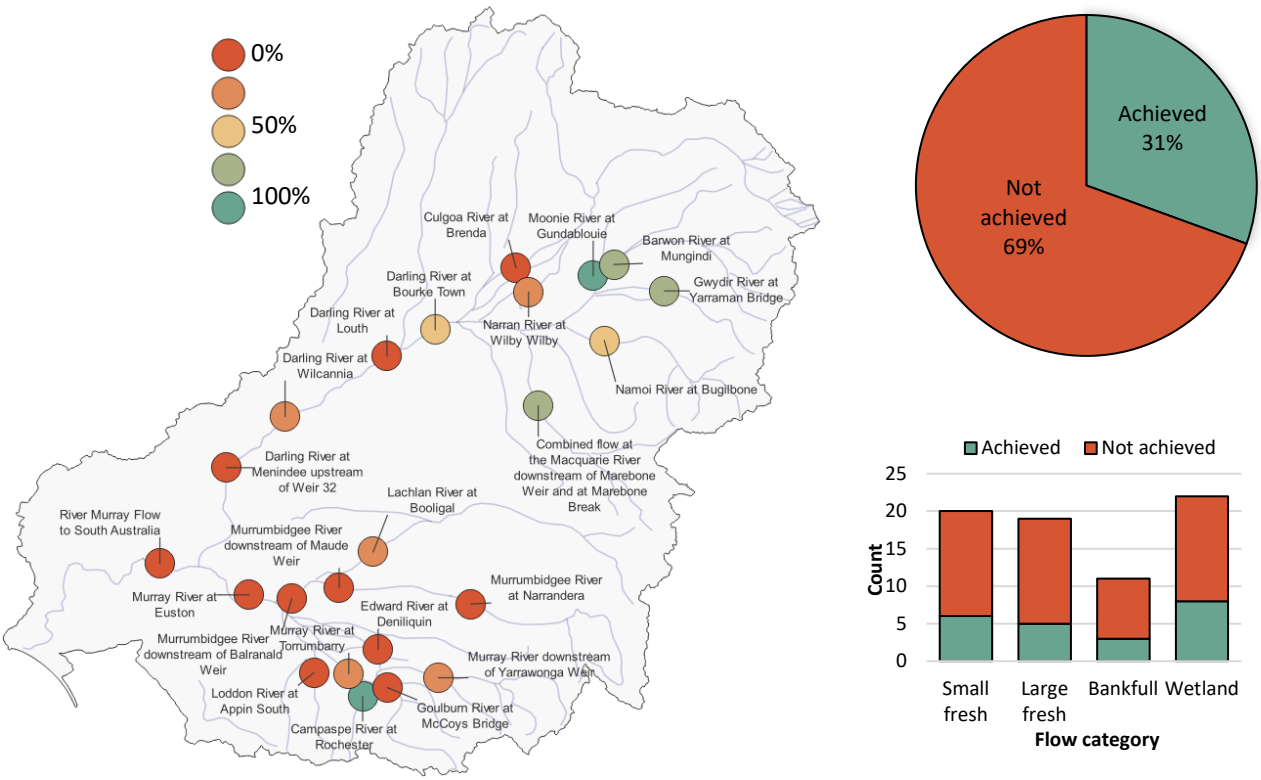

Figure 2. Left: Map showing the rivers in the Murray–Darling Basin and their flow gauges where the environmental flow requirements were assessed and the percent of environmental water requirements achieved at each river gauge site, across flow categories (Figure 1), based on analyses of actual flow data, 1979-2022 (43.5 years). Top right: percentage achievement of environmental water requirements assessed. Bottom right: environmental water requirements achieved and not achieved in relation to the four flow categories, analysed using actual flow data (1979-2022).

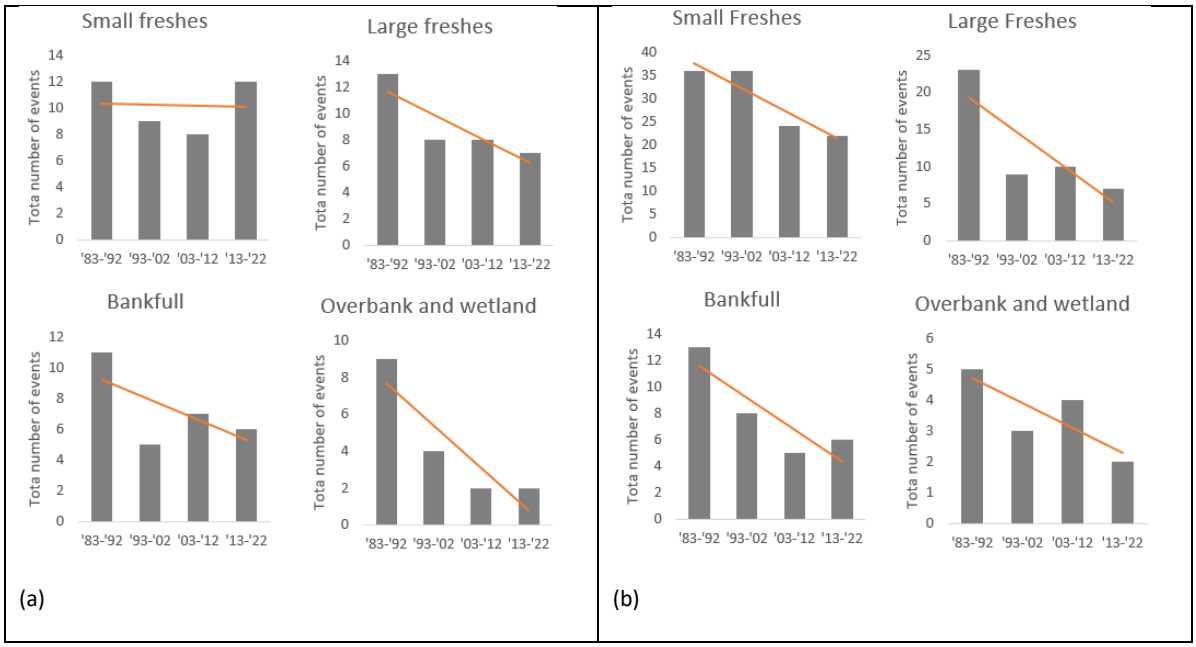

Figure 3. Decadal trends in total number of flow events that met environmental water requirements within flow categories (Figure 1) for (a) River Murray downstream at Euston (414203) in the southern basin and (b) Darling River at Bourke (425003) in the northern basin. Note, the final decade (2013-2022) was 9.5 years and not 10 years.

Without the required flows, the river system is under threat

The failure to achieve environmental water requirements across an extended period of time is reflected in evidence of poor species and ecosystem condition across the Murray-Darling Basin.

In the past decade alone, there have major fish kills in the Darling-Baaka River, toxic algal (cyanobacteria) blooms across the Basin, and degradation of river red gum and black box forests.

The poor condition of flow-dependent ecosystems continues to be documented in monitoring and evaluation assessments including the Sustainable Rivers Audits, the 2020 Murray–Daring Basin Plan evaluation and the 2021 State of the Environment Report. [6-9]

Without sufficient flows, there are serious and irreversible consequences for the long-term ecological health of the Basin, the quality of water, and the wellbeing of communities who depend on healthy rivers, including the 40 Aboriginal Nations that call the Basin home.

Four key factors limiting achievement of environmental flow requirements

While our analysis did not specifically evaluate the factors limiting achievement, we consider the possible reasons environmental flow requirements may not have been achieved. This is due to a combination of the following four factors:

1. **Insufficient long-term volumes of water for the environment.** Modelled data showed that the long-term average volumes of water available in the river system underpins achievement of flow requirements: the more water available in the system, the greater the opportunities for environmental water requirements to be met. So far, only about 2,100 GL/y of water has been recovered for the environment under the Basin Plan. This volume falls well short of what the scientific evidence demonstrates is the minimum volume required for a healthy river,[10] and is only two thirds of the 3,200 GL/y Basin Plan target.

2. **Physical and management constraints** (e.g. private property, roads, bridges and low-level crossings along floodplain corridors, operational rules) restrict the ability of river operators to release flows from storages in quantities sufficient to achieve minor overbank flooding and reconnect rivers to their floodplain ecosystems.

3. **Environmental water requirements only guide river management, they are not codified in water plans:** Environmental water requirements have been recently re-assessed as part of the Basin Plan's water resource planning process but remain inadequately specified and linked to water management decisions, codified in rules and practice of water resource plans. Water management rules defined in upstream sub-Basin water plans are often not sufficient to protect water needed to meet downstream flow requirements.

4. **Failure to account for and address impacts of climate change**: The water recovery targets mandated under the Basin Plan are based on the historic climate record from 1896 to 2009 and as such do not account for the most recent severe drought on record or future climate change. The Plan does not include sufficient measures to directly adapt to climate change, and water management rules are not always capable of protecting key river flow events (such as the first flow after a drought).

As a consequence of these failures, environmental water managers are limited in their ability to achieve additional flow requirements because of insufficient water volumes, rules which prevent required flows from reaching downstream valleys and constraints to the delivery of environmental water across floodplain wetlands.

Delivering the Basin Plan is a crucial step forward, but not enough

Recovery of water and constraints relaxation under the Basin Plan are now more urgent than ever – these actions are likely to improve the ability to achieve environmental water requirements.

Yet even with a 3,200 GL/y Basin Plan recovered, flows are not likely to be sufficient, nor management rules adequate, to substantially increase the achievement of environmental flow requirements.

The Guide to the Basin Plan determined environmental water recovery was between 3,856 GL/y (high risk of not achieving environmental outcomes) and 6,983 GL/y (low risk of not achieving environmental outcomes) to reinstate an environmentally sustainable level of take, as required under the Water Act.[10] This was later revised down in 2012 by the Murray-Darling Basin Authority, with the Commonwealth Government legislating a recovery volume of 2,750 GL/y plus 450 GL/y for 'enhanced environmental outcomes', further reduced by 70 GL/y after the northern Basin review.

A CSIRO review of the 2,800 GL/y water recovery volume in 2012 concluded that this was "not consistent with the currently stated environmental targets" and "the modelling indicates that the proposed [Sustainable Diversion Limits] would be highly unlikely to meet the specified ecological targets even in the absence of future climate change. Operational constraints are a key reason for this, but many achievable targets are also not met in the modelling".[11] The Sustainable Diversion Limits (SDLs), legislated in the Basin Plan, reflect inadequacies in the ecologically sustainable level of take, and the lack of achievement of more than half of the environmental water requirements we assessed (Figure 2).

Our assessment of modelled outputs showed that the Basin Plan scenario (2,750 GL/y SDL adjustment, less 70 GL/y in the northern Basin) would achieve less than half (46%) of the Basin's environmental water requirements, based on our analysis of the 72 flow requirements and model outputs provided by the Murray-Darling Basin Authority (Table 1). While this 114-year modelled assessment is not directly comparable to the period of our assessment, the reality is we are not yet achieving the Baseline (2009 levels of development) flow requirements that were assumed for the purpose of Basin Planning over the long-term.

Table 1. Modelled and actual (observed) flow (our analyses) comparisons for achieving the environmental water requirements across 22 sites on rivers in the Murray-Darling Basin and 71[a] environmental flow requirements assessed: modelled without development from 1895-2009; modelled baseline (i.e. pre-Basin Plan) from 1895-2009; modelled Basin Plan implementation from 1895-2009 (2,750 GL/y SDL adjustment scenario less 70GL/y in the Northern Basin); and actual (observed) data over the two time periods of our analyses.

	Modelled scenarios			Actual (observed) data	
	Without development (1895-2009)	Baseline (1895-2009)	Basin Plan 2750GL/y without 70GL/y (1895-2009)	43.5 years (1/7/1979-31/12/2022)	~10 Years 22/11/2012-31/12/2022 (~2100GL recovery)
Achieved	72	25	33	22	19
Not achieved	0	46	39	50	53
% achieved	100%	35%	46%	31%	26%

[a]Loddon River at Appin South gauge (407205A) was not assessed in the baseline scenario, as the modelled data was in monthly format and daily was required, therefore only 71 environmental flow were assessed in the baseline scenario.

Flow requirements need to be at the heart of water management if we are to reverse the trajectory of decline

A step-change is needed to reverse the trajectory of decline.

Flow requirements are the fundamental metric for determining whether the Basin Plan is satisfying ecosystem needs and achieving an ecologically sustainable level of take. Importantly, they provide near real-time evidence based on actual flow data for which rivers and wetlands in the Basin are receiving the flows they require, which rivers are not and where management changes are needed.

Despite this, flow requirements are not currently used as a reporting tool. They need to be embedded into all water management decisions, and used adaptively to inform water planning, management, access, use, monitoring and evaluation. Without them, water management will continue to focus on one side of the ledger - what is extracted from the river - with little regard for what is left over and whether it is sufficient to maintain a healthy river system.

With changes in climate and declining water availability, it may not be possible to achieve every water requirement in the Basin. Governments need to be transparent about what we are trying to achieve, what we are failing to protect, and how we manage the consequences.

Australia now has access to the best available information on the flows required to achieve an environmentally sustainable level of take. Communities, experts and managers also have the knowledge and practical expertise to implement them. Embedding these flow requirements into management is crucial if we are to safeguard the health of the Murray-Darling Basin in a variable and changing climate.

Why are the Basin's rivers worth protecting?

The Murray-Darling Basin is culturally, environmentally, and socially significant; it has been home to more than 40 Aboriginal Nations for more than 50,000 years, contains globally significant river, wetland and floodplain ecosystems and their biodiversity, and is now home to more than 2.3 million people, with a further 1.3 million people directly dependent on its water resources.

A healthy Murray-Darling Basin is vital for the wellbeing and livelihoods of these people, and of great importance to the whole of Australia. A healthy Murray-Darling Basin means:

- Clean water for drinking and for growing food and fibre, with flows that flush salt, sediment and excess nutrients out of the Basin;

- Economic benefits from recreation, fishing, tourism, agriculture and education;
- Cultural and economic benefits for Aboriginal Nations;
- Reduced risk of algal blooms, hypoxic blackwater events, acidification, salinisation and erosion, which pose significant health risks and impact farming, fishing and tourism;
- Improved soil fertility and enhanced pastures in grazing landscapes as a result of the natural wetting cycles of floodplains;
- Improved water security for farmers during dry periods, improved capacity of wetlands to buffer floods and refuge for animals during droughts;
- Resilience to climate extremes with greater capacity to adapt to a changing climate in the future; and
- Habitat, food, migration pathways and breeding opportunities for native fish, waterbirds and other native wildlife that rely on water in the Basin, some of which are nationally threated and/or recognised by international agreements.

Healthy river systems are a pre-requisite for delivering all these benefits. Water is key to protecting and restoring the health of the Basin's ecosystems that provide these benefits.

A way forward

If we are to reverse the current trajectory of decline, we need to ensure that the Basin Plan secures the minimum flow volumes needed, at the right place and the right time, to protect the health of the river and its people.

The following recommendations, if implemented together, would give public confidence that flow requirements based on best available evidence are capable of being met:

1) Deliver outstanding components of the Basin Plan, including:
    a. recover 3,200 GL of environmental water or equivalent outcomes, including 450 GL agreed under the Basin Plan, and support communities through this transition.
    b. remove physical and operational constraints to allow for overbank watering of floodplain wetlands.
2) Link flow requirements to water management decisions, by:
    a. regularly re-evaluating the environmentally sustainable level of take to ensure it is capable of achieving flow requirements under projected climate scenarios.
    b. Requiring flow targets to be achieved before major upstream extractions can take place.
3) Ensure a transparent, scientifically robust evidence base for implementing flow requirements, by:
    a. publishing a dashboard showing real-time achievement of water requirements over a range of timescales, based on gauge data as well as hydrological models;
    b. fast-tracking programs to define cultural water requirements and water for essential human needs, and return water to Aboriginal Nations of the Basin to support these requirements; and
    c. accounting for both sides of the ledger (extractions and river flows) in water management and compliance by annually validating models using actual river flows and adjusting for model error.

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